Comhshaol, Oidhreacht agus Rialtas Áitiúil
Environment, Heritage and Local Government

IRELAND'S
FIFTH NATIONAL COMMUNICATION

UNDER THE

UNITED NATIONS
FRAMEWORK CONVENTION
ON CLIMATE CHANGE

EXECUTIVE SUMMARY

This report is Ireland's fifth National Communication under the United Nations Framework Convention on Climate Change (UNFCCC). Ireland ratified the Convention in April 1994 and the Kyoto Protocol in May 2002. Ireland became a Party to the Protocol when it entered into force in February 2005. The report focuses primarily on activities during the three-year period 2005-2007, and is based largely on data available up to and including 2009 – including final emissions inventory data for 2007.

The European Union has been to the forefront in promoting international cooperation to tackle climate change through mitigation efforts to control greenhouse gas emissions, and through promoting adaptation measures to counter the adverse effects of climate change that are inevitable due to historic and present emissions. Ireland is committed to meeting its greenhouse gas limitation target in the Kyoto Protocol commitment period 2008-2012 through a combination of domestic policies and measures, supplemented as necessary through use of the Protocol's flexibility mechanisms.

National Circumstances

Ireland is situated off the north-west coast of the continent of Europe. The country enjoys a relatively mild temperate oceanic climate, influenced by the relatively warm waters of the Gulf Stream and the prevailing south-westerly winds from the Atlantic. By 2006, the population of Ireland was 4.2 million, a growth of over 20% on 1991 levels. Compared with the rest of Europe, Ireland has a markedly younger population profile with a high proportion of the population concentrated in the younger age-groups - over one-third of people are aged under 25. Almost 40% of the population is concentrated in Dublin and the Eastern Region while outside this region, the State has a highly dispersed and low-density population.

The Irish economy is a small, globalised economy that experienced an unprecedented level of growth during much of the last decade. However, in common with many other economies it has experienced contraction since 2008.

Greenhouse Gas Inventory Information

The national greenhouse gas inventory is compiled by the Environmental Protection Agency (EPA) using the guidelines of the Intergovernmental Panel on Climate Change (IPCC). The inventory is compiled on an annual basis and submitted by year-end in draft form to the European Commission to facilitate EU reporting, and in final form to the Secretariat by the April 15th deadline. The 2009 National Inventory Report (NIR) which contains the inventory data in the Common Reporting Format (CRF) along with full documentation of the assumptions underpinning the inventory has been submitted to the UNFCCC secretariat for the years 1990 to 2007.

The complete inventory currently comprises a time series from 1990 to 2007 for carbon dioxide (CO_2), methane (CH_4) nitrous oxide (N_2O) and for the fluorinated or F-gases (HFCs, PFCs, and SF_6) – the year 1995 has been chosen as the base year for the fluorinated gases for obligations under the Kyoto Protocol.

In recent years, emissions have fallen from a peak of 26.9% above 1990 levels in 2001 to 25% above 1990 levels in 2007, mainly due to:

- increasing use of natural gas in the power generation sector;
- the closure of ammonia and nitric acid production plants in 2002; and,
- reduction in the size of the national livestock herd.

Total emissions of the six greenhouse gases in Ireland (excluding net CO_2 from Land Use Change and Forestry) increased steadily from 55.38 million tonnes CO_2-equivalent in 1990 to 70.65 million tonnes CO_2-equivalent in 2001 and then decreased slightly to 68.58 million tonnes CO_2-equivalent in 2003. Emissions increased again in 2004 and 2005 to 68.60 and 70.26 million tonnes respectively. In 2007 emissions decreased by 0.7 percent to 69.21 million tonnes, which is 25 percent higher than in 1990.

In 2007, the energy sector accounted for 66.7 percent of total emissions. Agriculture contributed 5.6 percent while a further 4.7 percent emanated from industrial processes and 2.8 percent was due to waste. Emissions of CO_2 accounted for 67.2 percent of the national total in 2007, with CH_4 and N_2O contributing 18.7 percent and 11.7 percent respectively. The combined emissions of HFC, PFC and SF_6 accounted for 1 percent of total emissions in 2007.

Policies and Measures

Since the Fourth National Communication was published in 2007, the policy context for the principal greenhouse gas emitting sectors has continued to evolve. A new National Climate Change Strategy was published in 2007, and this has been backed up *inter alia* by major new strategy documents in the areas of sustainable transport and energy efficiency. New policies and measures have been introduced, some of which were envisaged by the 2007 National Climate Change Strategy while others derive from measures agreed at European Union level.

National primary legislation on climate change is being developed in line with the policy document on a *Framework for a Climate Change Bill 2010* issued in December 2009. It is intended that this legislation will, *inter alia*, provide a legal basis for national emission reduction goals in the short, medium and long term. It is also intended to provide for the establishment of a national advisory body to monitor and assess Ireland's progress in addressing both mitigation and adaptation, and to provide advice to the Government in moving forward the climate change agenda.

A significant contribution to the achievement of the national greenhouse gas emission reduction target for the purposes of the Kyoto Protocol will be made by firms in the energy and industry sectors that are covered by the EU Emissions Trading Scheme (EU-ETS). Collectively these firms account for some 33% of total national greenhouse gas emissions. The EU-ETS was brought into operation on 1 January 2005 with a three-year pilot phase from 2005 to 2007. A substantive five-year trading period began in January 2008 to coincide with the compliance period under the Kyoto Protocol. The EU-ETS is the largest 'cap and trade' scheme in the world covering 27 EU States and over 10,000 industrial installations. Effective participation by over 100 Irish installations in the EU-ETS has been a policy priority since the scheme commenced in 2005.

A range of national policies and measures are targeted at reducing greenhouse gas emissions in the energy, transport, residential, commercial, industrial and agriculture and forestry sectors. These are detailed in Chapter 3.

Projections and the Total Effect of Policies and Measures

On foot of a commitment in the 2007 National Climate Change Strategy, national greenhouse gas emission projections are now published on an annual basis. The most recently published set of projections (March 2009)[1] were based on three scenarios. As is standard and required under EU Decision 280/2004/EC, 'with measures' and 'with additional measures' scenarios were created. However, at the time of publication, there was a great deal of uncertainty regarding the economic outlook as a result of the international financial crisis and GDP projections were being regularly revised. As a result, a sensitivity analysis which became known as the 'Economic Shock Analysis' was also published at this time although the granularity of results associated with the shock analysis was far less detailed than the other two scenarios. A 'without measures' scenario, which is optional under Decision 280/2004/EC was not produced at that time.

It is important to note that subsequent to the publication of the March 2009 projections that historical data for the years 1990-2007 has been restated due to changes in methodologies. In order to avoid step changes in any charts or other analysis the inventory data as at the date of publication of the projections are used in Chapter 4.

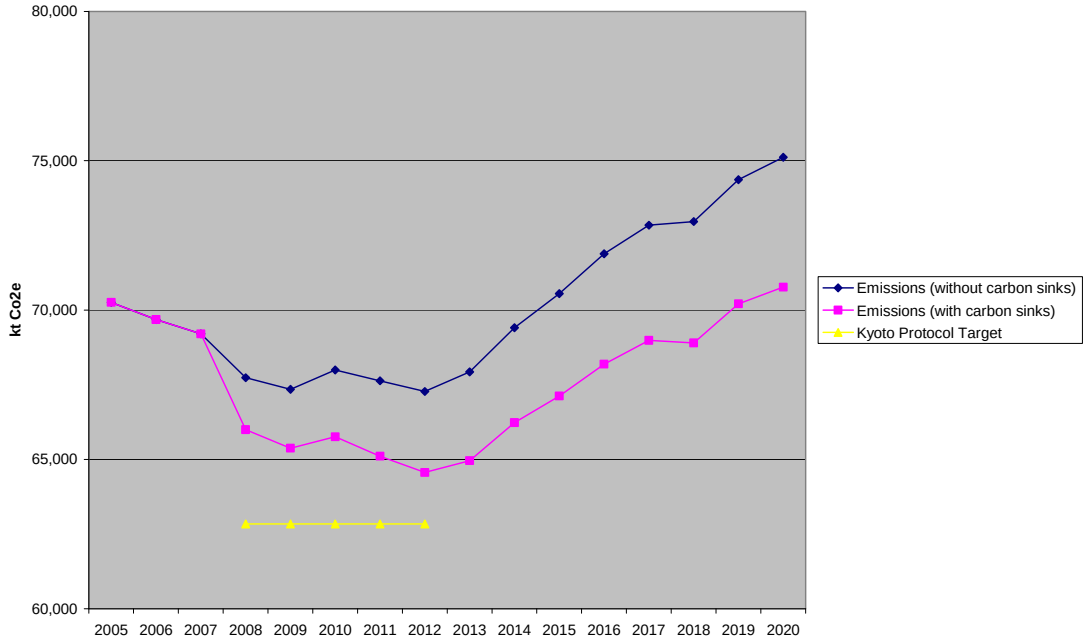
Overall emissions are projected to dip in the years 2008-2012 before reverting to an upward growth trend from 2013 onwards. This trend is somewhat in line with expectations for renewed economic growth. At just under 27% of total national emissions, the agriculture sector accounted for the largest single source of greenhouse gas emissions in 2007. Notwithstanding the fact that its share of national emissions is expected to fall to around 24% by 2020, the sector will remain the largest single source over the next decade.

Apart from a small volume of non-CO_2 emissions from the energy sector, emissions from waste will remain the smallest single source of greenhouse gas emissions. Its contribution is projected to remain broadly stable at around 3% of total emissions out to 2020. The projections for the waste sector were most impacted by the methodological changes mentioned earlier in this summary.

A comprehensive overview of national emissions for the period 1990 to 2020 is provided in figure 4.3 and Table 4.8, both in Chapter 4.

[1] http://www.epa.ie/whatwedo/climate/emissionsinventoriesandprojections/nationalemissionsprojections/

GHG Emissions Projections 2005-2020 - 'With Measures' Scenario



Vulnerability Assessment, Climate Change Impacts and Adaptation Measures

The Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (IPCC, 2007) represents the most authoritative international scientific assessment of climate change produced to date. Changes in Ireland's climate during the last century are in line with global and regional trends identified in the AR4. These changes are projected to continue and increase over the coming decades and to continue at least to the end of this century. Such changes will result in a range of impacts that are likely to increase vulnerabilities and require adaptation measures.

Research is the primary source of information on climate change impacts for Ireland. The Environmental Protection Agency's Climate Change Research Programme (CCRP) aims to advance understanding of a range of climate change issues and to provide information to support action to address climate change. Climate change impacts and adaptation is a key thematic area of the CCRP. The objective is to provide information on future climate impacts and vulnerability in order to support actions on adaptation and risk management.

An updated analysis of climate change indicators was produced by McElwain and Sweeney in 2007[2]. The report provides a detailed analysis of climate change signals from meteorological data.

Key findings include:

- Mean annual temperature records closely resemble global trends, with warming evident in 2 periods, 1910 to the mid-1940s, and 1980 to 2004. The warming in the latter period occurred at a much greater rate than the global temperature increase.

[2] Key Meteorological Indicators of Climates Change in Ireland, ERC Report series No. 6, mcElwain and Sweeney, 2007

- Nearly all stations reveal increases in annual and seasonal mean maximum and minimum temperatures.
- Changes to precipitation patterns are more spatially and seasonally variable than temperature changes.
- The number of days where daily precipitation is greater than or equal to 10mm (extreme precipitation events) reveals significant annual increases on the west coast.

Global climate models provide information on likely future climate conditions. However, the outputs from such models are spatially coarse, for example Ireland is typically represented by a small number of grid squares. More detailed outputs and analyses are required to inform planning requirements at smaller regional and local scales.

The National Climate Change Strategy 2007-2012 contains a commitment to develop a national response to the inevitable impacts of climate change. The Department of the Environment, Heritage and Local Government is currently in the process of developing a National Climate Change Adaptation Framework. It is intended that this work will progress in parallel with the development of the announced primary legislation, and that the Climate Change Bill will include provisions on national adaptation policy. In anticipation of a national framework, potential climate change impacts are already being addressed in a number of key areas including flood policy, foreshore and development planning.

Financial Resources and Transfer of Technology

Ireland's Overseas Development Assistance (ODA) has continued to grow since the publication of the fourth national communication. In 2006, total ODA stood at €813.962million, rising to an estimated €918.275million in 2008, representing 0.58% of GNP. In 1998 total ODA was €177,262. Despite the recent economic downturn, and as announced at the UN general assembly meeting in September 2008 Ireland remains committed to reaching the UN target of 0.7% ODA by 2012.

Ireland's development assistance is focused on the Least Developed Countries, particularly those in sub-Saharan Africa. Ireland has bilateral development programmes with Ethiopia, Mozambique, Tanzania, Uganda, Zambia, Lesotho, South Africa, Sierra Leone, Liberia and Malawi. Ireland also has programmes in Timor Leste and Vietnam.

The bulk of Ireland's assistance to developing countries is administered by Irish Aid, located in the Department of Foreign Affairs. The Departments of Agriculture, Environment and Revenue also contribute to Ireland's ODA.

Ireland's commitment to aid effectiveness involves aligning bilateral assistance with the national poverty reduction strategies of partner governments. This often results in providing financial support to sectors such as health, education and agriculture, or directly to the government's central budget through direct budget support. The very essence of the approach is that developing countries should prioritise their development needs and that donors should respond to these rather than their own priority issues. This new approach has obvious implications for reporting on bilateral climate related funding in two key ways: climate change must be stated as a national priority in order to receive bilateral funds; and it is often

difficult to segregate spending on climate change as it may be disbursed through support to the central budget or to a key sector such as agriculture or water.

Irish Aid has started to raise awareness of climate change and the risks to development posed by the impacts of climate change in the countries where it works. It also supports programmes which build the capacity of policy makers to integrate mitigation and adaptation to climate change into national development plans. Through these efforts Irish Aid hopes to create further awareness of the need to raise the policy profile of climate change in developing countries.

Research and Systematic Observation

In Ireland funding for climate change research, systematic observations and related activities is provided though a number of state agencies and organisations. The budgetary allocations are provided via relevant Government Departments. Since 2007 research funding at a national level has been provided through the National Development Plan (NDP) 2007-20013. This is a follow up programme to the NDP 2000-2006 under which a substantial investment in development of climate change research was also made. Climate related systematic observations are funded as a component of the operational activities of a number of state bodies. Other observations carried out by research institutions are funded through research programmes.

Direct funding for environmental research is the responsibility of the Department of Environment, Heritage and Local Government (DEHLG) which has mandated the Environmental Protection Agency (EPA) undertake the task of management of this research allocation. The NDP 2007-2013 also included additional funding for climate change research and allowed for the development of the more structured Climate Change Research Programme (CCRP) with improved co-ordination structures and processes.

The objective of the CCRP is to advance research or a cross sectoral basis through enhanced coordination, avoiding duplication and increasing overall use and value of research. A key aim is to coordinate climate change related research funded by the EPA and through other Government Departments who have similarly devolved responsibility for research funding. This includes: energy research funded by Sustainable Energy Ireland; agriculture research and soil carbon analysis funded through DAFF and Teagasc (www.teagasc.ie); forest research funded by the National Council for Forest Research and Development (COFORD, www.coford.ie); marine research funded by the Marine Institute (www.marine.ie); and socio-economic and enterprise orientated research being advanced by Forfas (www.forfas.ie) and Enterprise Ireland (www.enterprise-ireland.com).

The national meteorological service, Met Éireann, operates a climate analysis section from within its own budget and has primary responsibility for systematic observations of meteorological parameters. Individual non-Governmental organisations (NGOs) have also been engaged in research initiatives.

Education, Training and Public Awareness

A wide range of initiatives in the areas of education, training and public awareness are undertaken by different bodies in Ireland, including the Department of the Environment, Heritage and Local Government, Sustainable Energy Ireland (SEI); the Environmental Protection Agency (EPA) and others. These initiatives include lecture series, schools and teacher training initiatives, and consumer awareness programmes.

Summary

Since completion of the 4th National Communication, Ireland has made significant progress in developing national policy on climate change, both mitigation and adaptation, and is on course to meet its greenhouse gas emission limitation target for the purposes of the Kyoto Protocol.

While policy on mitigation has been influenced by EU policy developments, important domestic progress is reflected in the National Climate Change Strategy published in April 2007, the Carbon Budget process initiated later in 2007, and the work currently underway to develop primary legislation and a national framework on adaptation.

In parallel with these developments, Ireland provided a robust policy and operational context for effective participation by Irish installations in the EU Emissions Trading Scheme, and initiated a comprehensive carbon purchasing programme to supplement domestic action and ensure compliance for the purposes of the Kyoto Protocol.

While compliance with Kyoto Protocol obligations in the commitment period 2008-2012 is an immediate priority for Ireland, national policy development is being prioritised and progressed in the broader global context of transition to a low-carbon future, and the need for appropriate national adaptation measures to address the inevitable impact of current and historic emissions.

Chapter 1: NATIONAL CIRCUMSTANCES RELEVANT TO GREENHOUSE GAS EMISSIONS AND REMOVALS

1.1 Government Structure

Ireland is a parliamentary democracy. The national parliament is called the Oireachtas and consists of the President, and two houses - the Dáil (the lower house), and the Seanad (the upper house). Bunreacht na hÉireann, the written Constitution of Ireland, sets out the administrative structure of the Government and defines the structure and principles of legal and social policy to guide the Oireachtas. The rights of every citizen are also enshrined in the Constitution. The power of the two houses of the Oireachtas derives from Bunreacht na hÉireann and law. The Dáil is the primary House and the Government is answerable to the Dáil only. The Irish Government consists of not less than seven and not more than fifteen members. The Head of the Government is the Taoiseach, who is appointed by the President on the nomination of the Dáil. Departments of State are assigned to members of the Government, with a Minister occasionally being responsible for more than one Department. The Irish Government, in exercising the executive powers of the State and delivery of its policy, retains overall responsibility for ensuring delivery of Ireland's obligations under the UNFCCC and the Kyoto Protocol. The Department of Environment, Heritage and Local Government is responsible for Ireland's policy on climate change and has an overarching role in the delivery of this policy.

1.2 Geographic and Climate Profile

Ireland is situated off the north-west coast of the continent of Europe between longitude 5.5^{o} and 10.5^{o} West and latitude 51.5^{o} and 55.5^{o} North. The total area of the island of Ireland is 84,421 square kilometres. The Republic of Ireland comprises 70,282 square kilometres. The greatest length of the island from the north to the south is 486 kilometres and the greatest width, from east to west, is 275 kilometres. There are 3,172 kilometres of coastline. The island comprises a large central lowland of limestone with a relief of hills and a number of coastal mountains, the highest of which, Carrantouhill, is 1,040m and the longest river, the Shannon, is 340km. Ireland's National Parks are home to some of the most unique and spectacular scenery in the country while wild boglands occur in mountain and lowland areas and are among the most distinctive natural habitats in the country. The bio-diversity of wildlife is comparatively low due to Ireland's isolation from mainland Europe with many species present on the continent being absent. Many other common animals and plants have, in fact, been introduced by human settlers.

The country enjoys a relatively mild temperate oceanic climate, influenced by the relatively warm waters of the Gulf Stream and the prevailing south-westerly winds from the Atlantic. The coldest months are January and February, with mean daily air temperatures of between 4^{o}C and 7^{o}C while the warmest are July and August, with mean temperatures of between 14^{o}C and 16^{o}C. May and June are the sunniest, averaging 5 to 7 hours sunshine per day. Rainfall is well distributed throughout the year. In low-lying areas average annual rainfall is mostly between 800 and 1200 millimetres but ranges from less than 750mm in some eastern areas to 1500mm in parts of the west. In mountainous areas annual rainfall may exceed 2000mm.

1.3 Population Distribution Profile

By 2006, the population of Ireland was 4.2 million, a growth of over 20% on 1991 levels. On the basis of the 2006 census, Ireland had the largest population growth within the European

Union over the previous decade. This is being driven by high levels of immigration and natural increase. Compared with the rest of Europe, Ireland has a markedly younger population profile with a high proportion of the population concentrated in the younger age-groups - over one-third of people are aged under 25. Population density of 60 persons per square kilometre remains relatively low compared to other countries in Europe. However, almost 40% of the population is concentrated in Dublin and the Eastern Region. Outside this region, the State has a highly dispersed and low-density population.

Housing is generally one or two storey, detached or semi-detached, and in urban areas is mostly in low density suburbs (15 to 30 houses per hectare). Flats or apartments are now becoming more common, and prior to the coming into force of the Building Regulations in 1992 for new construction, insulation standards for housing were generally low. Only 31% of the population live in population settlements in excess of 100,000, compared with 35% of the population living in dispersed settlement patterns in rural areas. Comparative EU data shows that Ireland has the lowest population share living in settlements of between 2,000 and 100,000. The National Sustainable Development Strategy (1997) sets out Government policy of encouraging more sustainable residential development by the avoidance of excessive suburbanisation and the promotion of higher residential densities in appropriate locations in conjunction with improved public transport systems. The 2002 National Spatial Strategy is a twenty-year planning framework designed to achieve a better balance of social, economic, physical development and population growth between regions. Its focus is on people, on places and on building communities. Through closer matching of where people live with where they work, different parts of Ireland will for the future be able to sustain a better quality of life for people, a strong, competitive economic position, and an environment of the highest quality.

1.4 Economic Profile

The Irish economy is a small, globalised economy that experienced an unprecedented level of growth during much of the last decade. However, in common with many other economies it has, from 2008, experienced a contraction in national economy expected to last until 2010. The Irish economy remains heavily dependant on external trade and investment. After a period of exceptional growth when GDP grew by approximately 24% over the period 2003 - 2007 it is expected that GDP will have declined by 7% in 2009 following a further decline of 3% in 2008. Nonetheless, the period of sustained growth has moved Ireland to a more favourable position among its EU partners with a GDP per capita equivalent to €41,115 in 2008 – approximately 35% higher than the EU27 average in PPS terms.

1.5 Industrial Profile

In keeping with current world economic trends in developed economies, Ireland has experienced a decrease in the share of manufacturing as a percentage of GDP as the services sector continues to grow in importance. However, manufacturing continues to be an integral component to the Irish Economy contributing 22% of GDP in 2007 (33% in 1998). Since 1998, the overall industrial sector's share of Irish GDP has decreased from 41% to approximately 33%. While much of the industrialisation in recent years has been in large measure due to foreign owned firms, the share of Irish owned industries has also been growing in recent years. In 2008, approximately 18% of merchandise was exported to the US, 19% to the UK and 44% to the rest of the EU. Total merchandise exports in 2008 at €86.3bn were equivalent to 46% of GDP.

The ICT, chemical/pharmaceuticals and food/agricultural products continue to be the most important sectors in terms of exports and their contribution to GDP. In 2007, approximately 33,000 were employed in pharmaceutical/chemical and medical companies accounting for 7% of GDP, while the Office Machinery & Computers, Radio & Telecoms and Medical Precision/Optical Instruments sectors employed over 53,000 and contributed 5% of total GDP. The highest growth rates in Irish industry over recent years have been in the high-technology sectors of computer equipment, pharmaceuticals and engineering, where overseas investment in Ireland has played a vital role. Overseas-owned companies continue to account for the majority of total manufactured exports.

The services sector in Ireland accounts for 65% of GDP and for two-thirds of employment. In 2007, Ireland was one of the biggest exporters of internationally traded services on a per capita basis. The most important service industries are computer services, tourism and financial services. Ireland is currently the tenth highest exporter of services in the world with a 2.7 percent share of world services exports. Computer Related services accounted for 35% of total services exports in 2008 while Insurance and Financial Services between them accounted for 22.5%.

In 2008, the total labour force was approximately 2.2 million, representing about 65% of all persons aged 15 or over, with 2.1m in employment. The overall participation rate at 63.4% has been increasing gradually over the last few years, though the level of female participation is still below European averages. The level of unemployment was low at 5.2% (Mar-May 2008) but increased significantly in the latter half of the year and in 2009 due to the economic downturn (11.8% at end May 2009).

1.6 Energy Profile

In 2007 energy use in Ireland increased by 1.4% and energy-related CO_2 emissions increased by 0.8% while economic growth remained strong at 6%. Primary energy consumption in Ireland in 2007 was 16.1 million tonnes of oil equivalent (Mtoe). Since 2005, energy-related CO_2 emissions have reduced by 0.7% per annum (excluding international aviation), while the economy has grown by 5.9% per annum. In contrast, over the period since 1990, energy-related CO_2 emissions grew by 2.5% per annum, while the economy grew by 6.5% per annum. CO_2 emissions in non-emissions trading sectors (residential, services, transport and agriculture) have grown by 2.6% per annum since 2005 and were 5.3% above 2005 levels in 2007.

Sustainable Energy Ireland, which was established as Ireland's national energy agency under the Sustainable Energy Act 2002, is charged with implementing significant aspects of government policy on sustainable energy and climate change abatement, including statistics and projections on sustainable energy and achievement of targets.

Table 1 tabulates the growth rates for the economy (GDP), primary energy (TPER) and energy-related CO_2 emissions for the period 1990 – 2007 using five-yearly intervals. It emphasises the high GDP growth rates compared with those for energy and CO_2 and notes the small increase in primary energy and smaller increases in energy-related CO_2 in 2007.

Over the three year period to 2007, energy-related CO_2 emissions reduced by 0.1% per annum on average (and by 0.7% per annum excluding international aviation), while the

economy grew by 5.9% per annum. Over the period since 1990 by contrast, energy-related CO_2 emissions grew by 2.5% per annum, while the economy grew by 6.5% per annum.

Table 1 GDP[5], TPER and CO_2 Growth Rates[6]

	Growth %	Average annual growth rates %					
	1990 – 2007	'90 – '07	'90 – '95	'95 – '00	'00 – '05	'05 – '07	2007
GDP	190.4	6.5	4.6	9.6	5.6	5.9	6.0
TPER	69.8	3.2	2.2	5.5	2.7	1.1	1.4
Energy CO_2	51.2	2.5	1.6	4.6	2.3	-0.1	0.8
Energy CO_2 (excl. international aviation)	46.6	2.3	1.6	4.4	2.1	-0.7	0.5

Over the period 1990–2007 Ireland's total annual primary energy requirement grew in absolute terms by 70% (average annual growth rate of 3.2%). In 2007 Ireland's primary energy requirement increased by 1.4%. The individual fuel growth rates and shares are shown in Table 2.

Table 2 Growth Rates and Shares of TPER Fuels

	Growth %	Average annual growth rates%						Shares %	
	1990 – 2007	'90 – '07	'90 – '95	'95 – '00	'00 – '05	'05 – '07	2007	1990	2007
Fossil Fuels (Total)	66.6	3.0	2.2	5.4	2.4	1.0	1.4	98.2	96.4
Coal	-27.7	-1.9	-3.1	0.4	0.2	-9.3	-7.5	21.9	9.3
Peat	-49.1	-3.9	-3.0	-7.5	-0.7	-4.9	-0.8	14.5	4.3
Oil	104.4	4.3	4.6	7.3	3.0	-0.5	0.8	46.6	56.1
Natural Gas	196.8	6.6	5.8	9.8	2.6	11.1	6.8	15.2	26.6
Renewables (Total)	178.8	6.2	-1.6	8.7	9.3	13.0	10.9	1.8	2.9
Hydro	-4.4	-0.3	0.5	3.5	-5.7	2.8	-8.0	0.6	0.4
Wind	-	-	-	72.4	35.4	32.7	20.7	0.0	1.0
Electricity Imports	-	-	-	53.2	64.7	-16.9	-21.0	0.0	0.8
Total	69.8	3.2	2.2	5.5	2.7	1.1	1.4		

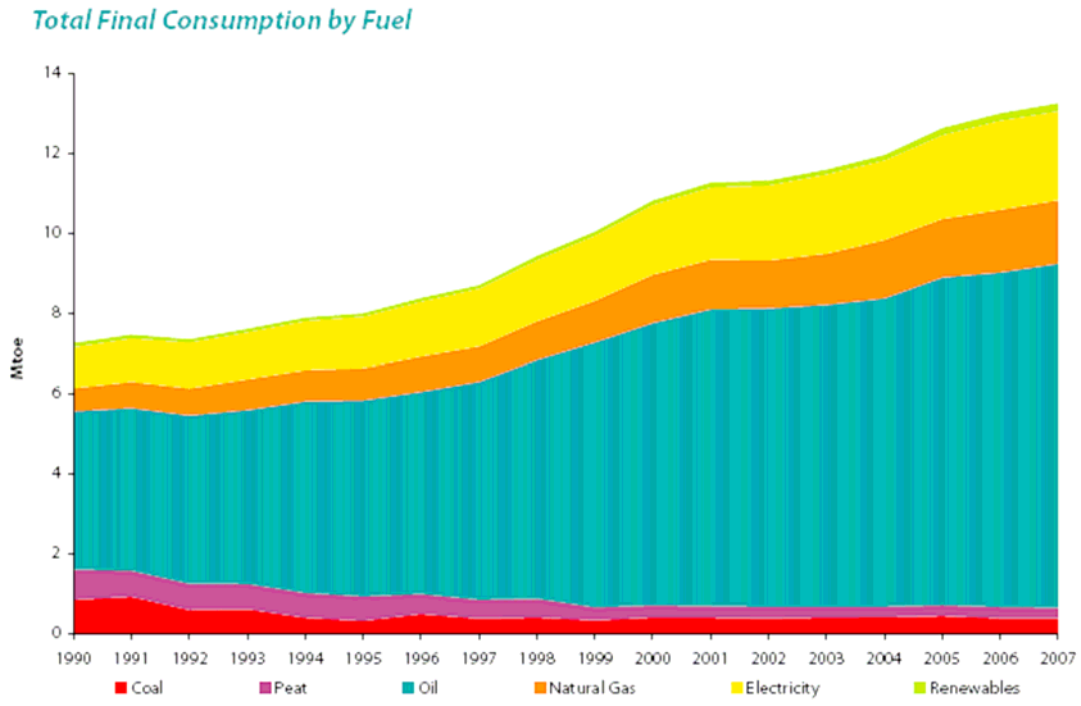
The Energy in Ireland 1990-2007 Report also highlighted the main trends in national fuel share over the period:

- Fossil fuels accounted for 96% of all energy used in Ireland in 2007. This does not include the embodied fossil fuel content of imported electricity.
- Oil is by far the dominant energy source with that dominance increasing from a share of 47% in 1990 to a peak of 60% in 1999. Consumption of oil, in absolute terms, increased slightly by 0.8% in 2007 with the share of oil in primary requirement in 2007 remaining at 56%.
- Natural gas use increased in 2007 by 6.8% and has increased its share to 27% of TPER. Over the three years 2005 –2007, natural gas has increased by 11% per annum, while oil has reduced by 0.5% and coal by 9.3% per annum.
- Wind energy experienced the highest growth again in 2007 (of 21%).Wind energy represented 1% of primary energy requirement in 2007.
- Renewable energy in total grew by 11% during 2007 and by 13% per annum on average in the period 2005 - 2007.

Use of fossil fuels increased by 1.4% in 2007 and accounted for 96% of all energy used in Ireland in 2007. Imported oil and gas accounted for 82% of energy supply and Ireland's overall import dependency was 89% in 2007. Oil dominated as a fuel, accounting for 56% of energy supply. Oil consumption increased by 0.8% in 2007 with growth in transport being offset by reductions in oil use in electricity generation. Renewable energy increased by 11%

in 2007, including a 21% increased in wind energy. Renewable energy accounted for 32% of indigenous energy in 2007. Figure 1.0 shows the shift in the pattern of final energy demand by fuel over the period 1990 – 2007.

Figure 1.0: Final Energy Consumption in Ireland



Ireland's Total Final Consumption (TFC) in 2007 was 13 Mtoe, an increase of 1.9% on 2006 and 83% above 1990 levels (representing an average growth rate of 3.6% per annum). This increase in final consumption in 2007 was achieved with just a 1.4% increase in primary energy, indicating continued improvement in efficiency of supply due to efficiency gains in electricity generation and increased contributions from renewables and combined heat & power. There have been a number of changes in the growth rates and respective shares of individual fuels in final consumption over the period, as shown in Table 3.

Table 3: Growth rates and Shares of TFC Fuels

	Growth %	Average annual growth rates%						Shares %	
	1990 – 2007	'90 – '07	'90 – '95	'95 – '00	'00 – '05	'05 – '07	2007	1990	2007
Fossil Fuels (Total)	76.5	3.4	1.6	6.2	2.9	2.2	2.2	84.5	81.7
Coal	-55.6	-4.7	-17.7	4.6	1.8	-7.3	-0.9	11.6	2.8
Peat	-64.1	-5.9	-4.2	-13.1	-2.0	-0.4	-4.3	10.4	2.0
Oil	116.9	4.7	4.4	7.5	3.0	2.5	2.8	54.6	64.9
Natural Gas	178.1	6.2	7.0	8.6	4.0	4.0	1.1	7.8	11.9
Renewables	93.8	4.0	-3.1	5.1	9.4	6.0	9.5	1.5	1.6
Combustible Fuels (Total)	76.8	3.4	1.5	6.2	3.0	2.3	2.3	86.0	83.2
Electricity	117.9	4.7	4.6	6.4	3.7	3.1	-0.1	14.0	16.8
Total	82.6	3.6	2.0	6.2	3.1	2.4	1.9		

1.7 Transportation

In Ireland, roads are the dominant mode of internal transport, accounting for about 90% of freight traffic and over 95% of passenger traffic, and are, therefore, vital for future economic and social development at both national and local level. At the end of 2008, there were 1.92 million private cars on Irish roads, compared to approximately 800,000 in 1990. In total, including goods vehicles, public service vehicles, excavators etc. there were almost 2.5 million vehicles registered in Ireland by the end of 2008. Specifically, goods vehicles increased from 143,000 in 1990, to 351,000 in 2008.

As a result of strong economic growth, rapidly increasing levels of ownership and usage of private transport are evident with car ownership approaching the EU-15 average of 488, from 230 per 1,000 head of population in 1990, to 435 in 2008. Clearly there is still significant scope for growth in the number of cars. Coupled to this substantial increase in car ownership has been an increase in total car kilometres travelled. On the basis of National Car Test Data, it is estimated that the total car kilometres travelled in Ireland increased from 23.5 billion kilometres in 2000, to 31.2 billion in 2008. As a result of this, and similar growth in goods transport, road transport contributes the vast majority of emissions from the transport sector in Ireland, accounting for around 96% of the sector's CO_2 emissions for 2008. It is still too early to assess the impact of the current economic downturn on overall transport demand.

The road transport sector in Ireland has undergone significant large-scale development and investment, ensuring more efficient movement of goods, and opening up the country for the movement of goods and people. This provides a challenge in terms of ensuring that the growth is environmentally sustainable. There have been a number of positive developments in this regard. Public transport provision in Dublin has been enhanced, with the LUAS tram system which opened in mid-2004 accounted for 27.5 million passenger trips in 2008, and a recent upgrade to the DART suburban rail system resulted 19.9 million passenger trips in 2008 (compared to 16.3 million in 2005). A slight dip in passenger numbers occurred in 2009, with 17.5 million passenger trips on the DART and 25.4 million on the LUAS.

The Department of Transport has a major part to play in providing a supportive framework to the industry through its policy making and regulatory functions in the areas of air travel, airports, haulage transport and passenger transport, and through its role as shareholder in the commercial state transport companies.

1.8 Agricultural Profile

The land area of Ireland is 6.9 million hectares, of which 4.3 million hectares is used for agriculture or about 62% of total land area, and 724,000 hectares for forestry or about 10.6% of total land area. Some 80% of the agricultural land is devoted to grass (silage, hay and pasture), 11% to rough grazing (0.5 million hectares) and 9% to crop production (0.4 million hectares). Beef and milk production currently account for 56% of agricultural output at producer prices. The average farm size is now around 32.3 hectares. Primary agriculture accounts for some 2.5% of GDP[1], 5.8% of employment and 6% of exports[1]. Ireland's livestock numbers in December 2008 included 5.93 million cattle, 3.42 million sheep and 1.6 million pigs.

[1] As expressed by Gross Value Added at Factor Cost

1.9 Forestry Profile

Ireland's national forest estate is very small when compared to other European Union countries. Consequently, an active afforestation programme has been in place for many years in an effort to increase the national forest resource. Ireland will continue to increase its level of afforestation under the National Development Plan for at least the next two decades. Since 1990, some 265,219 hectares of new forest has been established. During the same period the annual rate of deforestation is estimated to have been 500 hectares per year. Despite this rate of planting, however, Ireland remains one of the least forested countries in the EU. At the end of the year 2008, the national forest estate stood at 730,000ha. This represents about 10.60% of the area of the country, compared to the 35% average throughout the other EU Member States.

1.9.1 Afforestation Programme

The Strategic Plan for the Development of the Forestry Sector in Ireland *(Growing for the Future*) envisages 20,000 hectares of new afforestation per annum up to 2030. If achieved, these proposals will increase forest area to almost 1.2 million hectares by 2030, thereby increasing Ireland's forest cover from 7% (1990) to 17% of the national land territory. Afforestation rates in the 4 years from 2005-2008 averaged 7,832 hectares per annum. While conifer species still represent a considerable portion of the national planning programme, there has been a marked increase in the level of broadleaf species being planted since 2000, when broadleaves accounted for c.13% of total afforestation. In 2007 broadleaf species accounted for 31% of new afforestation carried out in that year.

The Irish wood harvest in 2007 was 3 million cubic metres, comprised mainly of conifer species, predominantly Sitka spruce[2]. The wood is used in wide range of products from structural sawnwood to fencing products, pallet products and panel products including OSB (oriented strand board) MDF and door panels. COFORD, (National Council for Forest Research and Development), has forecast a potential doubling of wood production to 5 million cubic metres per annum by 2015[3]. There is close liaison between the Forest Service and environmental and planning agencies in relation to forest development, especially in the area of forest establishment.

1.9.2 Carbon Sequestration

The Irish afforestation programme will play an important role in carbon sequestration during the first and any subsequent Kyoto carbon reporting periods. With the levels of afforestation that have occurred since 1990, it is forecast that between 2008 and 2012 the average rate of sequestration in qualifying forests over the Kyoto first commitment period as result of Article 3.3, will be 2.236 Mt CO_2 per annum. This revised forecast is based on approaches and methodologies for accounting of sequestration agreed to by Kyoto Protocol parties, particularly in the Marrakech Accords, the Good Practice Guidance of the Intergovernmental Panel on Climate Change, and on research and modelling of carbon sequestration in Irish forests undertaken by COFORD. Current afforestation will have little effect on levels of sequestration during the first commitment period 2008 - 2012, because forests grow relatively slowly as they establish themselves over the first five years or so. However, in the post 2012 period, these forests will make a substantial contribution to climate change mitigation.

[2] Source: *Estimated Woodflow for the Republic of Ireland in 2007* (Coford Connects - Processing/Products No. 18, COFORD, 2008)

[3] Source: Forecast of Roundwood Production from the Forests of Ireland (Gallagher, O'Carroll) COFORD, 2001

The total carbon stock in forest biomass (excluding soil carbon) is estimated to be circa 30 million tonnes for the year 2006[4]. Forest soils represent a very significant carbon pool; current estimates are that the total carbon stock in forest soils is in the region of 290 million tonnes[5].

1.10 Waste Management Profile

Ireland, as with other European countries, continues to show a steady increase in waste production in line with economic growth. Municipal solid waste arisings have increased by 75% between 1995 and 2008 and the greater amount of this waste is being consigned to landfill. The most recent figures available in the EPA's *National Waste Report 2008* indicate that more than 62% of municipal waste was sent to landfill in 2008.

The foundation for a modern waste management culture in Ireland was laid down in the 1996 Waste Management Act. This was followed in 1998 by the Policy Statement *Changing Our Ways*, which provided a national policy framework for the adoption and implementation of local and regional waste management plans. *Changing Our Ways* set down broad, ambitious national objectives and targets over a 15-year timescale. While successes have been recorded in some areas, such as recovery of packaging waste and farm plastics, considerable progress remains to be achieved in the areas of waste prevention, minimisation and recycling. The Policy Statement *Preventing and Recycling Waste: Delivering Change,* was published by the Government in March 2002 in recognition of the need to accelerate and drive change in a more systematic manner. *Waste Management – Taking Stock and Moving Forward* which was published in 2004 reviewed progress on waste management modernisation since 1998 and listed a programme of key points to underpin future progress.

Government policy in relation to waste management is grounded in the internationally recognised hierarchy of waste options. The most favoured option is waste prevention, followed by minimisation, reuse, recycling, recovery and the least favoured option of disposal to landfill. This commitment to the waste hierarchy has added significance in the context of the requirements of the EU Landfill Directive to divert waste from landfill.

The most recent figures available in the EPA's *National Waste Report 2008* indicate that the quantity of biodegradable municipal waste disposed of to landfill decreased by 19% in 2008 to approximately 1.2 million tonnes, which leaves Ireland requiring to divert a further 280,000 tonnes in order to meet the first Landfill Directive target due in July 2010. Recent Government initiatives such as increases in the Landfill Levy and Food waste requirements for the commercial sector will further drive the diversion of biodegradable waste from landfill.

The Programme for Government agreed in 2007 included a number of objectives relating to waste management, among them a commitment to carry out an international review of waste management plans, practices and procedures and to act on the conclusions. This report, t*he International Review of Waste Management Policy*, was launched in November 2009 and will act as a launching pad for new initiatives in Ireland's approach to waste management. A new waste and resource management Bill and a policy statement on waste management arising from recommendations in the report, will be published as soon as possible in 2010. This will

[4] Source: National Forest Inventory Results (Forest Service, 2007)
[5] Source: National Forest Inventory Results (Forest Service, 2007)

set a policy context, which will ensure that waste management services are delivered by the public and private sectors in an environmentally progressive and cost efficient manner.

Chapter 2: GREENHOUSE GAS INVENTORY INFORMATION

2.1 Introduction

The national greenhouse gas inventory is compiled by the Environmental Protection Agency (EPA) using the guidelines of the Intergovernmental Panel on Climate Change (IPCC). The inventory is compiled on an annual basis and submitted by year-end in draft form to the European Commission to facilitate EU reporting, and in final form to the Secretariat by the April 15th deadline. The 2009 National Inventory Report (NIR) which contains the inventory data in the Common Reporting Format (CRF) along with full documentation of the assumptions underpinning the inventory has been submitted to the UNFCCC secretariat for the years 1990 to 2007.

The complete inventory currently comprises a time series from 1990 to 2007 for carbon dioxide (CO_2), methane (CH_4) nitrous oxide (N_2O) and for the fluorinated or F-gases (HFCs, PFCs, and SF_6) – the year 1995 has been chosen as the base year for the fluorinated gases for obligations under the Kyoto Protocol. Summary tables showing emissions by gases and sector for the full time series are presented in Annex 1.

2.2 Inventory system – Institutional and Procedural Arrangements

2.2.1 Overview

Under Section 52 of the Environmental Protection Agency Act of 1992 (DOE, 1992), the Environmental Protection Agency is required to establish and maintain databases of information on the environment and to disseminate such information to interested parties. Section 55 of the Act states that the Agency must provide, of its own volition or upon request, information and advice to Ministers of the Government in the performance of their duties. This includes making available such data and materials as are necessary to comply with Ireland's reporting obligations and commitments within the framework of international agreements. These requirements are the regulatory basis on which the EPA prepares annual inventories of greenhouse gases and other important emissions to air in Ireland. It is in this context that in 1995 the Department of the Environment Heritage and Local Government (DEHLG) designated the EPA as the inventory agency with responsibility for the submission of emissions data to the UNFCCC Secretariat and to the Secretariat for the Convention on Long-Range Transboundary Air Pollution (CLRTAP). The Agency's Office of Climate, Licensing and Resource Use (OCLR) under Director Laura Burke is the single national entity with responsibility for Ireland's national greenhouse gas emission inventories for submission under the UN Framework Convention on Climate Change and Decision 280/2004/EC (EP and CEU, 2004a), the latter being the basis for EU Member States' reporting under the Convention and the Kyoto Protocol.

The establishment of Ireland's national inventory system was completed by Government Decision in early 2007, building on the framework that had been applied for many years. Established institutional arrangements directed towards national inventory reporting and involving the EPA, DEHLG and other stakeholders are reorganised, extended and legally consolidated across all participating institutions to strengthen inventory capacity within the EPA, ensuring that more formal and comprehensive mechanisms of data collection and processing are established and maintained for long term implementation. The system puts in

place formal procedures for the planning, preparation and management of the national atmospheric inventory and identifies the roles and responsibilities of all the organisations involved in its compilation. This was achieved through extensive discussions with all key data providers leading to the adoption of Memoranda of Understanding (MOU) between the key data providers and the inventory agency stipulating the scope, timing and quality of the inputs necessary for inventory compilation in accordance with the guidelines for national systems. Secondary MOUs are in turn used by some key data providers to formalise the receipt of data from their own particular sources. Table 2.1 lists the key data providers and indicates the range of data covered by MOU in the national system. A QA/QC plan is an integral part of the national system. This plan is set out at Annex 2.

Also set out at Annex 2 is a schematic overview of the institutions, procedures and information flows involved in the national system. In addition to the primary data received from the key data providers, the inventory team obtains considerable supplementary information from other teams in OCLR and the Office of Environmental Enforcement within the EPA. These sources include Annual Environmental Reports (AER) submitted by licensed companies and the National Waste Database. The inventory team also draws on national research related to greenhouse gas emissions and special studies undertaken from time to time to acquire the information needed to improve the estimates for particular categories and gases. The approval of the completed annual inventory involves sign-off by the QA/QC manager and the inventory manager before it is transmitted to the Board of the EPA via the Programme Manager of the Climate Change Unit in OCLR. Any issues arising from the Board's examination of the estimates are communicated to the inventory experts for resolution before final adoption of the inventory. The results for the inventory year are normally released at national level in December of the following year in advance of their official submission to the European Commission in accordance with Decision 280/2004/EC in January of the reporting year and subsequently to the UNFCCC secretariat.

The Emissions Trading Unit (ETU) forms part of OCLR and is a key component of the national system. Information submitted by participants in the European Union Emissions Trading Scheme (ETS) under Directive 2003/87/EC (EP and CEU, 2003) is managed by the ETU and is available to the inventory team in OCLR. The annual ETS compilation serves as an important source of activity-specific and company-specific data on CO_2 emissions, fuel use and emission factors for major combustion sources and industrial processes. Emissions trading covers approximately 110 installations in Ireland with combined CO_2 emissions of 20,384 Gg in 2008, accounting for 30.7 percent of total greenhouse gas emissions. Guidance provided under the associated Decision 2004/156/EC (EP and CEU, 2004) on methodologies for estimating and reporting greenhouse gas emissions to support Directive 2003/87/EC, together with monitoring and verification mechanisms administered by the ETU, consolidates and improves the information in relation to a substantial proportion of CO_2 emissions for the purposes of reporting national GHG inventories under the Convention and the Protocol.

All formal mechanisms together with the QA/QC procedures are fully operational since becoming established in the 2007 reporting cycle. The EPA Office of Climate, Licensing and Resource Use is the inventory agency and the EPA is also designated as the single national entity with overall responsibility for the annual greenhouse gas inventory. The national

system is also exploited for the purpose of parallel inventory preparation and reporting under the LRTAP Convention ensuring efficiency and consistency in the compilation of emission inventories for a wide range of substances using common datasets and inputs. As a formal management system, the national system aims for continuous improvement to increase the quality and robustness of the national atmospheric inventory over time.

2.2.2 Inventory Planning

The inventory agency plans for preparation of the annual inventory as soon as possible after completion of the annual reporting cycle through the April submission to the UNFCCC secretariat. Planning largely involves the internal identification of improvements to be undertaken by way of revised methodologies and updated activity data or emission factors and addressing the issues and recommendations in the review of the previous inventory submission. Planning also considers the further development of inventory reporting for the LULUCF sector and for activities under Article 3.3, which are not handled by the OCLR inventory team and for which new information is becoming available on a continuous basis through national research and development of the forest inventory. In addition, any changes required by the outcome of review activities conducted among the Member States of the European Union, or by the need to report in a manner consistent with other Member States for the purposes of Decision 280/2004/EC, are taken into account in inventory planning. The target date for the first release of the latest annual inventory at national level, which has become established as that given by the Government's economic and carbon budget presentation in December of the following year, is adopted as part of inventory planning.

2.2.3 Overview of Inventory Preparation and Management

The OCLR of the EPA performs the role of inventory agency and prepares the GHG inventory for all IPCC sectors except LULUCF through the system described above and using the data sources listed in Table 2.1. The estimates of emissions and removals for forest lands under the Convention, as well as those in respect of Article 3.3 activities under the Kyoto Protocol, are prepared by consultants contracted to COFORD, the Council for Forest Research and Development, and are delivered to the inventory agency under a Memorandum of Understanding between COFORD and OCLR. Research fellows contracted directly to OCLR are responsible for completion of the annual inventory for all other land categories in LULUCF for the annual inventory under the Convention. The deliverables received by OCLR from COFORD and the research fellows include the completed CRF tables and draft NIR sections for their respective areas of responsibility.

This first version of the latest annual inventory produced in December of the following year is then used to comply with the subsequent 15 January deadline prescribed by Decision 280/2004/EC, which governs the reporting of greenhouse gases and implementation of the Kyoto Protocol by the European Union and its EU Member States. The inventory preparation and management process thereafter involves making any revisions consequent on the receipt of updated or outstanding information nationally, accounting for any observations or amendments following initial assessment at EU level of the 15 January submission by Member States to the European Commission and the completion of the National Inventory Report in order to comply with the 15 March deadline for the delivery of the complete and final inventory submission under Decision 280/2004/EC. This version of the latest inventory is fixed

and retained for submission to the UNFCCC secretariat by 15 April to complete the reporting cycle. Ireland's national system is operating very successfully and the timeliness of inventory preparation has benefited from the implementation of more formal arrangements and enhanced engagement among the various institutions and contributors.

Table 2.1. Key Data Providers and Information covered by MOU

Key Data Provider	Data Supplied	Deadline	Sector in which data are used
Sustainable Energy Ireland	National Energy Balance; Detailed national energy consumption disaggregated by economic sector and fuel	30 September	Energy, Waste
Department of Agriculture and Food	Use of nitrogen fertilizer, cattle populations from CMMS (Cattle Movement and Monitoring Scheme)	30 September	Agriculture
Central Statistics Office	Annual population, livestock populations, crop statistics, housing survey data	30 September	Agriculture, Industrial Processes, Waste
COFORD (National Forest Research Institute)	Estimates of CO_2 emissions and removals and other GHG emissions for forest land; Statistical data on afforestation, reforestation and harvesting; Estimates of CO_2 emissions and removals and other GHG emissions for Article 3.3 activities	30 September	LULUCF
Bord Gais	Analysis results for indigenous and imported natural gas	30 September	Energy
Marine Institute	Annual Report on Discharges, Spills and Emissions from Offshore Gas Production Installations	30 October	Energy
Emissions Trading Unit	Verified CO_2 estimates and related fuel and production data for installations covered by the EU ETS[1]	30 April	Energy, Industrial Processes
*Department of Communications, Energy and Natural Resources	National Oil Balance (as a component of the energy balance)	30 September	Energy
*Road Safety Authority	Road transport statistics from the National Car Test (NCT)	30 April	Energy
**Forest Service	(i) GIS data base on premiums and grants afforestation areas (iFORIS) with associated attributes (II) NFI database	30 September 2007, 2012	LULUCF and Article 3.3 activities
**Coillte	GIS data base of intersected of NFI permanent sample plot points (Coillte-NFI plots) with sub-compartment and management unit data.	30 September	LULUCF and Article 3.3 activities

[1]ETS – Emissions Trading Scheme
*These bodies have MOUs with SEI rather than with OCLR
**These bodies have MOUs with COFORD rather than with OCLR

2.3 Inventory Preparation

2.3.1 GHG Inventory and KP-LULUCF Inventory

An emissions inventory database normally contains information on measured emission quantities, activity statistics (populations, fuel consumption, vehicle/kilometres of travel, industrial production, land areas), emission factors and the associated emission estimates for a specified list of source categories. In practice, very few measured data are available for greenhouse gases and, consequently, the emissions from most activities are estimated by applying emission factors for each source/gas combination to appropriate activity data for the activity concerned. Virtually all emissions and removals estimates may be ultimately derived on the basis of such simple product of activity data and emission factor. However, a certain amount of data analysis and preparatory calculations are generally needed in order to make available suitable combinations of activity data and emission factors at the level of disaggregation that gives the best estimates of emissions and removals. In the case of some source/gas combinations, such as methane emissions from solid waste landfills and CO_2 sequestration by forest biomass, it may be necessary to apply sophisticated models to generate the activity data, the emission factors or the emissions. The methods recommended by the Revised 1996 IPCC Guidelines (IPCC, 1997), IPCC Good Practice Guidance (IPCC, 2000) and IPCC Good Practice Guidance on LULUCF (IPCC, 2000) use a tier system to take account of these issues and other factors, such as data availability, technical expertise, inventory capacity and other circumstances, which may vary considerably across countries.

2.3.2 Data Collection Processing and Storage

Preparation for the annual GHG inventory takes place in an EXCEL spreadsheet system where activity data stored in *Source Data* files are linked to calculation sheets in *Data Processing* files that produce the emissions estimates at the lowest possible level of disaggregation, which are combined and allocated according to IPCC requirements for direct transmission into the CRF Reporter utility for the generation of the CRF tables. These results are stored in *Outputs* files while supporting QA/QC sheets extracted from *Data Processing* files are held in summary *QA/QC* record files. The *Data Processing* files hold the emission factors and they are structured on a time-series basis, which facilitates efficient recalculation and output to the CRF Reporter. This procedure applies to all IPCC sectors of the GHG inventory for which the calculations are made by the inventory team and the full set of files applicable to each year under the four headings is stored using appropriate version control on the OCLR servers. A national model is used to derive the estimates of emissions and removals for forest lands, which are incorporated in the overall scheme for LULUCF reporting under the Convention following the procedure outlined above.

Table 2.1 lists the principal data suppliers and the information that they are required to deliver to the inventory agency annually under MOU for the preparation of the GHG inventory. In some cases, e.g. the national energy balance, the input file received from the data supplier may be linked directly to the *Data Processing* files, but generally some degree of preparation and pre-processing is needed before the activity data are used in inventory preparation. The inventory team draws on various other data streams available within the EPA, such as the National Waste Database, reports on wastewater treatment, Annual Environmental Reports from companies subject to Integrated Pollution Prevention Control and submissions prepared under the European Pollutant Release and Transfer Register and also obtains information from other diverse sources to prepare the inventories for fluorinated gases and solvent use. A variety of databases related to land cover, soil type and forest areas are applied for the LULUCF inventory under the Convention. These include the National Forest Inventory (NFI), the Forest Inventory and Planning System (FIPS), the Land Parcels Information System (LPIS), CORINE

Land Cover Maps, the General Soil Map of Ireland, which are supported by statistical information from Bord na Mona and the National Roads Authority.

The static national model used for many years to estimate emissions and removals for forest lands for Convention reporting has been extensively developed to a dynamic version to provide the necessary estimates for Article 3.3 activities under the Kyoto Protocol. This work has been undertaken by FERS Ltd, the consultants working to COFORD, which supplies the Article 3.3 results to OCLR under an agreed MOU (Table 2.1). Secondary MOUs between COFORD and its data suppliers formalise annual data collection for this area of the inventory. The model contains a multitude of component modules needed to produce estimates of the carbon stock changes for the various carbon pools under afforestation and deforestation areas and for reporting any relevant emissions of CH_4 and N_2O. The model processes detailed spatially explicit data on forest species and soil type obtained from the NFI and FIPS and soils maps, supported by the Grants and Premiums Administration System (GPAS) and felling license records, using complex pre-processing functions, growth models, allometric equations and pool allocation and transfers to produce the results required for Article 3.3 activities.

2.3.3 Quality Assurance and Quality Control

In early 2005, the inventory agency in Ireland commissioned a project with UK consultants NETCEN to establish formal QA/QC procedures in emission inventories that would meet the needs of the UNFCCC reporting requirements. The project developed a QA/QC system including a documented QA/QC plan and procedures along with a QA/QC manual. The manual provides a general overview to the QA/QC system and guidance on the application of the plan and procedures. The QA/QC plan identifies the specific data quality objectives related to the principles of transparency, consistency, completeness, comparability and accuracy required for Ireland's national inventory and provides specific guidance and documentation forms and templates for the practical implementation of QA/QC procedures. The QA/QC procedures cover such elements as data selection and acquisition, data processing and reporting so that the international requirements under the Kyoto Protocol and Decision 280/2004/EC are met. The manual provides guidance and templates for appropriate quality checking, documentation and traceability, the selection of source data and calculation methodologies and peer and expert review of inventory data and outlines the annual requirements for continuous improvement for the inventory.

Table 2.2 Summary of Methods

IPCC SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFC	PFC	SF_6
1. Energy						
A. Fuel Combustion (Sectoral Approach)						
1. Energy Industries	Tier 2& 3	Tier 2& 3	Tier 2& 3	NA	NA	NA
2. Manufacturing Industries and Construction	Tier 1	Tier 1	Tier 1	NA	NA	NA
3. Transport	Tier 1& 2	Tier 1& 3	Tier 1& 3	NA	NA	NA
4. Other Sectors	Tier 1	Tier 1	Tier 1	NA	NA	NA
5. Other	NA	NA	NA	NA	NA	NA
B. Fugitive Emissions from Fuels						
1. Solid Fuels	NA	NA	NA	NA	NA	NA
2. Oil and Natural Gas	CS	CS	NA	NA	NA	NA
2. Industrial Processes						
A. Mineral Products	Tier 1& 2	NA	NA	NA	NA	NA
B. Chemical Industry	Tier 1	NA	Tier 1	NA	NA	NA
C. Metal Production	NA	NA	NA	NA	NA	NA
D. Other Production	NA	NA	NA	NA	NA	NA
E. Production of Halocarbons and SF_6	NA	NA	NA	NA	NA	NA
F. Consumption of Halocarbons and SF_6	NA	NA	NA	Tier 1,2& 3	Tier 2	Tier 1& 2
G. Other	NA	NA	NA	NA	NA	NA
3. Solvent and Other Product Use	CS, C	NA	NA	NA	NA	NA
4. Agriculture						
A. Enteric Fermentation	NA	Tier 1& 2	NA	NA	NA	NA
B. Manure Management	NA	Tier 1& 2	Tier 1	NA	NA	NA
C. Rice Cultivation	NA	NA	NA	NA	NA	NA
D. Agricultural Soils	NA	NA	Tier 1a,1b	NA	NA	NA
E. Prescribed Burning of Savannas	NA	NA	NA	NA	NA	NA
F. Field Burning of Agricultural Residues	NA	NA	NA	NA	NA	NA
G. Other	NA	NA	NA	NA	NA	NA
5. Land-Use Land-Use Change Change and Forestry						
A. Forest Land	Tier 1& 3	Tier 1	Tier 1	NA	NA	NA
B. Cropland	Tier 1	NA	Tier 1	NA	NA	NA
C. Grassland	Tier 1	NA	NA	NA	NA	NA
D. Wetlands	Tier 1	NA	Tier 1	NA	NA	NA
E. Settlements	Tier 1	NA	NA	NA	NA	NA
F. Other Land	Tier 1	NA	NA	NA	NA	NA
G. Other	NA	NA	NA	NA	NA	NA
6. Waste						
A. Solid Waste Disposal on Land	NA	Tier 2	NA	NA	NA	NA
B. Wastewater Handling	NA	Tier 1	Tier 1	NA	NA	NA
C. Waste Incineration	NA	NA	NA	NA	NA	NA
D. Other	NA	NA	NA	NA	NA	NA
7. Other	NA	NA	NA	NA	NA	NA

Article 3.3 Afforestation and Deforestation	Tier 3	Tier 1	Tier 1	NA	NA	NA
International Bunkers						
Aviation	Tier 1	D	D	NA	NA	NA
Marine	D	D	D	NA	NA	NA
Multilateral Operations	NA	NA	NA	NA	NA	NA
CO_2 Emissions from Biomass	Tier 1	Tier 1	Tier 1	NA	NA	NA

Tier 1 : IPCC Tier 1 or equivalent
Tier 2 : IPCC Tier 2 or equivalent
Tier 3 : IPCC Tier 3 or equivalent

CS : Country specific
C : CORINAIR
D : IPCC Default

Table 2.3. Summary of Emission Factors

IPCC SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFC	PFC	SF_6
1. Energy						
A. Fuel Combustion (Sectoral Approach)						
1. Energy Industries	PS, CS	D	D	NA	NA	NA
2. Manufacturing Industries and Construction	C	D	D	NA	NA	NA
3. Transport	CS	M, C	M, C	NA	NA	NA
4. Other Sectors	CS	D	D	NA	NA	NA
5. Other	NA	NA	NA	NA	NA	NA
B. Fugitive Emissions from Fuels						
1. Solid Fuels	NA	NA	NA	NA	NA	NA
2. Oil and Natural Gas	CS	CS	NA	NA	NA	NA
2. Industrial Processes						
A. Mineral Products	CS, PS, D	NA	NA	NA	NA	NA
B. Chemical Industry	CS	NA	CS	NA	NA	NA
C. Metal Production	NA	NA	NA	NA	NA	NA
D. Other Production	NA	NA	NA	NA	NA	NA
E. Production of Halocarbons and SF_6	NA	NA	NA	NA	NA	NA
F. Consumption of Halocarbons and SF_6	NA	NA	NA	CS	CS	CS
G. Other	NA	NA	NA	NA	NA	NA
3. Solvent and Other Product Use	C	NA	NA	NA	NA	NA
4. Agriculture						
A. Enteric Fermentation	NA	CS, D	NA	NA	NA	NA
B. Manure Management	NA	CS, D	D	NA	NA	NA
C. Rice Cultivation	NA	NA	NA	NA	NA	NA
D. Agricultural Soils	NA	NA	CS, D	NA	NA	NA
E. Prescribed Burning of Savannas	NA	NA	NA	NA	NA	NA
F. Field Burning of Agricultural Residues	NA	NA	NA	NA	NA	NA
G. Other	NA	NA	NA	NA	NA	NA
5. Land-Use Land-Use Change and Forestry						
A. Forest Land	CS, D	D	D	NA	NA	NA
B. Cropland	D	NA	D	NA	NA	NA
C. Grassland	D	NA	NA	NA	NA	NA
D. Wetlands	D	NA	D	NA	NA	NA
E. Settlements	D	NA	NA	NA	NA	NA
F. Other Land	D	NA	NA	NA	NA	NA
G. Other	NA	NA	NA	NA	NA	NA
6. Waste						

A. Solid Waste Disposal on Land	NA	CS, M	NA	NA	NA	NA
B. Wastewater Handling	NA	D	D	NA	NA	NA
C. Waste Incineration	NA	NA	NA	NA	NA	NA
D. Other	NA	NA	NA	NA	NA	NA
7. Other	NA	NA	NA	NA	NA	NA
Article 3.3 Afforestation and Deforestation	CS	D	D	NA	NA	NA
International Bunkers						
Aviation	CS	C	C	NA	NA	NA
Marine	CS	C	C	NA	NA	NA
Multilateral Operations	NA	NA	NA	NA	NA	NA
CO_2 Emissions from Biomass	C	C	C	NA	NA	NA

PS : Plant specific D : Default
CS : Country specific M : Model
C : CORINAIR

2.4 Methodologies and Emission Factors

Table 2.2 and Table 2.3 present summaries of the methodologies and emission factors used by Ireland to estimate GHG emissions reported for the years 1990-2008. Tier 2 or Tier 3 methods are used for the majority of CO_2 combustion source categories and country-specific emission factors are used for all fuels. Even for those combustion categories where data limitations dictate the use of Tier 1 methods, such as 1.A.2 and 1.A.4, the CO_2 emissions obtained using the energy balance fuel data and country-specific emission factors are reliable. Tier 2 methods also apply to important process sources of CO_2 emissions, such as cement and lime production, where country-specific circumstances are again taken fully into account. Ireland's national circumstances are well captured in the Tier 2 methods applied for the major sources of CH_4 in the inventory, which are enteric fermentation and manure management associated with cattle and the CH_4 emissions from solid waste disposal sites. Tier 2 and Tier 3 methods are used for CH_4 emissions from 1.A.1 Energy Industries and 1.A.3(b) Road Transport, respectively, while Tier 1 methods and IPCC default emission factors are used for other CH_4 emissions. Ireland relies on the simplified IPCC Tier 1 methodologies and default emission factors available to estimate all N_2O emissions in agriculture, which is the main source of N_2O in the inventory. Tier 2 and Tier 3 methods are used for N_2O emissions from 1.A.1 Energy Industries and 1.A.3(b) Road Transport, respectively, while Tier 1 methods and IPCC default emission factors are used for other N_2O emissions. The national model used to estimate carbon stock change in the various carbon pools for forest lands in respect of both Convention reporting and Article 3.3 activities is a Tier 3 methodology. The methods for CO_2 in other LULUCF categories and for relevant CH_4 and N_2O emissions in this sector are invariably Tier 1. More than 80 percent of the total emissions (excluding LULUCF) are covered by Tier 2 methods in Ireland's GHG inventory under the Convention and a Tier 3 model is applied for carbon stock changes for Article 3.3 activities under the Kyoto Protocol.

2.5 Overview of key Categories

The IPCC good practice guidance defines a key category as one that is prioritised within the national inventory system because its emission estimate has a significant influence on the Party's total inventory in terms of the absolute level of emissions, the trend in emissions or both. Information about key categories is considered to be crucial to the choice of methodology for individual sources and to the management and reduction of overall inventory uncertainty. The identification of such categories is recommended in order that inventory agencies can give them priority in the preparation of annual inventories, especially in cases where resources may be limited. Information on key categories is clearly also vital for the development of policies and measures for emissions reduction. The IPCC

good practice guidance provides several methods for undertaking the analysis of key categories that can be applied at any appropriate level of source aggregation, depending on the information available. The simplest Tier 1 approach is again used for 2008 to further highlight which sources of emissions are the most important in Ireland.

2.5.1 Key Categories at IPCC Level 2

As inventories of CO_2, CH_4 and N_2O were being developed in Ireland during the 1990s, it was quickly established that CO_2 emissions from fuel combustion made by far the largest contribution to the combined national total for these three primary greenhouse gases. It was also evident that CH_4 emissions produced by large cattle herds and the N_2O emissions from agricultural soils, associated with intensive farming practices and large inputs of nitrogen to agricultural soils, were also major sources, even if the estimates were more uncertain than those for CO_2. A good first estimate of key categories is therefore provided by considering the emissions aggregated at the IPCC Level 2 source category classification, which clearly indicates the importance of CO_2 emissions from fuel combustion and CH_4 and N_2O emissions from agriculture.

The results at the IPCC Level 2 source category classification may be readily drawn from the CRF Summary 2 and those for 1990 and 2008 are shown in Table 2.4 and Table 2.5, respectively. It can be seen that there are six highly significant key categories of emissions in Ireland. They are the CO_2 combustion sources *in 1.A.1 Energy Industries, 1.A.4 Other Sectors, 1.A.2 Manufacturing Industries and Construction* and *1.A.3 Transport,* along with the CH_4 emissions from category *4.A Enteric Fermentation* and N_2O emissions from *4.D Agricultural Soils*. These categories accounted for 85.2 percent and 89.0 percent of total emissions in 1990 and 2008, respectively. In the case of 2008 emissions, only two additional Level 2 source categories are needed to reach the cumulative 95 percent threshold that defines a key category. The increase in the contribution of CO_2 emissions from category *1.A.3 Transport* from 9.2 percent in 1990 to 20.8 percent in 2008 is notable, along with the corresponding reductions in the contributions from the two categories in *Agriculture*. This simple analysis of key categories continues to prove useful to the formulation of abatement strategies and for prioritising work on inventories in Ireland. When LULUCF is accounted for in the Level 2 analysis, the CO_2 removals in 5.A Forest Land become a key category in 2008.

Table 2.4. Key Categories at IPCC Level 2 in 1990

IPCC Level 2 Source Category		GHG	Emissions in 1990 Gg CO_2 eq	1990 Level Assessment %	Cumulative Total of Level %
1.A.1	Energy Industries	CO_2	11,158.61	20.36	20.36
1.A.4	Other Sectors(Comm/Resid/Agric)	CO_2	10,052.73	18.34	38.70
4.A	Enteric Fermentation	CH_4	9,493.47	17.32	56.02
4.D	Agricultural Soils	N_2O	7,008.17	12.79	68.81
1.A.3	Transport	CO_2	5,039.39	9.19	78.00
1.A.2	Manufacturing Industries and Construction	CO_2	3,940.06	7.19	85.19
4.B	Manure Management	CH_4	2,324.53	4.24	89.43
6.A	Solid Waste Disposal on land	CH_4	1,173.05	2.14	91.57

2.B.2	Nitric Acid Production*	N_2O	1,035.40	1.89	93.46
2.B.1	Ammonia Production*	CO_2	990.23	1.89	95.26

* nitric acid and ammonia plants ceased operation in 2002 and 2001, respectively

Table 2.5. Key Categories at IPCC Level 2 in 2008

IPCC Level 2 Source Category		GHG	Emissions in 2008 Gg CO_2 eq	2008 Level Assessment %	Cumulative Total of Level %
1.A.1	Energy Industries	CO_2	14,495.44	21.49	21.49
1.A.3	Transport	CO_2	14,061.80	20.85	42.34
	Other				
1.A.4	Sectors(Comm/Resid/Agric)	CO_2	10,923.78	16.20	58.54
4.A	Enteric Fermentation	CH_4	8,804.09	13.05	71.59
4.D	Agricultural Soils	N_2O	6,245.40	9.26	80.85
1.A.2	Manufacturing Industries and Construction	CO_2	5,522.95	8.19	89.04
4.B	Manure Management	CO_2	2,152.42	3.19	92.23
2.A.1	Cement Production	CH_4	2,106.73	3.12	95.35

2.5.2 Disaggregated key Categories

Ireland uses the Tier 1 methods provided in the IPCC good practice guidance to extend the analysis above to identify key categories that may be treated separately at a more disaggregated level, which gives more information about the individual sources or combination of sources and gases that are of most importance within a Level 2 category. The disaggregation corresponds generally to that at which the emissions are calculated and to that used for estimating uncertainty. The results of the analysis for the Tier 1 level assessment in relation to emissions in both 1990 and 2008 are presented in Table 2.6 and Table 2.7, respectively. Ranking in this way identifies those categories that should be prioritised in the inventory process itself and also the individual components of emissions that could be targeted by specific abatement measures. There is insufficient information available on uncertainties to allow for analysis using the Tier 2 methods. Results for Tier 1 trend assessment for 2008 are shown in Table 2.8. The results of the assessment for 2008 excluding LULUCF categories may be summarised as follows

(i) level assessment identifies 23 key categories;

(ii) there are 14 key categories of CO_2 in level assessment, accounting for 69.0 percent of total emissions;

(iii) there are five key categories of CH_4 and three key categories of N_2O in level assessment, which account for 16.0 percent and 9.3 percent, respectively, of total emissions;

(iv) *Energy* accounts for 13 key categories, *Agriculture* for seven while *Industrial Processes* contributes two and *Waste* contributes one;

(v) trend assessment identifies 21 key categories, all of which are key categories for level assessment;

(vi) there are 12 key categories of CO_2 in trend assessment, accounting for 76.5 percent of the total trend;

(vii) there are five key categories of CH_4 and three key categories of N_2O in trend assessment, which account for 10.5 percent and 6.6 percent, respectively, of the total trend.

The list of key categories given by level assessment in 2009 is very similar to that for 1990 but the higher ranking of the main CO_2 sources in *Energy,* at the expense of CH_4 and N_2O sources in *Agriculture*, is notable in 2008. The top ten key categories contributed 70.2 and 72.2 percent, of total emissions in 1990 and 2007, respectively. The emissions of CO_2 from fuel combustion in *1.A.1 Energy Industries* and from the use of petrol and diesel by road traffic were the largest source categories of greenhouse gas emissions in Ireland in 2008, accounting for approximately 21 percent each of the total. The CO_2 removals in category *5.A.1 Forest Land Remaining Forest Land* and the CO_2 emissions in *5.C.1 Grassland Remaining Grassland* are key categories in level assessment when the LULUCF sector is included in the detailed analysis. Similarly, CO_2 removals in category *A.1 Afforestation and Deforestation (*which are determined largely by *5.A.1 Forest Land Remaining Forest Land* under LULUCF) is a key category in 2008 when Article 3.3 activities are included instead of the LULUCF sector. Under trend assessment including LULUCF, two additional categories (*5.A.2 Land Converted to Forest Land* and *5.B.2 Land Converted to Cropland*) become key categories in 2008.

2.6 Quality Assurance and Quality Control

The inventory agency used the 2006 reporting cycle to begin implementation of the new approach to QA/QC developed for the national system and its application was completed and consolidated in delivering the submissions up to 2009. This involved the allocation of responsibilities linked to the national system and the use of a template spreadsheet system to record the establishment and maintenance of general inventory checking and management activities covering the overall compilation process, as well as the undertaking of specific annual activities and any necessary periodic activities in response to specific events or outcomes in inventory reporting and review. The system facilitates record keeping related to the chain of activities from data capture, through emissions calculations and checking, to archiving and the identification of improvements. The system has been carried forward for use in completing the 2010 submission.

Ireland's calculation spreadsheets in all sectors are structured and organised to facilitate the QA/QC process and more efficient time-series analysis and also to ensure ease of transfer of the outputs to the CRF Reporter Tool. This facilitates rapid year-on-year extension of the time-series, rapid inter-annual comparisons and efficient updating and recalculation, where appropriate, in the annual reporting cycle. Internal aggregation to various levels corresponding to the CRF tables provides immediate and complete checks on the results.

External reviews of the agriculture sector and of the entire ETS results for 2005 were conducted as important new components of quality assurance at the beginning of 2007. The review for Agriculture was performed by a technical inspector in the Department of Agriculture and Food using the new calculation files with a view to assessing the consistency of the time series which had been subject to considerable improvement and recalculation in the 2006 reporting cycle to account for higher tier methods for enteric fermentation in cattle and advice from the Department on various aspects of input data and calculation parameters. As there have been no further changes to the methodologies in

agriculture the detailed external review has not been repeated. However, the inventory agency continues to work closely with the Department and seeks advice and guidance from experts in Teagasc, who developed the improved methods, in relation to technical inventory matters that may arise. The ETS returns to the Agency's Office of Climate, Licensing and Resource Use (OCLR) provide for the complete coverage of CO_2 estimates for in a number of sub-categories under 1.A.1 Energy Industries and 2.A. Mineral Products. When the allocation to these categories from the ETS raw data is completed, the output is returned to the ETS administrator in OCLR for final checking against the source data. This ensures the efficient and consistent transfer of the verified ETS emissions estimates into the national inventory. Inventory development continues to benefit from the internal review procedures that are ongoing with regard to the EU and its Member States. The most recent work in this forum focused on harmonising the reporting relating to sub-categories under 2.A Mineral Products across the EU Member States.

2.7 Recalculations of Previously Submitted Inventory

Ongoing demands for more complete and more accurate estimates of greenhouse gas emissions means that the methodologies being used are subject to regular revision and refinement as inventory capacity is increased and better data become available. The general improvement in inventories over time may therefore introduce inconsistencies between the emissions estimates for recent years and those for years much earlier in the time-series. Recalculated estimates are often needed to eliminate these inconsistencies and to ensure that the inventories for all years in a time-series are directly comparable with respect to the sources and gases covered and that the methods, activity data and emission factors are applied in a transparent and consistent manner. In this way, the results can be used with greater confidence in identifying trends and in monitoring progress towards the commitments that have been defined with reference to emissions in the base year. The UNFCCC reporting guidelines provide for the reporting of recalculations as part of the annual submissions from Annex I Parties. Justification for the recalculations should be provided, as well as explanations of the changes that have been made and the numerical values of the original and revised estimates must be compared to show the impact of the changes.

Recalculations are systematically planned and undertaken annually by Ireland as part of the normal inventory reporting cycle. The recalculations reflect the inventory agency's own inventory development and improvement process and Ireland's response to the UNFCCC inventory review process. Each sectoral chapter of Ireland's NIR describes recalculations and improvements for the individual Level 1 source sectors of the inventory undertaken for the annual submission and they present the corresponding quantitative changes in emissions and removals within the individual sectors. Chapter 9 of the NIR records the major changes in regard to methodologies, activity data and emission factors and summarises the recalculations and assesses their effect in relation to total national emissions to record the updates and the most recent emissions estimates as they appear in the latest submission CRF tables. The original and revised numerical values of the emissions estimates for the years 1990-2007, along with the changes related to methods, activity data and emission factors are detailed in the respective CRF Tables 8(a) and 8(b) in the 2010 submission.

Table 2.6. Key Category Level Assessment 1990

1990 Rank	IPCC Sub-Category	Emission Source/Activity	Gas	1990 Emission exc LULUCF Gg CO_2 eq	1990 Emission LULUCF Gg CO_2 eq	1990 Absolute Values Gg CO_2 eq	1990 Level Assessment inc LULUCF %	Cumulative Level inc LULUCF %	1990 Level Assessment exc LULUCF %	Cumulative Level exc LULUCF %
1	1.A.1.	Energy Industries - Solid Fuels	CO2	8009.44		8009.44	13.97	13.97	14.61	14.61
2	1.A.4.b	Residential- Solid Fuels	CO2	5606.94		5606.94	9.78	23.76	10.23	24.84
3	4.A.1.	Enteric Fermentation - Non-Dairy Cattle	CH4	5546.63		5546.63	9.68	33.43	10.12	34.96
4	1.A.3.b.	Road Transportation - Liquid Fuels	CO2	4700.93		4700.93	8.20	41.64	8.58	43.54
5	4.A.1.	Enteric Fermentation - Dairy Cattle	CH4	2875.51		2875.51	5.02	46.65	5.25	48.78
6	4.D.1.	Agricultural Soils - Direct Soil Emissions	N2O	2861.74		2861.74	4.99	51.65	5.22	54.01
7	4.D.2.	Agricultural Soils - Pasture, Range and Paddock	N2O	2802.31		2802.31	4.89	56.53	5.11	59.12
8	1.A.2.	Manufacturing Ind & Const - Liquid Fuels	CO2	2195.69		2195.69	3.83	60.37	4.01	63.12
9	1.A.4.a.	Commercial/Institutional - Liquid Fuels	CO2	1976.61		1976.61	3.45	63.81	3.61	66.73
10	1.A.1.	Energy Industries - Gaseous Fuels	CO2	1880.66		1880.66	3.28	67.10	3.43	70.16
11	4.D.3.	Agricultural Soils - Indirect Emissions	N2O	1344.11		1344.11	2.35	69.44	2.45	72.61
12	1.A.1.	Energy Industries - Liquid Fuels	CO2	1268.51		1268.51	2.21	71.65	2.31	74.93
13	4.B.1.	Manure Management - Non-Dairy cattle	CH4	1255.57		1255.57	2.19	73.84	2.29	77.22
14	1.A.4.b	Residential - Liquid Fuels	CO2	1177.50		1177.50	2.05	75.90	2.15	79.37
15	6.A.	Waste - Solid Waste Disposal on land	CH4	1173.05		1173.05	2.05	77.94	2.14	81.51
16	2.B.	Chemical Industry	N2O	1035.40		1035.40	1.81	79.75	1.89	83.40
17	4.A.3.	Enteric Fermentation - Sheep	CH4	1032.48		1032.48	1.80	81.55	1.88	85.28
18	5.A.1	LULUCF - Forest Land Remaining Forest Land	CO2		-999.06	999.06	1.74	83.30		
19	2.B.	Chemical Industry	CO2	990.23		990.23	1.73	85.02	1.81	87.09
20	2.A.1.	Cement Production	CO2	884.00		884.00	1.54	86.57	1.61	88.70
21	1.A.2.	Manufacturing Ind & Const - Gaseous Fuels	CO2	873.14		873.14	1.52	88.09	1.59	90.29
22	1.A.2.	Manufacturing Ind & Const - Solid Fuels	CO2	871.24		871.24	1.52	89.61	1.59	91.88
23	1.A.4.c.	Agriculture/Forestry/Fisheries - Liquid Fuels	CO2	660.30		660.30	1.15	90.76	1.20	93.09
24	5.A.2.	LULUCF - Land Converted to Forest Land	CO2		659.24	659.24	1.15	91.91		
25	5.C.1	LULUCF - Grassland Remaining Grassland	CO2		621.96	621.96	1.09	93.00		
26	4.B.1.	Manure Management - Dairy Cattle	CH4	611.80		611.80	1.07	94.06	1.12	94.20
27	1.A.4.b	Residential - Solid Fuels	CH4	356.29		356.29	0.62	94.69	0.65	94.85
28	4.B.13.	Manure Management - Solid Storage	N2O	341.48		341.48	0.60	95.28	0.62	95.48

Table 2.7. Key Category Level Assessment 2008

2008 Rank	IPCC Sub-Category	Emission Source/Activity	Gas	2008 Emission exc LULUCF Gg CO_2 eq	2008 Emission LULUCF Gg CO_2 eq	2008 Absolute Values Gg CO_2 eq	2008 Level Assessment inc LULUCF %	Cumulative Level inc LULUCF %	2008 Level Assessment exc LULUCF %	Cumulative Level exc LULUCF %
1	1.A.3.b.	Road Transport - Liquid Fuels	CO2	13649.83		13649.83	19.15	19.15	20.24	20.24
2	1.A.1.	Energy Industries - Solid Fuels	CO2	6754.54		6754.54	9.47	28.62	10.01	30.25
3	1.A.1.	Energy Industries - Gaseous Fuels	CO2	6230.57		6230.57	8.74	37.36	9.24	39.49
4	4.A.1.	Enteric Fermentation - Non-Dairy Cattle	CH4	5593.34		5593.34	7.85	45.20	8.29	47.78
5	1.A.4.b	Residential - Liquid Fuels	CO2	3689.48		3689.48	5.17	50.38	5.47	53.25
6	1.A.2.	Manuf Ind and Const - Liquid Fuels	CO2	3085.03		3085.03	4.33	54.71	4.57	57.83
7	4.D.2.	Agricultural Soils - Pasture, Range & Paddock	N2O	2664.25		2664.25	3.74	58.44	3.95	61.78
8	4.A.1.	Enteric Fermentation - Dairy Cattle	CH4	2524.28		2524.28	3.54	61.98	3.74	65.52
9	4.D.1.	Agricultural Soils - Direct Soil Emissions	N2O	2375.10		2375.10	3.33	65.31	3.52	69.04
10	5.A.1	LULUCF - Forest Land Remaining Forest Land	CO2		-2368.95	2368.95	3.32	68.64		
11	1.A.4.b	Residential - Solid Fuels	CO2	2110.61		2110.61	2.96	71.60	3.13	72.17
12	2.A.1.	Cement Production	CO2	2106.73		2106.73	2.95	74.55	3.12	75.29
13	1.A.2.	Manuf Ind and Const - Gaseous Fuels	CO2	1941.45		1941.45	2.72	77.28	2.88	78.17
14	1.A.4.a.	Commercial/Institutional - Liquid Fuels	CO2	1684.62		1684.62	2.36	79.64	2.50	80.67
15	1.A.4.b	Residential - Gaseous Fuels	CO2	1592.58		1592.58	2.23	81.87	2.36	83.03
16	1.A.1.	Energy Industries - Liquid Fuels	CO2	1510.33		1510.33	2.12	83.99	2.24	85.27
17	4.D.3.	Agricultural Soils - Indirect Emissions	N2O	1206.05		1206.05	1.69	85.68	1.79	87.06
18	4.B.1.	Manure Management - Non-Dairy Cattle	CH4	1148.46		1148.46	1.61	87.29	1.70	88.76
19	1.A.4.a.	Commercial/Institutional - Gaseous Fuels	CO2	971.72		971.72	1.36	88.66	1.44	90.20
20	6.A.	Solid Waste Disposal on land	CH4	947.19		947.19	1.33	89.98	1.40	91.61
21	1.A.4.c.	Agriculture/Forestry/Fisheries - Liquid Fuels	CO2	771.19		771.19	1.08	91.07	1.14	92.75
22	4.A.3.	Enteric Fermentation - Sheep	CH4	633.11		633.11	0.89	91.95	0.94	93.69
23	5.C.1	LULUCF - Grassland Remaining Grassland	CO2		595.75	595.75	0.84	92.79		
24	2.F.	Consumption of F Gas and SF6	HFC	517.36		517.36	0.73	93.51	0.77	94.46
25	1.A.2.	Manuf Ind and Const - Solid Fuels	CO2	496.47		496.47	0.70	94.21	0.74	95.19
26	4.B.1.	Manure Management - Dairy Cattle	CH4	473.89		473.89	0.66	94.88	0.70	95.90
27	4.B.8.	Manure Management - Pigs	CH4	402.59		402.59	0.56	95.44	0.60	96.49

Table 2.8. Key Category Trend Assessment 2008 (excluding LULUCF)

Rank	Category	Emission Source	Gas	Emissions in 1990 Gg CO_2 eq	Emissions in 2008 Gg CO_2 eq	Level Assessment %	Trend Assessment	Contribution to Trend %	Cumulative Contribution to Trend %
1	1.A.3.b.	Road Transport - Liquid Fuels	CO2	4700.93	13649.83	20.24	9.48	21.91	21.91
2	1.A.4.b	Residential - Solid Fuels	CO2	5606.94	2110.61	3.13	5.77	13.34	35.24
3	1.A.1.	Energy Industries - Gaseous Fuels	CO2	1880.66	6230.57	9.24	4.72	10.91	46.15
4	1.A.1.	Energy Industries - Solid Fuels	CO2	8009.44	6754.54	10.01	3.74	8.64	54.79
5	1.A.4.b	Residential - Liquid Fuels	CO2	1177.50	3689.48	5.47	2.70	6.24	61.03
6	1.A.4.b	Residential - Gaseous Fuels	CO2	269.73	1592.58	2.36	1.52	3.51	64.54
7	4.A.1.	Enteric Fermentation - Non-Dairy Cattle	CH4	5546.63	5593.34	8.29	1.48	3.43	67.97
8	4.D.1.	Agricultural Soils - Direct Soil Emissions	N2O	2861.74	2375.10	3.52	1.38	3.19	71.16
9	2.A.1.	Cement Production	CO2	884.00	2106.73	3.12	1.23	2.84	74.00
10	4.A.1.	Enteric Fermentation - Dairy Cattle	CH4	2875.51	2524.28	3.74	1.22	2.82	76.83
11	1.A.2.	Manuf Ind and Const - Gaseous Fuels	CO2	873.14	1941.45	2.88	1.04	2.41	79.24
12	4.D.2.	Agricultural Soils - Pasture, Range & Paddock	N2O	2802.31	2664.25	3.95	0.94	2.18	81.42
13	1.A.4.a.	Commercial/Institutional - Liquid Fuels	CO2	1976.61	1684.62	2.50	0.90	2.08	83.51
14	1.A.4.a.	Commercial/Institutional - Gaseous Fuels	CO2	223.37	971.72	1.44	0.84	1.94	85.45
15	4.A.3.	Enteric Fermentation - Sheep	CH4	1032.48	633.11	0.94	0.77	1.78	87.22
16	1.A.2.	Manuf Ind and Const - Solid Fuels	CO2	871.24	496.47	0.74	0.69	1.60	88.83
17	2.F.	Consumption of F Gas and SF6	HFC	0.69	517.36	0.77	0.62	1.44	90.26
18	6.A.	Solid Waste Disposal on land	CH4	1173.05	947.19	1.40	0.60	1.38	91.65
19	4.D.3.	Agricultural Soils - Indirect Emissions	N2O	1344.11	1206.05	1.79	0.54	1.25	92.89
20	4.B.1.	Manure Management - Non-Dairy Cattle	CH4	1255.57	1148.46	1.70	0.48	1.10	94.00
21	1.A.2.	Manuf Ind and Const - Liquid Fuels	CO2	2195.69	3085.03	4.57	0.46	1.07	95.07

2.8 General Summary 1990-2007

In recent years, emissions have fallen from a peak of 26.9% above 1990 levels in 2001 to 25% above 1990 levels in 2007, mainly due to:

- increasing use of natural gas in the power generation sector;
- the closure of ammonia and nitric acid production plants in 2002; and,
- reduction in the size of the national livestock herd.

Total emissions of the six greenhouse gases in Ireland (excluding net CO_2 from Land Use Change and Forestry) increased steadily from 55.38 million tonnes CO_2-equivalent in 1990 to 70.65 million tonnes CO_2-equivalent in 2001 and then decreased slightly to 68.58 million tonnes CO_2-equivalent in 2003. Emissions increased again in 2004 and 2005 to 68.60 and 70.26 million tonnes respectively. In 2007 emissions decreased by 0.7 percent to 69.21 million tonnes, which is 25 percent higher than in 1990.

In 2007, the Energy sector accounted for 66.7 percent of total emissions. Agriculture contributed 25.6 percent while a further 4.7 percent emanated from Industrial Processes and 2.8 percent was due to Waste. Emissions of CO_2 accounted for 67.2 percent of the national total in 2007, with CH_4 and N_2O contributing 18.7 percent and 11.7 percent, respectively. The combined emissions of HFC, PFC and SF_6 accounted for 1 percent of total emissions in 2007. The Energy and Industrial Processes sectors account for the bulk of the CO_2 emissions, CH_4 emissions are produced mainly in the Agriculture and Waste sectors and most of the N_2O emissions are generated in Agriculture.

Greenhouse gas emissions associated with road traffic increased by 4.9 percent in 2007, making this source category the main contributor to the sustained high level of emissions for Ireland. There was a decrease of 3.7 percent in emissions from electricity generation in 2007 while the emissions from agriculture, which account for a large proportion of Ireland's emissions, decreased by 3.7 percent.

Greenhouse Gas Emissions 1990-2007 (Million tonne CO_2 equivalent)

Fig. 2.1 Emissions by gas (excluding LULUCF)

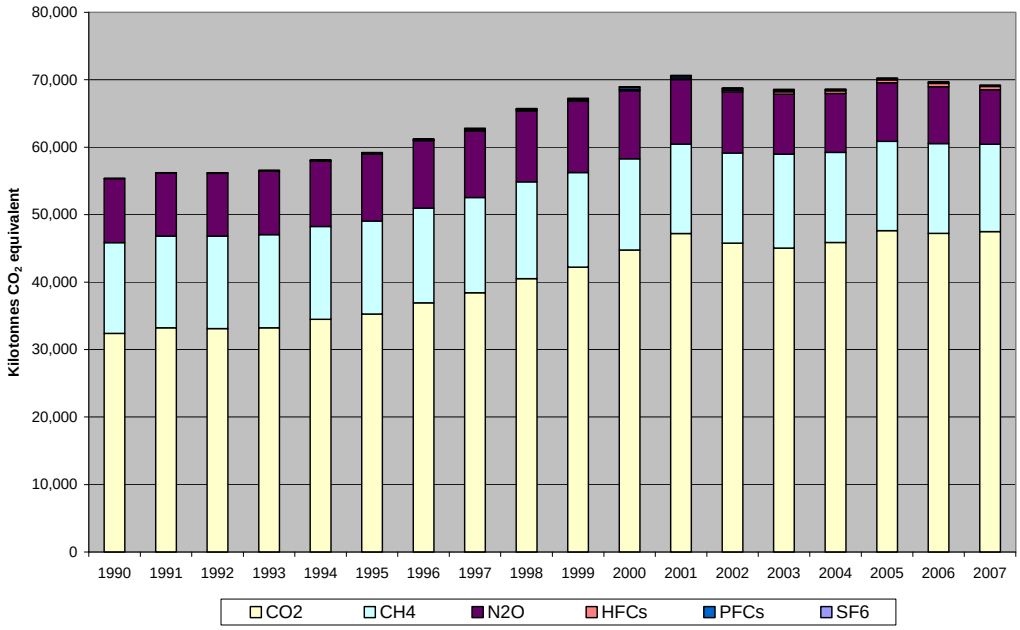
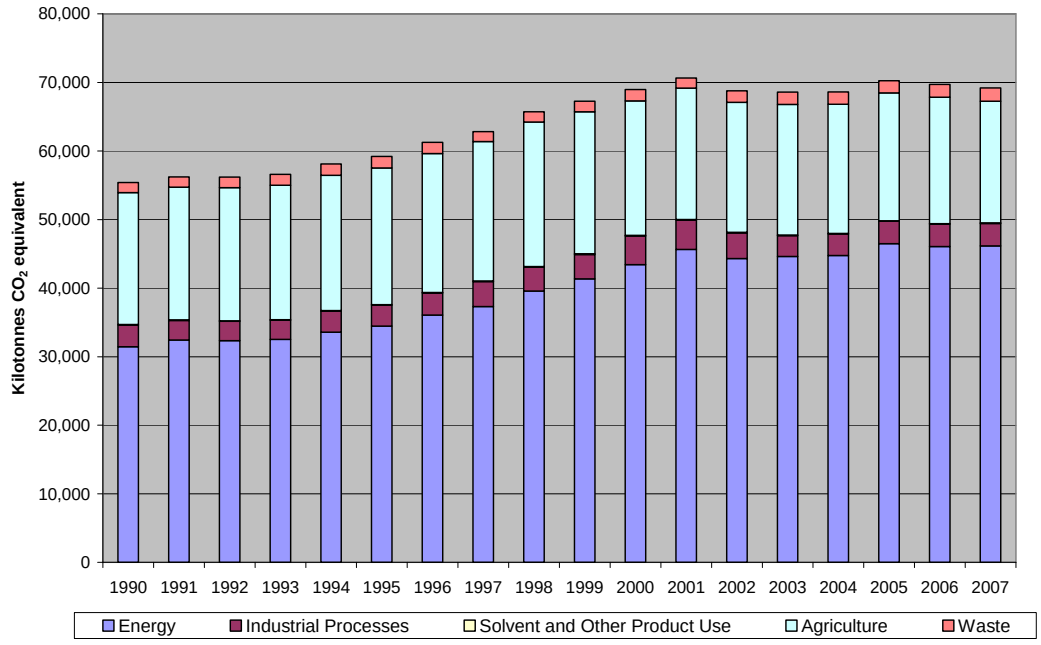


Fig. 2.2 Emissions by Sector (including LULUCF)



2.9 Carbon Dioxide CO_2.

Emissions of CO_2 accounted for 67.2 percent of the total (excluding LULUCF) of 69.21 million tonnes CO_2 equivalent in 2007, increasing from 32.64 million tonnes in 1990 to 46.48 million tonnes in 2007, an increase of 42.4 percent. The main driver behind this increase in emissions is fuel combustion in energy industries and transport.

There continues to be heavy reliance on carbon intensive fuel for electricity generation and as electricity demand increased steadily during the 1990s, the associated CO_2 emissions from energy industries increased by 46.8 percent from 31.45 million tonnes CO_2 equivalent in 1990 to 46.16 million tonnes in 2007. The increase occurred during the 1990s, driven by major increases in emissions from energy industries and transport, and emissions are comparatively stable between 2001 and 2007. Some reductions were achieved in 2002, 2003 and 2004 from improvements in energy efficiency and fuel switching as some new electricity producers entered the market, but subsequently increased in 2005 as two new peat fired power stations came into service. Emissions in 2006 decreased again due to a reduction in the use of Moneypoint coal-fired station for the installation of pollutant control measures, while further reductions in 2007 are largely as a result of the displacement of oil by natural gas.

In 2007 transport emissions stood at 14.38 million tonnes, a 4.7% increase on 2006 levels to 13.73 million tonnes. In 1990 transport emissions stood at 5.17 million tonnes, meaning that by 2007 levels had increased by 178% from 1990 levels. The increase in transport emissions is largely accounted for by a 190.8 percent increase in road transport associated emissions over the same period due to sustained growth in the use of passenger cars and goods vehicles. Ireland has only a small number of energy intensive industries and emissions of CO_2 from combustion in the industrial sector accounted for only 8.8 percent of total emissions in 2007, these emissions increased by 53.4 percent between 1990 and 2007.

In the residential sector, while total energy consumption increased by 29.1 percent from 1990 to 2007 there has been a decline in the use of carbon-intensive fuels, such as peat and coal and greater use of oil and natural gas. The emissions of CO_2 from coal and peat use in the residential sector decreased by 64.4 percent between 1990 and 2007, while those from oil and natural gas more than tripled over this period.

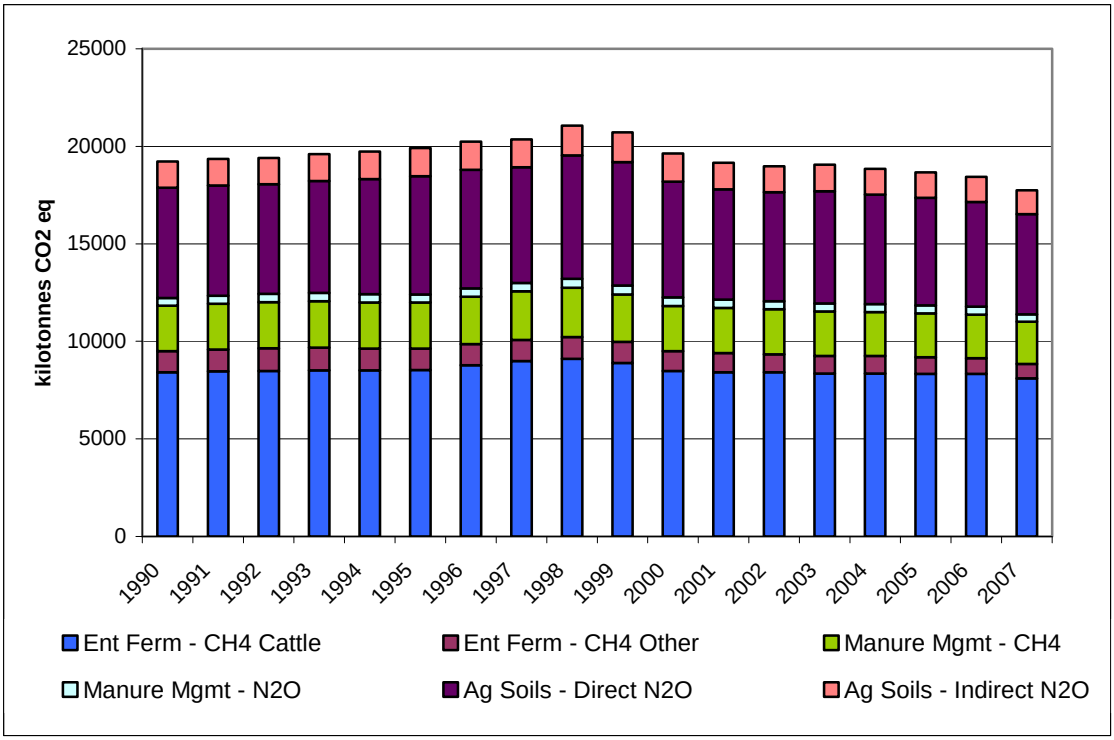
2.10 Methane (CH_4).

Emissions of CH_4 accounted for 18.73% of the total 69.205 million tonnes CO_2-equivalent in 2007, with 84.9% of this from the agriculture sector and the remainder from waste disposal and the energy sector.

The livestock populations produce about 0.52m tonnes of CH_4 annually through enteric fermentation and manure management. Methane emissions from agriculture have shown a decrease between 1990 and 2007 of 0.039 Kt. However, it is likely there will be a small further reduction from this source category as the size of the national herd is predicted to fall.

The waste sector is an important source of CH_4 emissions, the contribution of which is increasing steadily due to the continued dominance of landfill as a means of solid waste disposal in Ireland. Emissions in the waste sector increased by 32.5 percent from 1,461.00 Kt CO_2 equivalent in 1990 to 1,936.25 Kt in 2007. This figure takes into account the recovery of landfill gas for energy production and flaring at landfill sites, without which emissions in this sector would be considerably larger.

Fig. 2.3 Emissions from Agriculture



2.11 Nitrous Oxide N_2O.

Emissions of N_2O accounted for 11.6% of the total 69.205 million tonnes CO_2-equivalent in 2007, with 83.9% of this from the agriculture sector (of which 94.3% from agricultural soils) and the remainder is from the energy sector, from industrial process and waste source categories.

The largest single agricultural 'crop' in Ireland is grassland to feed the national cattle herd and this is maintained by the sustained application of appropriate dressings of chemical fertiliser to supplement the recycled organic manures produced on farms. Together, these two categories produce most of the nitrous oxide emissions from agriculture – there is also a small emission associated with crop residues and N-fixing crops.

Total agricultural emissions have fallen from 19,228 million tonnes CO_2e in 1990 to 17,747 million tonnes CO_2e in 2007. Fertiliser use has fallen from 379 Kt in 1990 to 321 Kt in 2007, reflecting an improvement in fertiliser use efficiency.

Emissions of N_2O decreased by 15.1% from their 1990 levels, to 8,043.09 Kt CO_2e in 2007, having peaked in 1999 reflecting increased use of synthetic fertilisers and increased amounts of organic manures associated with increasing animal numbers over the 1990 to 999 period. Emissions of N_2O subsequently show a downward trend following the closure of Ireland's only nitric acid plant in 2002 and reductions in synthetic fertiliser use and organic manure applications as a result of the effect of CAP reform on animal numbers.

2.12 F-gases (HFC, PFC, and SF_6).

Emissions of the F-gases accounted for only 1% of the total 69.205 million tonnes CO_2-equivalent in 2007, with 71 percent of these emissions from HFCs, 18.6 percent from PFCs and 10.4 percent from SF_6. There has been an eleven fold increase in emissions of HFCs between 1995 and 2007, mainly as a result of HFC use in refrigeration and air conditioning. Over the same period, PFC emissions increased overall, however after 1997 PFC emissions decreased, only to significantly increase in 2000. A downward trend has been evident since then and emissions in 2007 were 130.58 kilo tonnes CO_2 equivalent. Emissions of SF_6 have declined by almost 12% over the period 1995-2007. Despite increases in the F-gases overall between 1995 and 2007, they still only account for 1% of overall emissions.

Chapter 3: POLICIES AND MEASURES

3.1 CLIMATE CHANGE STRATEGY

Since the Fourth National Communication was published, the policy context for the principal greenhouse gas emitting sectors has continued to evolve. A new National Climate Change Strategy was published in 2007, and this has been backed up *inter alia* by major new strategy documents in the areas of sustainable transport and energy efficiency. New policies and measures have been introduced, some of which were envisaged by the 2007 National Climate Change Strategy, while others derive from measures agreed at European Union level.

Table 3.1 lists the expected impact of the various planned and adopted policies and measures in the years 2010, 2015 and 2020 summarised by type and sector. Energy efficiency targets based on EU requirements and domestic policy will lead to further savings which have been quantified by not yet formally identified.

Table 3.1 – Annual Reduction as a result of Adopted and Planned Measures Mt CO_2e

Measure Category	**2010**	**2015**	**2020**
All Renewables	2.01	4.04	6.22
Reduced energy demand from energy efficiency measures	2.06	2.25	2.13
Other Electricity measures	0.30	0.38	0.98
Other Transport measures incl efficiency improvements	0.47	0.86	1.01
Other Industry measures	0.41	0.75	1.06
Other Commercial/Services Sector measures	0.08	0.28	0.60
Other Residential measures	0.23	1.04	1.85
Landfill directive	0.01	0.42	0.89
Energy Efficiency Targets further potential measures	0.00	0.16	0.79
Afforestation	2.24	3.43	4.35
Total	**7.80**	**13.62**	**19.86**

A more detailed description of sector specific policies and measures, and their impact on overall projected emissions are outlined in Section 3.3 and in Chapter 4.

National primary legislation on climate change is being developed in line with the policy document on a *Framework for a Climate Change Bill 2010* issued in December 2009. It is intended that this legislation will, *inter alia*, provide a legal basis for national emission reduction goals in the short, medium and long term. It is also intended to provide for the establishment of a national advisory body to monitor and assess Ireland's progress in addressing both mitigation and adaptation, and to provide advice to the Government in moving forward the climate change agenda.

3.2 CROSS-SECTORAL MEASURES

Cross-sectoral measures will be used to provide an across-the-board incentive for a wide range of actions to reduce emissions. The Kyoto target cannot be met by actions in one, or indeed in a limited number of sectors; action is required to be taken across all sectors.

Economic instruments comprise a variety of measures, which use market processes to achieve objectives. These include measures to change prices of goods or services, and the development of carbon markets where they do not currently exist.

3.2.1 Emissions Trading in Ireland

A significant contribution to the achievement of the national greenhouse gas emission reduction target for the purposes of the Kyoto Protocol will be made by firms in the energy and industry sectors that are covered by the EU Emissions Trading Scheme (EU-ETS). Collectively these firms account for some 33% of total national greenhouse gas emissions. The EU-ETS was brought into operation on 1 January 2005 with a three-year pilot phase from 2005 to 2007. A substantive five-year trading period began in January 2008 to coincide with the compliance period under the Kyoto Protocol. The EU-ETS is the largest 'cap and trade' scheme in the world covering 27 EU States and over 10,000 industrial installations. Effective participation by over 100 Irish installations in the EU-ETS has been a policy priority since the scheme commenced in 2005.

Under the Scheme, responsibility for a portion of each EU Member State's national emissions reduction targets is placed on individual emitters of greenhouse gases, primarily large industrial and power generation facilities. The Scheme provides an incentive for individual installations to reduce their emissions through having the amount of carbon dioxide they can emit capped. Installations that succeed in reducing their emissions below the capped level can sell surplus allowances. For some, it may be more cost-effective to purchase allowances arising from emissions reductions by other firms than to reduce their own emissions. The key rationale behind emissions trading, therefore, is to achieve emissions reductions at least cost through a market mechanism.

Firms in the EU ETS have been able to purchase credits, with some exceptions, from the Kyoto Protocol's project-based mechanisms – Joint Implementation (JI) and the Clean Development Mechanism (CDM) - to provide a cost-effective way of achieving compliance with their target under the scheme. As well as being able to purchase credits, firms can now invest in projects to reduce emissions inside or outside the EU through JI or CDM and convert the credits they earn from those projects into allowances that can be used for compliance under the EU scheme.

In accordance with terms of the EU ETS, each Member State is required to outline in its National Allocation Plan (NAP) the basis on which allocations of free greenhouse gas emission allowances are made to individual installations covered by the EU ETS. Ireland's most recent NAP was approved by the EU Commission on 5 February 2008. This NAP2 is in respect of the Kyoto period 2008 to 2012 and outlines the allocations of greenhouse gas emission allowances to be made under the EU ETS to Ireland's major greenhouse gas emitters for the period. These allocations are issued to the installations on an annual basis over the 5 years. This NAP2 follows the first NAP (NAP1) which covers the period 2005 to 2007 and which was approved by the EU Commission on 7 July 2004.

3.2.2 Government use of the Kyoto Protocol Flexible Mechanisms

The flexible mechanisms available under the Kyoto Protocol allow the Government to acquire allowances arising from emission reduction initiatives elsewhere in the world. The Government recognises that greenhouse gas emissions are not limited by national boundaries; the effect is global rather than local. A tonne of carbon dioxide released or reduced anywhere in the world will have the same effect on the climate system. The mechanisms included in the Kyoto Protocol are designed to ensure that a global problem can be addressed in a global manner.

The National Climate Change Strategy signalled the possibility of supplementing greenhouse gas emission reductions with the purchase of up to 3.6 million carbon units on average each year in the five-year Kyoto Protocol commitment period 2008-2012 or 18 million units in total, costing €270m, at a projected unit price of €15.

Under the Carbon Fund Act 2007, the National Treasury Management Agency has been designated as purchasing agent for the Irish State. In 2008, the Agency purchased 3.455m certified emission reduction units at a cost of some €53m. In 2009, they have purchased 1.8m units at a cost of some €21.6m. These units were generated under the Clean Development Mechanism provided for in Article 12 of the Kyoto Protocol.

In December 2006, Ireland entered into an agreement with the European Bank for Reconstruction and Development to invest €20 million in the Multilateral Carbon Credit Fund. Ireland also committed €10 million each to the Carbon Fund for Europe and the BioCarbon Fund operated by the World Bank. These investments are expected to yield some 3 million credits during the five–year Kyoto Protocol commitment period 2008 – 2012.

The economic downturn has implications for the purchasing programme and recent projections suggest that purchasing requirements may now be significantly less than originally signalled in the National Climate Change Strategy. In the circumstances, the National Treasury Management Agency has been asked to put its purchasing programme on hold for the foreseeable future. Purchasing requirements to ensure Kyoto compliance are being kept under review and will be revised as necessary in the light of future projections.

3.2.3 European Climate Energy Package

At the European Council of December 2007, the EU committed to a unilateral emission reduction of 20% by 2020. The EU Climate Energy Package agreed at the end of 2008, sets out each Member State's share of that effort. In the non-traded sector, Ireland's emission reduction for 2020 will be 20% on 2005 emission levels. The Emissions Trading System, amended as part of the package will deliver a 20% reduction on an EU-wide basis.

3.2.4 Meeting Ireland's Kyoto Commitments

During the most recent round of Emissions Projections the Environmental Protection Agency was asked to publish a sensitivity analysis which took account of the rapidly deteriorating outlook on economic growth at that time. This sensitivity analysis, known as the 'Economic Shock Analysis' is the basis for the following comments. This analysis points to the fact that Ireland would likely meet its Kyoto Protocol target in aggregate but not without recourse to the

flexible mechanisms of the Kyoto Protocol as discussed above. Emissions in the Emissions Trading Scheme are projected to average 16.6 Mt, which is below the total allocation of permits for that sector. In the non traded sector further measures will be required in order to meet the target through:

- further measures to be decided on by the Government, over and above those in Table 3.1 and
- use of the Kyoto Protocol flexible mechanisms by Government to purchase carbon allowances.

The National Allocation Plan for the period 2008-2012 was agreed by Ireland and the European Commission and published in March of 2008. This determined that the total annual allocation to Irish installations would be 22.3 Mt, of which a portion is reserved for new entrants and CHP (1.9 Mt) and a further portion is retained by the Environmental Protection Agency in order to defray the costs of running the scheme in Ireland(0.1 Mt). At the time of publication it was envisaged that the sector would be responsible for 3.02 million tonnes per annum of the national distance to target, through a combination of internal emissions reductions or the purchase of allowances although this has proven an over estimate due to the downturn in economic activity.

Table 3.2 shows that the balance of the distance to target, expressed as a range 1.3-1.8 Mt per annum, is to be addressed across the whole economy. Any emission-reducing measures that are adopted over and above those set out in Table 3.1, will count under this heading. Since those projections were published the Government has announced the introduction of a carbon tax on fossil fuels of €15 per tonne that will be gradually introduced over the course of 2009 and 2010. A new set of emissions projections will become available later in 2010 which are based on an up to date economic outlook and which should facilitate a more specific projection for the Kyoto Protocol commitment period.

Table 3.2: Approach to meeting Ireland's Kyoto Protocol target

Million tonnes per annum	**Emissions Trading Sector**	**Rest of Economy**	**TOTAL**
Average annual emissions 2008-2012 without any action	16.6	41.8-42.3	58.4-58.9
Share of reduction	n/a	1.3-1.8	1.3-1.8
Target	**22.638**	**40.394**	**63.032**

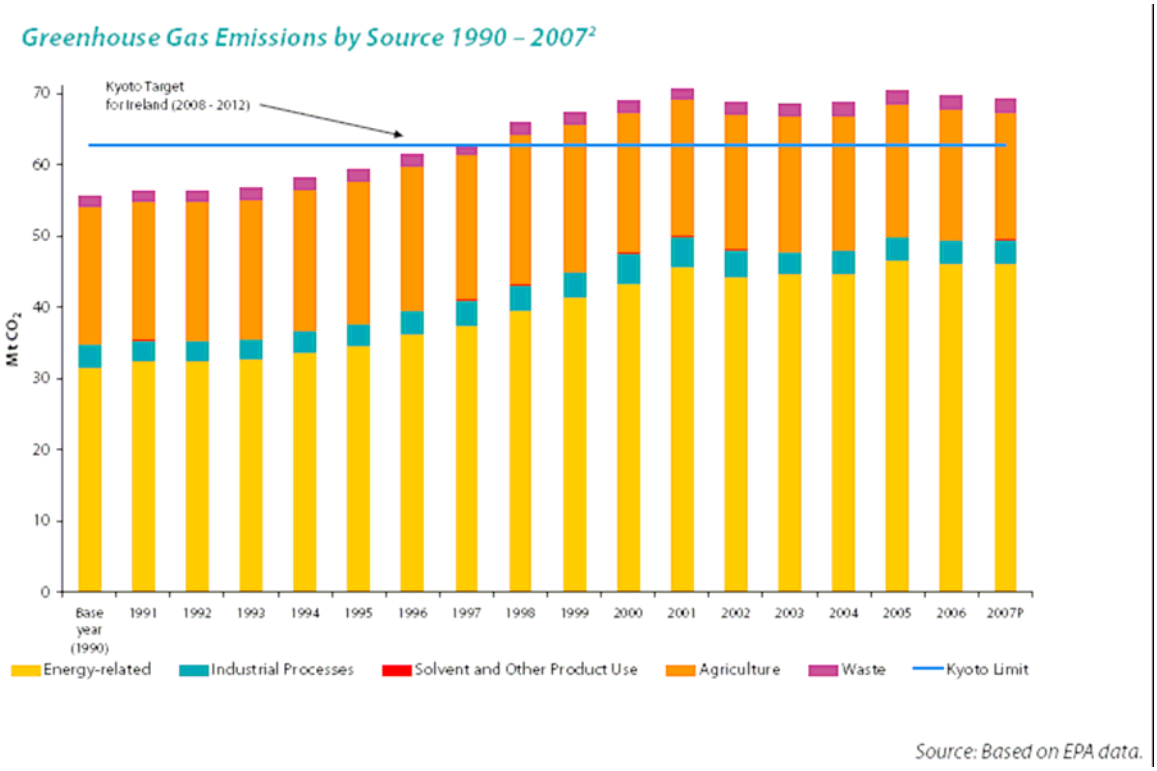
3.3 SECTOR SPECIFIC MEASURES

3.3.1 ENERGY SECTOR

Figure 3.1 shows that the share of Greenhouse Gas Emissions (GHG) arising from energy related Activities. The Environmental Protection Agency published projections of greenhouse gas emissions in September 2008 incorporating existing measures (*with measures*) in the National Climate Change Strategy (NCCS) 2007 – 2012. These indicate that emissions levels

may rise to 72 Mt CO_2 equivalent per annum during the Kyoto period (29% above 1990 levels and 9.0 Mt CO_2 equivalent above the Kyoto target). Figure 3.1 shows the trend in annual GHG emissions for the period 1990 – 2007 (with 2007 figures being provisional). The emissions are grouped according to the individual source. These are energy, industrial processes (including cement production), solvent and other product use, agriculture and waste.

Figure 3.1: Greenhouse Gas Emissions by Source



Source: Based on EPA data.

Figure 3.2 shows the trend in Total Fuel Consumption (TFC) over the period, here allocated to each of the sectors of the economy. Over the period the relative weighting of the sectors has changed. Transport has continued to increase its dominance (since the mid 1990s) as the largest energy consuming sector (on a final energy basis) with a share of 43% while the share of industry and residential have decreased.

Figure 3.2:

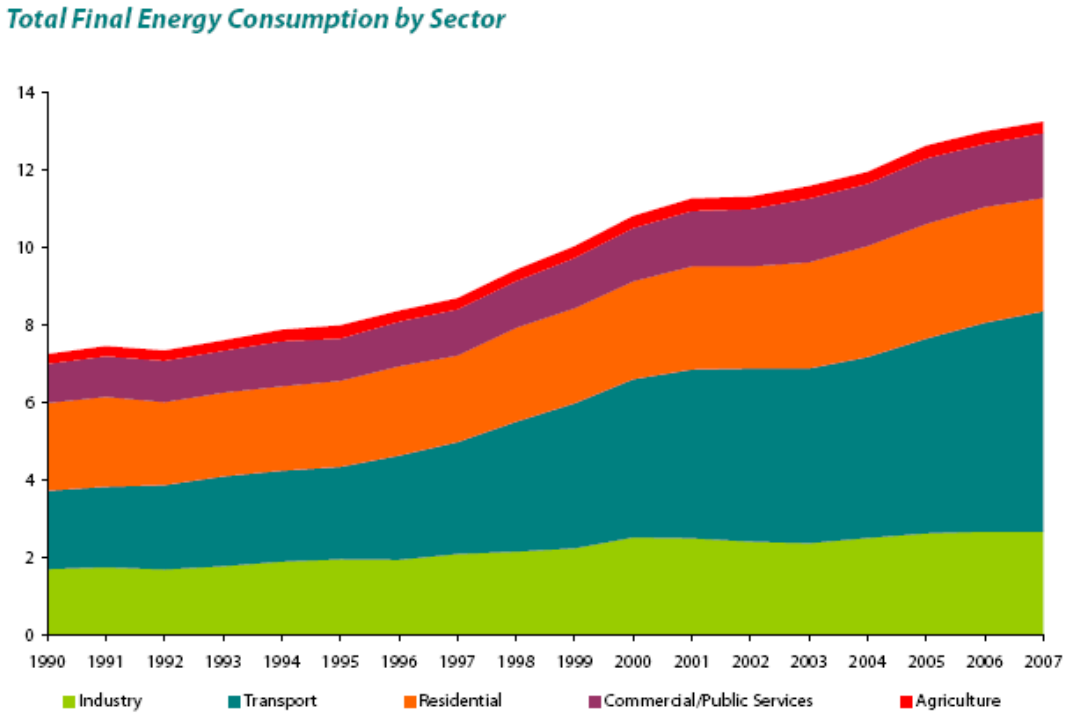


Table 3.3 Growth rates and shares of TFC per sector

	Growth %	Average annual growth rates %						Shares %	
	1990 – 2007	'90 – '07	'90 – '95	'95 – '00	'00 – '05	'05 – '07	2007	1990	2007
Industry	56.1	2.7	2.8	5.2	0.8	0.9	0.1	23.7	20.3
Transport	181.1	6.3	3.4	11.3	4.3	6.3	5.5	27.8	42.9
Residential	29.1	1.5	-0.4	2.6	3.2	-0.6	-2.4	31.1	22.0
Commercial / Public	65.9	3.0	1.6	4.6	4.2	-0.4	3.0	13.9	12.6
Agriculture	19.3	1.0	6.2	-1.4	1.2	-5.4	-6.5	3.5	2.3
Total	82.6	3.6	2.0	6.2	3.1	2.4	1.9		

The changes in growth rates are tabulated in Table 3.3 and summarised as follows:

- Overall final energy consumption increased by 1.9%. This was achieved with just a 1.4% growth in primary energy requirement.
- Transport final energy use increased by 181% over the period 1990 – 2007. Final consumption of energy in transport was 5.7 Mtoe in 2007. This represents an average annual growth rate of 6.3% and transport's share of TFC increased from 28% to 43%. Growth in 2007 was 5.5%, the highest sectoral growth in the year. In the period 2005 – 2007, transport energy demand grew by 6.3% per annum, while demand in all other sectors reduced or grew at a rate of less than 1% per annum
- Industry's final energy use increased by 0.1% (to 2.7 Mtoe) in 2007. Over the 1990 – 2007 period industry experienced an average growth rate of 2.7% per annum (or 56% in absolute terms) and its share of TFC dropped from 24% to 20%. Since 2000, industry energy demand growth has been less than 1% per annum on average, in contrast to the growth levels in the late 1990s of more than 5% per annum, Final energy use in the residential sector fell by 2.4% in 2007 and by 0.6% per annum in the period 2005 - 2007. Fossil fuel use decreased by 3.4% in households and electricity use decreased by 0.2%. Renewable energy use in the residential sector, on

the other hand, increased by 42%, due to the Greener Homes Scheme, albeit from a low base

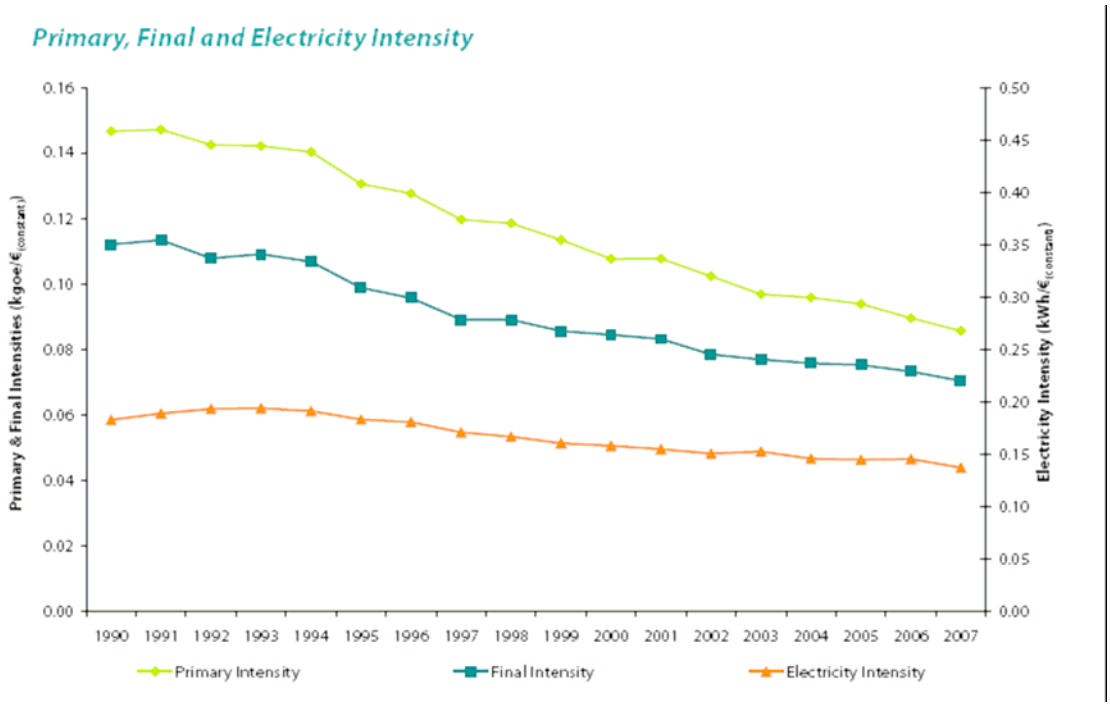
- The commercial and public services sector experienced an increase of 3% in final energy use in 2007 but saw a reduction over the period 2005 – 2007 of 0.4% per annum.
- The agricultural sector's relative share fell from 3.5% in 1990 to 2.3% in 2007 although final energy consumption grew by 19% to 0.3 Mtoe (1.0% per annum). In absolute terms, agriculture also experienced a decrease of 6.5% in energy consumption in 2007.

3.3.1.1. Energy Intensity

The intensity of primary and final energy and of electricity requirements have been falling (reflecting improving energy productivity) since 1990 as shown in Figure 3.3. The primary energy intensity of the economy fell by 42% between 1990–2007. (3.1% per annum). In 1990 it required 0.15 kilograms of oil equivalent (kgoe) to produce one euro of GDP (in constant 2006 values) whereas in 2007 just 0.09 kgoe was required. This would suggest that the economy is continuing to become more energy efficient.

Figure 3.3 shows the trend in both primary (TPER/GDP) and final (TFC/GDP) energy intensities (at constant 2006 prices). The difference between these two trends reflects the amount of energy required in the transformation from primary energy to final energy – primarily used for electricity generation. Throughout the 1990s there has been a slight convergence of these trends, particularly since 1994, mostly reflecting the increasing efficiency of the electricity generation sector. The recent improvement in the transformation sector is illustrated from 2001 onwards when primary intensity fell at a faster rate than final intensity. The decrease in primary intensity since 2001 was 20% whereas for final intensity the decrease was 15%.

Figure 3.3 Primary, Final and Electricity Intensity



Final electricity intensity of the economy has not been falling as fast as primary or final energy intensities. Over the period 1990–2007 the electricity intensity fell by 25%. This is attributed to the shift towards increased electricity consumption in energy end use. While electricity consumption increased by 118% since 1990 (4.7% average annual growth), final energy demand increased by 83% (3.6% annual growth).

3.3.1.2 Energy Efficiency

Irish energy efficiency policy seeks to contribute to the competitiveness of the economy, maintain security of supply, and meet the needs of a sustainable environment. It also fulfils social objectives such as the alleviation of fuel poverty. Much of the challenge in creating a sustainable energy environment lies in the ability to influence consumer behaviour and to provide the technical capability to make the switch to sustainable energy practices. Energy efficiency policies require the effective engagement of all actors – regulators, utilities, local authorities, companies and individuals – in investment decision-making and everyday actions. The aim is to ensure that energy efficiency principles are at the core of such decisions.

Figure 3.4 shows how energy efficiency relates to energy use and the benefits derived from energy use. The horizontal axis indicates the change in energy use, increasing from left to right. The vertical axis shows the change in benefits derived from the energy use, increasing from bottom to top. The left hand side of the graph corresponds to energy conservation, i.e. a reduction in energy usage. The green dotted line that moves from the bottom left quadrant to the top right quadrant separates the graph into two areas associated with increasing or decreasing energy efficiency. This shows that:

- Energy efficiency can coincide with increasing energy usage (top-right quadrant to the left of the green dotted line), as long as the benefits of energy usage are increasing at a faster rate than the energy.
- Energy conservation does not always result in increasing energy efficiency, when the benefits are decreasing more rapidly than the energy use is (bottom-left quadrant to the right of the green dotted line).

A decline in energy use with increasing benefits (top-left quadrant) always corresponds to increasing energy efficiency.

Figure 3.4- Explaining Energy Efficiency

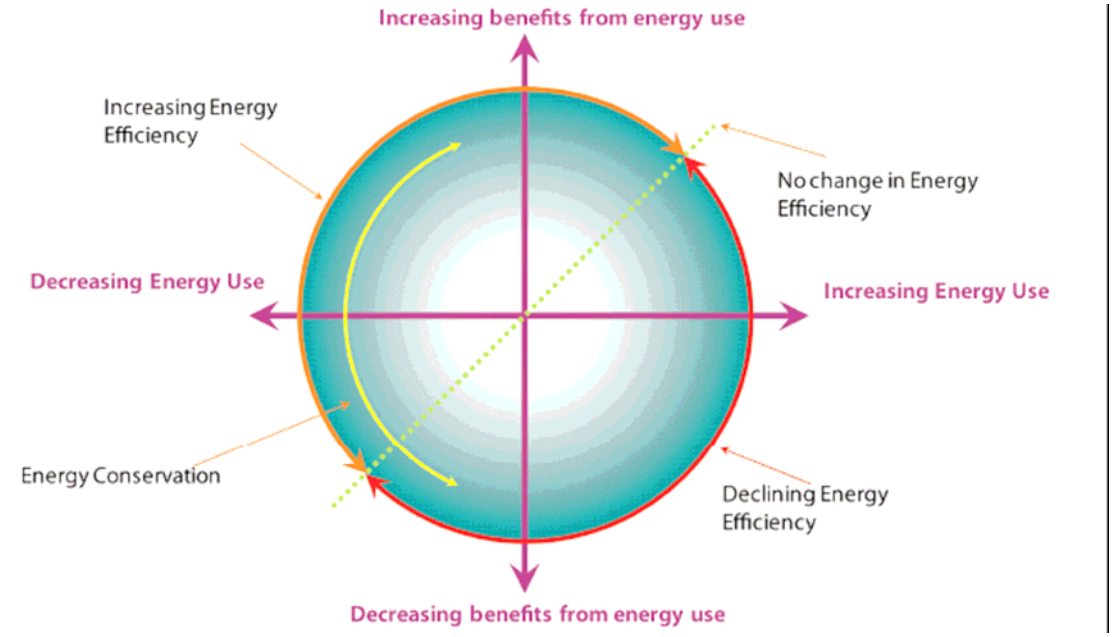
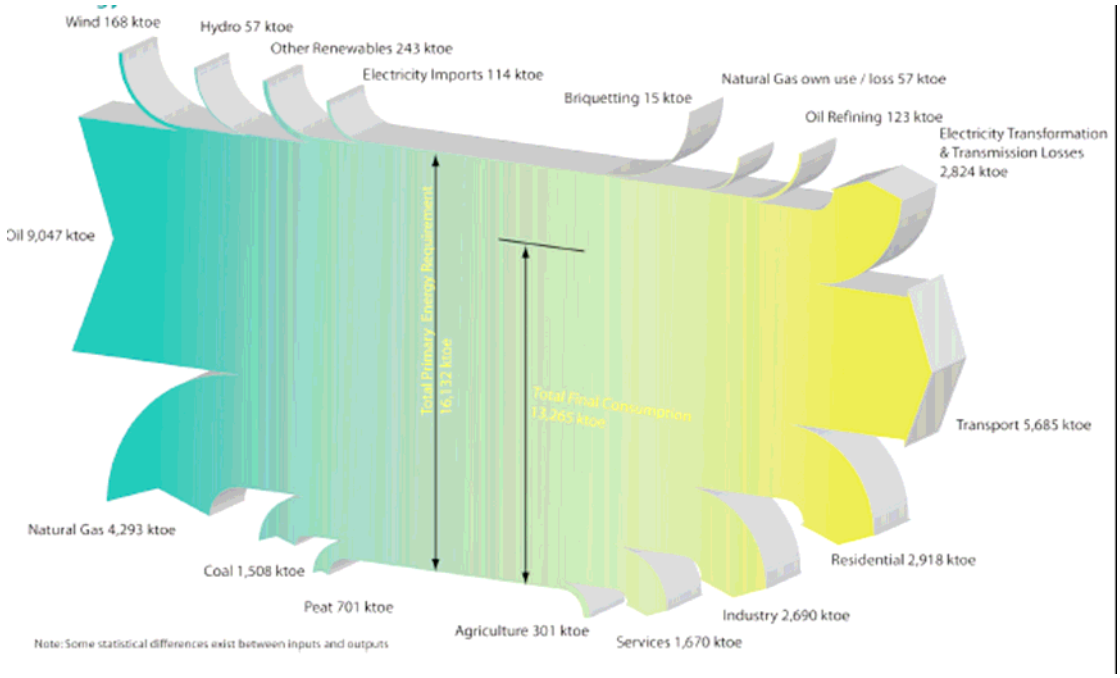


Figure 3.5 shows the energy balance for Ireland in 2007 as a flow diagram. Primary fuel inputs are shown on the left while TFC outputs, by sector, are illustrated to the right. Figure 4 illustrates clearly the significance of each of the fuel inputs as well as showing how much energy is lost in transformation.

Figure 3.5: Energy Flow in Ireland 2007

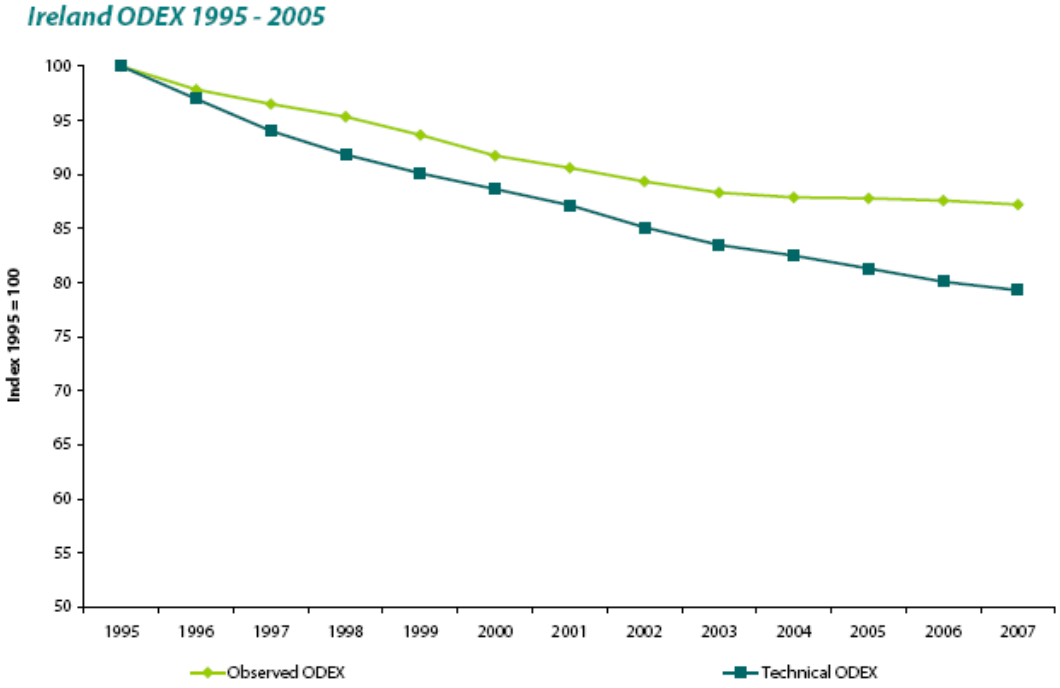


In 2006, SEI developed a new set of metrics for Ireland, known as ODEX indicators, to examine the evolution in energy efficiency in Ireland.

The ODEX indicators are referenced in the Energy End-use Efficiency and Energy Services Directive (ESD). They are innovative compared to similar indices as they aggregate trends in unit consumption by sub-sector or end-use into one index per sector based on the weight of each sub-sector/end-use in the total energy consumption of the sector. The sectoral indicators can then be combined into an economy wide indicator. The observed ODEX shows that between 1995 and 2007 there was a 13% (1.1% per annum on average) decrease, which means a 13% improvement in energy efficiency. To separate out the influence of behavioural factors, a technical ODEX is calculated and used to better assess the technical energy efficiency progress. As shown in Figure 9, technical efficiency improved by 21% (1.9% per annum) from 1995 to 2007.The difference between the two indicators is the effect of behavioural effects13 i.e. Ireland would have achieved the greater reduction in energy efficiency but for the increases in energy usage due to behaviour.

Figure 3.6 presents two ODEX indicators for Ireland for the period 1995 – 2007.

Figure 3.6 Ireland ODEX 1995-2005



In 2008 Ireland developed its first National Energy Efficiency Action Plan (NEEAP) 2009-2020. The plan was published in 2009 and outlines policies and measures that will contribute to achievement of Ireland's national 20% energy savings target for 2020. Since then, a national consultation period has been completed and the document developed to address both Ireland's 9% ESD target for 2016, and our national 20% energy savings target for 2020.

SEI's most recent publication, *Energy Efficiency in Ireland 2009,* examines energy usage and efficiency. The research examines energy trends, based on the most recent data available and adds to our understanding of how we use energy and what policies and measures are required to improve our efficiency further. The report shows that Ireland performed better than the European average for energy efficiency gains in both the residential and industrial

sectors. The Irish economy recorded savings of €750 million in 2007 as a result of energy efficiency measures undertaken since 1995. The economy recorded a 10% improvement in energy efficiency between 1995 and 2007 and the savings made in 2007 alone were the equivalent to the annual energy usage of half a million houses.

The main highlights from an energy efficiency perspective include:

- Total final consumption of energy in the economy would have been 8.4% higher in 2007 were it not for energy efficiency improvements made since 1995
- The energy savings due to energy efficiency improvements recorded in 2007 were two and a half times greater than the contribution of renewable energy
- Energy efficiency for industry improved by 16% between 1995 and 2007
- Energy efficiency for the residential sector improved by 15% in the same period
- Despite the fact that transport energy use grew faster than the economy between 1995 and 2007, energy efficiency in the sector improved slightly by 1.4%.

Energy efficiency is a key element of Ireland's energy and economic policy and SEI's report underlines the important role it plays. The carbon emissions savings made as a result of energy efficiency measures greatly exceed the contribution from renewable energy.

The report also shows that Ireland's final energy usage increased by 66% (4.3% per annum) between 1995 and 2007. Despite this increase, Ireland scores highly in most areas of energy efficiency when compared with the rest of the EU-15, showing a 10% improvement when compared to the EU-15's average of 9%. In the Transport sector however, Ireland was ranked second lowest for energy efficiency improvements.

Grid 2025

EirGrid, Irelands electricity transmission system operator, published its Grid25 strategy to deliver a reliable electricity network out to 2025. In the study, "Grid25", EirGrid outlines its plan to double the capacity of the national transmission grid by 2025, by upgrading the existing network and by constructing new transmission infrastructure. The investment is estimated at €4 billion, including an estimated €800 million investment in the eastern region, as well as a €310 million investment in the midlands and €830 million in the southeast.

The regional basis of grid development will facilitate regional harnessing of Ireland's abundant renewable energy resources to provide clean and competitively priced electricity to both homes, business and potentially for export.

3.3.1.3 Renewable Energy

3.3.1.3.1 Renewable Energy (RE)R&D Programme:

The goal of the Renewable Energy Research, Development and Demonstration programme (RERD&D) is to accelerate the deployment rate of renewable-energy technology and thus improve implementation of renewable energy in the Irish market. This goal is achieved by providing support for product R&D, market demonstration activity and studies to investigate market barriers. The current programme strategy is focused on areas in which utility-scale, grid-connected renewable energy features strongly**.**

3.3.1.3.2 Small- and Micro- Scale Generation Pilot Field Trials:

The key objectives of SEI's Small- and Micro- Scale Generation Programme are to assess technical, financial and regulatory issues surrounding the deployment of small and micro generation technologies in Ireland. The programme includes a detailed review of commercial arrangements and potential supports for small scale and micro-generation and the definition of quality standards for products and installers as well as the pilot trial of monitored installations.

3.3.1.3.3 Ocean Energy Development Unit

The Ocean Energy Development Unit (OEDU) has been established to accelerate the research and development of ocean energy (wave and tidal technologies) in Ireland. The Unit specifically will advance the deployment of ocean energy technologies in Ireland by increasing the capacity for relevant research and development both in academic institutions and commercial entities in Ireland.

3.3.1.3.4 Renewable Heat and Combined Heat & Power Deployment programme

The Renewable Heat Deployment (ReHeat) programme aims to increase the deployment of renewable heating technologies in the commercial and industrial sectors. With an indicative budget of €26 million for 2006-2010, the programme provides financial assistance for boilers fuelled by wood chips and wood pellets, solar thermal collectors, and heat pumps.

The *CHP Deployment* programme aims to increase the deployment of small-scale (<1MWe) fossil-fired and biomass CHP systems across Ireland in accordance with the requirements of the EU Directive on CHP. This is achieved by means of grant assistance of up to 30% of the cost of equipment purchase and installation, as well as a 40% grant for qualifying feasibility studies. The programme focuses on applicants from the commercial, agricultural, industrial and service sectors as well as energy supply companies (ESCOs).

3.3.2 TRANSPORT SECTOR

Transport has remained the fastest growing contributor to national greenhouse gas (GHG) emission levels in Ireland. In 2007 transport emissions stood at 14.38 million tonnes, a 4.7% increase on 2006 levels of 13.73 million tonnes. In 1990 transport emissions stood at 5.17 million tonnes, meaning that by 2007 levels had increased by 178% from 1990 levels.

Road transport accounts for 97% of accounted transport emissions. The increase in transport GHG emissions is a direct result of increased energy demand, in the form of petrol and diesel, from the sector.

The underlying trends that have caused this increase in emissions from 1990-2007 are many and well known. They include rapid increases in GDP, strong population growth, increased demand for housing (with construction leading to strong growth in freight sector emissions), urban sprawl and increased car ownership. Between 1990 and 2007 the number of private cars in Ireland increased from 796,000 in 1990 to 1.88 million in 2007. Mode share of car drivers for travel to work increased from 38% in 1990 to 64% in 2006. The settlement patterns of our population have meant that the average distance travelled to work increased from 7.7.km at the time of the 1991 Census, to 15.8km at the time of the 2006 Census. The

increase in population, car ownership and average distances travelled have resulted in the marked transport emission increases since 1990.

Clearly the current state of the economy is leading to reductions in transport demand and a consequent reduction in emissions, however, emissions projections published by the EPA in March 2009 suggest that transport emissions will continue to grow in the longer term, with emissions in 2020 being between 11% and 25% higher in 2020 than they were in 2007. Therefore, a significant challenge remains.

3.3.2.1 Smarter Travel Policy

In 2009, the Department of Transport began progressing the actions set out in the Smarter Travel Policy. This policy contains a number of high level targets that, if achieved as hoped, will result in significant emissions reduction in 2020 compared to business as usual. The objectives contained in the policy aim to ensure that:

- There will be a considerable shift to public transport and other sustainable forms of travel.
- The present levels of traffic congestion and travel times will be significantly reduced.
- Ease of access to public transport congestion and other sustainable forms of travels will be improved for all citizens, irrespective of location and mobility needs.
- The transport system will enhance Ireland's economic competitiveness.
- A reduction in greenhouse gas emissions and increased efficiency in the transport sector will contribute to Ireland's international commitments regarding climate change.
- Emissions of other atmospheric pollutants from transport will continue to be reduced.
- Land use planning and the provision of transport infrastructure and services will be better integrated.
- Individual and collective quality of life will be enhanced.
- Health risks and the incidence of accidents and fatalities will be reduced.
- Individual awareness will be heightened to understand and accept the changes in behaviour necessary and level of responsibility required to achieve the vision.

To meet these objectives, 49 actions are outlined. These are broadly classified under 4 key headings.

1. Actions to reduce distance travelled by private car and encourage smarter travel, including focusing population and employment growth predominantly in larger urban areas and the use of pricing mechanisms or fiscal measures to encourage behavioural change.
2. Actions aimed at ensuring that alternatives to the car are more widely available, mainly through a radically improved and more accessible public transport service and through investment in cycling and walking.
3. Actions aimed at improving the fuel efficiency of motorised transport through improved fleet structures, energy efficient driving, and alternative technologies resulting in a reduction in environmentally damaging greenhouse gas emissions from the transport sector.
4. Actions aimed at strengthening institutional arrangements to deliver the targets.

To date good progress has been made in implementing this policy. Steps undertaken include:

- The National Sustainable Travel Office (NSTO) was established as a division within the Department of Transport to oversee the many initiatives in the policy.
- A Local Authority Network has been established to provide for structured liaison between central and local government to ensure the Government's vision is delivered consistently and in accordance with best international practice at local level in Ireland.
- Ireland's first National Cycle Policy Framework was launched in April 2009. It outlines 19 specific objectives, and details the 109 individual but integrated actions, aimed at ensuring that a cycling culture is developed in Ireland so that by 2020, 10% of all journeys will be by bicycle.

3.3.2.2 Green Schools Travel Programme

The Green Schools Travel Programme, funded by the Department of Transport and run by An Taisce, has engaged the country's school children and can be held up as one of the most successful "green" initiatives ever undertaken. 317 schools are now involved in this programme, which translates into involvement by 70,000 pupils. By 2012, 265,000 pupils will be involved in the programme. Their involvement in the various actions, which promote walking, cycling, carpooling and use of public transport in turn engages parents and the wider community, raising awareness. Year 2 of the 5 year programme delivered with 76,000 children reached by 2009, resulting in a reduction of car journeys to school by 18%.

3.3.2.3 Cycling facilities

Over recent years, despite various attempts to improve the lot of cyclists, including limited investment in cycle lanes and facilities, the popularity of cycling has steadily declined. The numbers using a bicycle for commuting fell from 7% in 1986, to 4.2% in 1996 and to 2% in 2006.

Ireland's first National Cycle Policy framework (NCPF) was launched in April 2009. The actions set out in the policy aim to create a new culture of cycling in Ireland by 2020 with 10% of all trips to work being made by bike within the next twelve years. That will mean an extra 125,000 people commuting to work by bike.

International experience indicates that having an NCPF can be a powerful tool to encourage cycling in urban areas. Such a framework can provide a common, integrated basis for the long term development and implementation of cycling policies among various sectors and levels of government. At the highest level, all planning should consider the needs of cyclists. This should be articulated in all National, Regional, Local and sub-local plans. Cycle friendly urban planning principles will cover the need to keep distances between origin and destination short, through making developments permeable (i.e. easy for pedestrians and cyclists to pass through without making long detours) and well connected.

3.3.2.3 National Car Test (NCT)

All member States of the European Union are required to test the roadworthiness of motor vehicles. Cars are due a roadworthiness test once they are four years old and every two years thereafter.

The following show the number of cars which underwent the National Car test in Ireland in recent years:

- In 2006, 681,799 full tests were conducted with a pass rate of 52.7% while 415,386 retests were conducted with a pass rate of 93.2%.
- In 2007, 686,705 full tests were conducted with a pass rate of 51.8% while 330,997 retests were conducted with a pass rate of 86.3%.
- In 2008, 835,802 full tests were conducted with a pass rate of 51.9% while 402,125 retests were conducted with a pass rate of 86.8%

Changes to NCT Car Test

During 2008, the Road Safety Authority, in consultation with its Technical Advisory Forum, reviewed the current car testing specification. Following on from that review the RSA have sought approval from the Minister to (a) have additional test items included in the National Car Test (NCT) from 1 April 2010 and (b) the annual testing of cars over 10 years old from the later date of 1 June 2011. A submission is being prepared in relation to those proposed amendments.

3.3.2.4 Fuel Efficiency Measures

The Department of Transport, the Road Safety Authority and Sustainable Energy Ireland are all involved in the promotion of fuel efficient driving or eco-driving. As part of the Government's Smarter Travel Policy a module will be included in the national driving test on efficient driving. It is envisaged that all public authorities will ensure that their drivers are trained in efficient driving and that this is part of their job specification. There will be a sustained focus on the issue of driver behaviour as part of the Climate Change Awareness Campaign.

3.3.2.5 Fiscal Measures to influence travel behaviour

3.3.2.5.1 VRT and Motor Tax

The Government has already introduced appropriate fiscal policies by ensuring that the VRT and Motor Tax systems, from July 2008, are entirely based on CO_2 emissions with rates considerably varying between models on the basis of their emissions. This has had a positive impact, with initial indications suggesting that average emissions of new cars purchased following the changes are up to 8% less than before the changes.

3.3.2.5.2 Tax exemption for public transport commuting

The TaxSaver Commuter Ticket Scheme was initiated in 1999, and can be availed of by any employer or employee. Under the scheme, employers and employees may receive tax relief on the cost of annual or monthly bus, Luas or rail tickets. The incentive is a positive way to encourage more people to choose public transport for their journeys. In 2009 approximately 1,800 companies (public and private sector) availed of the scheme offered by Dublin Bus, Iarnród Éireann and LUAS and other approved operators.

3.3.2.6 Technological Improvements

There are potential alternative technologies for motor vehicles, which are likely to have a significant impact beyond 2020 as technology is developed. These include plug in and electric fuelled vehicles.

The Government has set a target of 10% of all vehicles in the transport fleet to be powered by electricity by 2020. This will represent some 250,000 cars on Irish roads over the next 12 years.

The Electric Vehicles plan includes:

- Tax incentives for business to purchase electric vehicles.
- A €500,000 project by Sustainability Energy Ireland (SEI) to research, develop and demonstration of electric vehicles nationally.
- Assistance for individuals purchasing electric vehicles – publication of a "Buyers Guide" and a "Cost of Ownership Calculator" by SEI
- Establishment of a National Task Force which will examine infrastructure options for national roll-out of electric vehicles, including street charging.

The Government will provide leadership through the use of alternative technologies in the public vehicle fleets and will require every public sector organisation and public transport provider to prepare a plan for fleet replacement based on the most sustainable vehicle and fuel type.

In 2008 the Department of Transport invested €425,000 in Ireland's first Hybrid Electric Bus which forms part of one of Dublin Bus's cross city routes. The bus is powered by a 2.4 litre Ford Transit Euro 4 diesel engine and a Siemens hybrid electric drive system, supported by lithium ion batteries and regenerative braking.

The indications are that the bus can deliver fuel savings of up to 30% on normal diesel powered buses. A 30% savings on fuel for Dublin Bus across all its buses would equate to some 10.8 million litres of diesel annually, and an emissions saving of 29,000 tonnes of CO_2e.

3.3.2.7 Transport 21

Transport 21 continues to provide the strategic framework guiding Government investment in national roads and public transport up to 2015. In the light of the changed economic circumstances, it has been necessary to review investment priorities. The priorities for investment in national roads are the completion of the five major interurban routes (Dublin to Border, Cork, Galway, Limerick and Waterford) by 2010 and the progressive development of the Atlantic Road Corridor. The provision of increased capacity will be the key consideration in determining public transport investment priorities. In the Greater Dublin Area this includes Metro North, DART Underground and associated investment on the suburban rail network and bus priority investment. The bus-related investment will be influenced by the Deloitte cost and efficiency review of the CIE bus companies and the availability of current funding for public service obligations.

3.3.2.8 Freight

Road freight accounts for the bulk of Irish freight transport. The efficient movement of goods is vital to our competitiveness and economic welfare. 65% of our GDP is based on the export of goods and services whereas the EU-25 average is 30%. At present 95% of all goods are moved by road and over 30% of transport greenhouse gas emissions are from the freight sector. A specific target to reduce energy and emissions from the freight sector is needed while at the same time enhancing our economic competitiveness. Action 10 of the Smarter Travel policy framework outlines Government's intention to set a target aimed at reducing the environmental impact of freight while at the same time improving efficiency in the movement of goods and promoting economic competitiveness.

3.3.2.9 Maritime Transport

Our ports are vital to our national interest. They handle 99% of our exports, by volume, and provide valuable access passenger services to the island. As part of the transport framework policy Ireland will continue to contribute to EU and IMO advances which benefit Ireland as well as other countries, in protection of the marine environment and human health from the ill effects of ship-sourced pollution.

Under IMO terms – and covering international (not coastal or internal) shipping – all marine fuels for use on board ships will, from 1 January, 2012, have sulphur content of less than 3.5%m/m, (the present limit being less than 4.50%m/m). In an Emissions control Area (ECA) the current limit is less than 1.50%m/m after 1 July 2010, though Irish seas have no ECA. Under IMO terms ship engines will be altered to reduce Nitrogen Oxide emissions, the first major improvement set for 1 January, 2011. The new fuels and engine specification will benefit human health and environment for inland waterways as well as marine areas.

3.3.2.10 Demand Management

3.3.2.10.1 Relationship between transport and spatial policies

Demand-side measures, correctly targeted, seek to maximise the efficiency of the transport network by managing the demand for travel and influencing patterns of commuting behaviour. Demand management comprises a range of measures, including:

- land use policies that bring homes, workplaces and services closer together or facilitate better links with public transport, cycling or walking;
- soft measures to reduce car use including e-working, car sharing, flexible working hours and individual or workplace travel plans; and
- fiscal measures to encourage sustainable travel behaviours and discourage unsustainable travel once the relevant infrastructural investment has taken place.

The Government's objective is to support sustainable travel by requiring that future population growth and population growth and employment will predominantly take place in sustainable compact urban areas or rural areas, thereby discouraging dispersed development and long distance commuting.

The recently established National Transport Authority (NTA) will have overall responsibility for integrated transport planning and delivery for the Greater Dublin Area (GDA) comprising

Dublin City and County, Kildare, Meath and Wicklow. The NTA will set out the framework for the delivery of infrastructure and services in an integrated transport plan covering a 12 to 20 year period. It will prepare a traffic management plan for the GDA so as to ensure a consistent approach across all local authority areas. Most traffic management functions will continue to be discharged by the local authorities within the strategic framework provided by the Authority. However, the Authority will be able to decide to carry out certain functions itself if it judges this to be most effective and to give directions to local authorities.

The Authority will be closely engaged in each stage of the planning process i.e. from the Regional Planning Guidelines through City and County Development Plans to Local Area Plans, in order to ensure the fullest consistency between the Authority's transport strategy and the land use planning process. At the same time, the Authority's transport strategy will have to be consistent with the Regional Planning Guidelines in the GDA.

One of the objectives of the transport framework policy is to strengthen legislative provisions to support sustainable development. A new Planning and Development (Amendment) Bill will be enacted by mid-2010.

3.3.2.10.2 Transport and the National Spatial Strategy

The Department of Transport developed a set of Guiding Principles to guide and inform new transport policies and strategies, which include facilitating a closer integration between land-use planning and transport investment. The daily peak demand for passenger transport is inextricably linked to the places where people live and work. The choice of these places is in turn influenced, in part, by spatial, land use and planning policies.

The Guiding Principles recognise that the National Spatial Strategy to 2020 is a key backdrop to all transport plans and policies. The integration of spatial development and transport investment should support more sustainable travel patterns for individuals and business, including facilitating a modal shift to more sustainable forms of transport (e.g. public transport, cycling and walking) and delivering net benefits in terms of reduced environmental and health costs. The National Spatial Strategy notes that transport's role in supporting balanced regional development is to:

- build on Ireland's radial transport system of main roads and rail lines connecting Dublin to other regions, by developing an improved mesh or network of roads and public transport services;
- ensure, through building up the capacity and effectiveness of Ireland's public transport networks, that increases in energy demand and emissions of CO_2 and other air pollutants arising from the demand for movement are minimised;
- allow internal transport networks to enhance international access to all parts of the country, by facilitating effective interchange possibilities between the national transport network and international airports and sea ports;
- address congestion in major urban areas by increasing the use of public transport;
- address decisions on land use and development which must take account of the existing public transport networks or support the emergence of new or augmented networks.

The National Spatial Strategy is given regional effect through the Regional Planning Guidelines and Local Authority City/County Development Plans, which reflect the RPG principles and priorities at local planning level. It is estimated that a 2.5% reduction in passenger kilometres travelled on implementation of the National Spatial Strategy could contribute to an annual saving of around 0.075 Mt of CO_2 emissions over the period 2008 – 2012. This reduction in emissions will arise because of shorter commuting distances and a shift to public transport, cycling and walking. Passenger journeys undertaken by public transport will also have associated CO_2 emissions. However, the distances travelled are anticipated to be shorter and emissions much less compared to private car travel.

3.3.2.10.3 Regional Planning Guidelines

Regional Planning Guidelines (RPGs) are a key implementation mechanism of the National Spatial Strategy and are now an established feature of the legislative and policy framework for forward planning in Ireland. The next round of RPGs will set a strategic planning framework for development plans from 2010 to 2022.

The process of reviewing and updating regional planning guidelines will continue to work within the overall policy frameworks established by the NSS while working to maximise buy-in from the key government departments and state agencies. It will also set clear objectives and targets in relation to the development plans of the planning authorities in each regional authority area that are specific in relation to future population, settlement strategy and development distribution, and infrastructure investment priorities in line with Government policy. Furthermore, the next round of RPGs will promote the effective integration and co-ordination of development plans within an overall regional vision for development, supported by an enhanced and clear legislative requirement for consistency between plans at different levels, specifically, the Planning and Development (Amendment) Bill 2009. The new RPGs will also be supported by effective regional level implementation structures that work and report regularly, within an overall NSS and NDP reporting framework, on progress made within the region in achieving regionally balanced and sustainable development.

3.3.2.10.4 Planning and Development (Amendment) Bill 2009

The Planning and Development (Amendment) Bill 2009 will strengthen the strategic guidance role of RPGs by requiring city and county development plans to incorporate a succinct statement of "core strategy" reflecting relevant RPG objectives for the particular planning authority area[1]. This evidence-based core strategy will ensure that development plans contain relevant information to show that the development plan and the housing strategy are consistent with RPGs and the National Spatial Strategy 2002-2020. The core strategy will take account of any policy of the Minister in relation to national and regional population targets and shall strengthen further the development plan as the fundamental link with national, regional, county/city and local policies. Within the new requirement of the core strategy, the development plan of a city or a town council, will have to provide details of the availability of public transport within the catchment of residential or commercial development in their area.

[1] For example, by ensuring that planning authority settlement and housing strategies take due account of national and regional population targets.

In further support of the broader climate change agenda, development plans must now contain mandatory objectives for the promotion of sustainable settlement and transportation strategies in urban and rural areas, including appropriate measures to reduce man-made greenhouse gas emissions.

3.3.2.10.5 Developing Areas Initiative

Implementation of NSS principles at a practical, delivery level is well demonstrated by the Developing Areas Initiative, which was established in 2007 to better coordinate the delivery of hard and soft infrastructure in tandem with new development and to deliver optimal investment in providing key education, community and other services. A number of developing areas have been identified around the country, focusing on fast growing areas around the NSS Gateways and Hubs. Baseline assessments of these areas have been completed, identifying critical enabling infrastructure, scope for integrated delivery and to address any blockages to their release or mismatches in the co-ordinated infrastructure delivery and services for development creating vibrant, sustainable communities. This will also include, where necessary, re-aligning national infrastructure programmes with the needs identified at local level. A number of proposals aimed at delivering better targeting of investment and improved governance arrangements to secure development in these areas have been set out.

3.3.2.10.6 Provision of Schools and the Planning System

The Provision of Schools and the Planning System - A Code of Practice for Planning Authorities, was published by the Department of Education and Science and the DEHLG in July 2008 under section 28 of the Planning and Development Act 2000. The Code of Practice has been developed between the two departments in conjunction with the City and County Manager's Association and is to ensure best practice approaches are followed by planning authorities in ensuring that the planning system plays its full part in facilitating the timely and cost-effective roll-out of school facilities by the Department of Education and Science.

At its core is a set of agreed actions to ensure best practice in forecasting future education demand; planning for new schools through local authority development plans; location of schools; site development standards; school development proposals and the development management process; and school site identification and acquisition. Planning authorities are committed to, *inter alia*, seeking to situate new schools within the existing/proposed catchment in a manner that aids ease of access from surrounding areas and encourages sustainable mobility by walking, cycling and public transport.

3.3.2.10.7 Cork Area Strategic Plan

The Cork Area Strategic Plan 2001-2020 (CASP) provides an excellent example of successful land-use planning, with appropriate use of rail, bus and cycle solutions. The Department of Transport is committed in Transport 21 to the implementation of the CASP including investment in rail infrastructure and in bus priority Green Routes as envisaged in the CASP. The CASP areas to the east and north of Cork City provide good examples of successful land use and transport planning. New development adjoins to existing urban areas and is contiguous to existing transport infrastructure, such as rail lines where the particular strengths

of rail can be exploited by operating from and to substantial catchment areas and on routes where rail has a competitive advantage over road transport.

The Cork Area Strategic Plan 2001 - 2020 states that "There will be a major growth corridor in the northern and eastern part of the Metropolitan area between Blarney and Midleton. This will help achieve greater social inclusion by improving access to public transport, jobs and services, amenities and a wider range of housing. The location for the development must be close to the existing rail system in order to avoid the traffic gridlock that would occur if a simple roll out of the City were to be adopted as a policy."

3.3.3 BUILT ENVIRONMENT AND RESIDENTIAL SECTOR

3.3.3.1 Improved Spatial and Energy Use Planning

3.3.3.1.1 National Spatial Strategy

The National Spatial Strategy, published in 2002, aims to achieve a better balance of social, economic and physical development across Ireland. The Strategy provides a 20-year framework for planning at national, regional and local level. Balanced regional development requires that the full potential of each region be developed on a sustainable economic, social and environmental basis to contribute to the overall performance of the State. Good spatial planning has the potential to deliver beneficial environmental impacts in areas such as transport and a general holistic approach to continued spatial development. The National Spatial Strategy will therefore contribute to preparing Ireland for more stringent emission reduction requirements in the future, in particular through reducing the dependence on private car-based transport arising from more sustainable spatial planning.

As previously referred to, substantial progress is being made at national level in implementing the NSS, which is having an increasing influence on policies and programmes across a range of Government Departments and agencies. At regional level, a key policy bridge between national development priorities and local planning has been put in place with the adoption of Regional Planning Guidelines. These provide a strategic framework for local planning. At county and city level, strategic land use and planning frameworks for a number of Gateways are in place, with work well advanced on others.

The regional dimension of the 7-year National Development Plan, is broadly based on the NSS. The priorities of the NSS and regional planning guidelines have also been recognised in the Government's 10-year investment plan for transport, Transport 21.

3.3.3.1.2 Development Plan Guidelines

Guidelines for Planning Authorities on the preparation of County and City Development Plans were published in 2007. The Guidelines emphasise the importance within such plans of creating a clear strategic framework for the proper planning and sustainable development of the relevant area consistent with the longer-term aims set out in the NSS, national policies and regional planning guidelines.

In particular, the Planning and Development Act 2000 provides that a development plan may include objectives for promoting design in structures for the purposes of flexible and sustainable use, including conservation of energy and resources. The Planning and Development (Amendment) Bill 2009 contains provisions for the inclusion of measures to reduce greenhouse gas emissions in development plans.

3.3.3.1.3 Delivering Homes, Sustaining Communities and Planning Guidelines

The reform agenda set out in the Government's housing policy statement Delivering Homes, Sustaining Communities (2007) has been actively pursued with its objectives for the creation of compact, walkable neighbourhoods complete with a wide range of facilities and amenities and a number of initiatives have already been undertaken, including preparation of a suite of guidance on planning and design matters.

In March 2007, the Department of the Environment, Heritage and Local Government published new design guidelines on housing delivery entitled Quality Housing for Sustainable Communities. As well as housing design issues, the guidelines address integrated approaches to the delivery of community facilities.

New guidelines on Sustainable Residential Developments in Urban Areas were published in December 2008. These guidelines, which replace the 1999 Planning Guidelines on Residential Density, are intended to assist planning authorities, An Bord Pleanála, developers and the general public by providing guidance on the benefits of higher residential density in appropriate locations and on the safeguards required in promoting greater residential density generally.

The guidelines address issues relating to how high quality residential development can deliver more sustainable communities, with improved integration between residential development and supporting community and social infrastructure, including schools, child care amenities, and public transport facilities.

3.3.3.1.4 Energy in Business Programme

The Energy in Business programme provides a number of services that promote structured energy management and supports the efforts of all business sectors to improve energy efficiency and competitiveness. The programme aids the development of the Irish market for energy-efficiency advice and services. SEI, through the Energy Agreements Programme (EAP) and the Large Industry Energy Network (LIEN), supports larger industrial sites, with a combined energy spend of up to €1Bn, that are ready to commit to strong energy management. The EAP aims to reduce energy-related CO_2 emissions in Irish industry. Companies joining the programme commit to implementing the Irish Energy Management Standard (IS393) and performing a number of special investigations. The LIEN members commit to reducing their energy usage and recognise the benefits of collaborating with like-minded organisations

3.3.3.1.5 Accelerated Capital Allowance

The Accelerated Capital Allowance (ACA) scheme introduced in the Finance Act 2008. This scheme enables businesses to write off the entire cost of a specified set of energy efficient motors, lighting and building energy management systems in the first year of purchase.

3.3.3.1.7 Promotion of ecodesign for Energy Using Products

In relation to promoting ecodesign of energy using products, implementation of the "EuP" or "Ecodesign" Directive is now under way. The overall objective of the Directive is to improve the environmental performance of energy using products, thereby protecting the environment. The framework in the Directive is used to adopt Commission Regulations for individual products, each setting out ecodesign requirements, usually upper limits on energy consumption, to be incorporated into the product at the design stage. The requirements apply to energy-using products, such as televisions, water heaters and light bulbs, produced in Ireland or elsewhere in the world when put on the market in Ireland or elsewhere in the EU/EEA Market. Accordingly, industry in Ireland will have to ensure that its products for sale in the Internal Market comply with any relevant ecodesign requirements set under the Directive.

The Department of Enterprise, Trade and Employment chairs the co-ordination of the national position on Ecodesign proposals, involving close consultation with industry and an inter-Departmental Group involving the Department of Environment, Heritage and Local Government, the Department of Communications, Energy and Natural Resources and relevant agencies of the three Departments. The Department of Enterprise, Trade and Employment also represents Ireland on the Regulatory Committee which votes on proposed Commission Regulations. During 2008, five Regulations received a favourable opinion at Regulatory Committee and approval by the European Parliament and the Council of Ministers. These Regulations, which come into effect in 2009, relate to products such as standby and off-mode controls, tertiary lighting, external power supplies, simple set-top boxes and domestic lighting. It is expected that Regulations will continue to be adopted for the foreseeable future. About thirty products are currently listed to become subject to a Regulation, and this list will expand further as time goes on.

3.3.3.2 Sustainable and Energy Efficient Buildings and Low Energy Housing

3.3.3.2.1 More Energy Efficient New Buildings Regulations

Part L (Conservation and Fuel Energy) of the Building Regulations sets statutory minimum energy performance requirements for new buildings.

In the case of dwellings, an ambitious programme for upgrading the regulations is well underway with the standards that pertained in 2005 being used as a benchmark for further improvements. The regulations were thus upgraded in 2007 to achieve a 40% improvement in energy efficiency and a 40% reduction in associated carbon emissions relative to 2005 standards. These upgraded standards which became fully operational (on the expiry of transitional planning related exemptions) from 1 July 2009 include provision for:-

- specified values for calculated Primary Energy and Carbon Dioxide Performance Coefficients to be met for each dwelling to achieve a 40% improvement relative to the 2005 benchmark;
- the mandatory use of Renewable Energy Sources - a minimum of 10 kilowatt hours per square metre per annum, approximating to 50% of annual water heating energy consumption, and representing the contribution of a typical solar water heating system;
- boilers with an energy efficiency of 86% or greater
- energy-efficient mechanical ventilation systems, where such are installed;
- improved air tightness of the building fabric, including mandatory air tightness testing of an approximately 5% sample of dwellings;
- a focus on the performance of completed dwellings and on commissioning of services, with an emphasis on ensuring that the design and construction processes are such that the completed building satisfies compliance targets and design intent; and
- user information for the owner of the new dwelling to ensure that adequate operating and maintenance instructions are available to facilitate operation in an energy-efficient manner.

Framework plans are currently being finalised which will see a further upgrading of Part L requirements for dwellings in 2010 to give a 60% improvement in both energy efficiency and carbon dioxide emissions standards relative to 2005 standards. The ultimate aim is to achieve a Carbon Neutral standard for Dwellings by 2013.

A comparable programme of change for buildings other than dwellings is currently being developed with a view to achieving a carbon neutral standard for such buildings by 2016. A consultancy study to identify suitable preliminary targets for various categories of buildings (e.g. public buildings, hotels, offices, factories, retail outlets, etc.) is planned to commence in 2010.

3.3.3.2.2 EU Energy Performance of Buildings Directive (EPBD)

The Building Energy Rating (BER) scheme was established under the European Communities (Energy Performance of Buildings) Regulations 2006. A BER is an indication of the energy performance of a house on a scale of A (most efficient) and G (least efficient). SEI has been designated as the issuing authority with responsibility for registering BER assessors, logging BER assessments and managing the BER scheme. The Building Energy Rating (BER) was introduced for new dwellings in January 2007. The focus for 2008 was on developing the complex systems, codes and procedures, and commissioning studies, that would enable the introduction of BER for the sale and rental of second-hand homes from 1st January 2009.

The original EPBD has been fully transposed and implemented in Ireland in the form of the European Communities (Energy Performance of Buildings Regulations) 2006-2008 which require a valid Building Energy Rating (BER) to be obtained whenever a building is commissioned or is offered for sale or rent. As at the end of January 2010 some 2,000 BER assessors for dwellings are registered with Sustainable Energy Ireland and some 95,000 BER certificates for individual dwellings are in place. For buildings other than dwellings (where

certain planning related exemptions apply until 1 July 2010) the corresponding numbers are 400 assessors and 2,000 BER certificates.

The recently agreed recast EPBD will come into force in 2010 and will require some modifications to the BER scheme and the building code to accommodate additional requirements, including:-

- the quoting of building energy ratings in advertisements for buildings offered for sale or letting;
- the setting of statutory minimum energy performance requirements for buildings and building elements to be informed by the cost optimal framework methodology to be developed by the EU Commission.
- the application of minimum energy performance requirements to existing buildings undergoing a major renovation; and
- the development of plans for increasing the numbers of low or zero energy buildings with the public sector showing leadership by investing in such buildings.

Since 1 January 2009 public bodies are required to secure and display a valid display energy certificate in respect of buildings which they occupy with a useful floor area of 1000m^2 or greater. The display energy certificate rates a building's operational energy performance by comparing the its total energy consumption over a twelve month period with that of a reference building of similar type and function. A DEC must be updated every year and operates as an additional requirement on public bodies which are also required to obtain a BER certificate in the usual manner whenever they commission a building or offer a building for sale or letting. In line with the recast EPBD the requirement for a display energy certificates will be extended to public buildings with a useful floor area of at 500m^2 by late 2012 and 250m^2 by 2015. The recast EPBD also requires provision to be made for display energy certificates to be extended to other buildings (e.g. hotels, retail outlets, etc) with a useful floor area of 500m^2 which are frequently visited by the public.

3.3.3.2.3 House of Tomorrow

The *House of Tomorrow RD&D* programme encourages the widespread uptake of superior sustainable energy planning, design, specification and construction practices in both the new house building and home improvement markets. The primary objective of funding demonstration projects in this sector is to create a nationwide network of accessible, replicable, model examples of more sustainable energy practices in Irish housing. New building regulations were announced in 2008 that require all new homes built in Ireland to be 40 per cent more energy efficient from next year. The Regulations, informed by the lessons from the SEI House of Tomorrow programme, provide for a dramatic improvement in energy efficiency standards in Irish homes and ensure that new housing stock in Ireland is built to the highest international standards. The 2008 Regulations have built on the market activation and learning achievements of the House of Tomorrow programme to date. The Programme is currently closed for new applications.

3.3.3.2.4 Public Sector Building Programme

SEI's Public Sector Building programme promoted energy-efficient design, technologies and services in new and retrofit public-sector projects. The programme was established to support projects that serve as examples of good practice, where the energy performance of public-

sector buildings was improved through better design, investment and management. While the programme is closed for applications, it agreed to support projects under three funding elements:

- The *Design Study Support* scheme supports professional expertise to examine the technical and economic feasibility of design and technology solutions.
- The *Model Solutions Investment Support* scheme supports energy-management and technology solutions in existing buildings and new-build specifications.
- The *Energy Management Bureaux* supports outsourced energy-management services to manage energy usage and to identify and implement energy-related projects.

3.3.3.2.5 Design of Large Buildings

The European Communities (Energy Performance of Buildings) Regulations 2006–2008 require that the economic and technical feasibility of alternative/renewable energy systems be assessed during the design of large buildings over 1,000 m^2. This requirement has been operative since 1 January 2007. The recast EPBD will further require that such feasibility studies will apply to all buildings (the size threshold of 1000m^2 no longer applies).

A renewable energy technology component has been mandatory for dwellings since 1 July 2009. For buildings other than dwellings, the general position regarding alternative/renewable energy systems will be considered as part of the upcoming review of Part L requirements for such buildings. Preliminary work in relation to this review has commenced. Sustainable Energy Ireland has published a national feasibility study covering a wide range of buildings.

3.3.3.2.6 Energy Efficiency Design and Technology

To promote sustainable energy efficiency in housing, the Department of the Environment, Heritage and Local Government is now funding a programme of eight demonstration projects to deliver new homes to a minimum Building Energy Rating of A2. These projects are being supported with the objective of building up the expertise of Irish local authorities in new construction methodologies to deliver energy efficient social housing.

3.3.3.2.7 Design Guidelines for Social Housing

In recent years significant efforts have been made to ensure that all new construction projects, including the delivery of social housing stock, are designed and built to high energy efficiency and sustainable development standards. To that end, Part L of the current Building Regulations requires that all new housing, including social housing:

- has 40% lower heat energy demand than previous buildings standards;
- requires the installation of boilers with not less than 86% energy efficiency (condensing boilers);
- requires the mandatory use of renewable energy sources (a minimum of 10 kilowatt hours per square metre per annum).

A review of the design guidelines for social housing was completed in 2007 and new guidelines were published early that year. These new guidelines, *Quality Housing for Sustainable Communities*, outline the essential requirements for the design of good quality sustainable housing developments which should be energy efficient.

3.3.3.3 Improved Efficiency of Existing Buildings

It is generally argued in Europe that the housing stock consists primarily of older, less efficient dwellings and that, consequently, the relatively small annual addition to this stock, as represented by new house-building to higher energy performance standards, has a limited impact on overall energy efficiency of the housing stock. This is less true in Ireland because of the house construction boom since the mid 1990s. Up to 2008, new dwellings were being built at the rate of around 20 per 1000 population or about 5 times the EU average. About 38% of our housing stock has been built since modern building regulations were introduced in 1992 and this proportion will be significantly higher by 2012.

However, there still remains a large proportion of the stock that could benefit from the retrofitting of energy efficiency measures. The Irish Government is currently developing the detail of a ten year National Programme for Retrofitting, with the Department of the Environment, Heritage, and Local Government charged with delivering improvements within the existing stock of 125,000 social dwellings. In order to meet this objective of "greening" the national housing stock, a new scheme was established in May 2009, aimed at improving vacant stock and occupied apartment complexes to an average BER of C1. To support this initiative a fund of €20 million was set aside in the year. This funding provision has doubled in 2010 with the intention of improving some 2,000 dwellings in the year. Additional guidance is currently being developed to support local authorities in this endeavour. The Department continues to liaise closely with colleagues in other Government Departments and State Agencies to ensure the co-ordination of actions across improvements in the public and private housing stock. In addition, a number of retrofitting demonstration projects, which will contribute to the overall approach to retrofitting across the public and private housing stocks, are being supported.

3.3.3.2.1 Home Energy Saving (HES) scheme

In 2008, SEI launched the Government's Home Energy Saving pilot scheme (HES) where grants to homeowners wishing to retrofit existing properties in counties Clare, Limerick, Louth and Tipperary. The scheme was aimed at older houses that would not typically have the energy-efficiency features of recently built homes and a contribution was made to the initial investment cost of installing various remedial measures. The scheme provided assistance to homeowners interested in improving the energy efficiency of their houses in order to reduce energy use, energy costs and greenhouse-gas emissions. In 2009, the Government launched a full rollout of the scheme countrywide. It is intended that, during 2009, the scheme will cut heating bills for householders, reduce carbon emissions and create thousands of jobs both directly and indirectly

3.3.3.2.2 Greener Homes Scheme

The Greener Homes Scheme, launched in March 2006, supports householders wishing to install renewable-energy heating technologies, including wood pellet/chip stoves and boilers, solar panels and geothermal heat pumps. Through SEI, the Government contributes to the initial investment cost of installing a renewable-energy heating system. This programme facilitates the wider deployment of renewable-energy heating technologies in the residential sector and supports the development of a sustainable market, resulting in reduced

dependence on fossil fuels and in lower CO_2 emissions. The Greener Homes Scheme encourages homeowners who are installing or replacing their heating system to opt for a renewable-energy system.

3.3.3.3.3 Building Regulations in relation to existing buildings

Minimum energy performance requirements for works to an existing building which involve an extension, a change of use or material alterations (i.e. major refurbishments that have implications for structure or fire safety) are specified under Part L of the Building Regulations. It is understood that the EU Commission will develop the cost-optimal framework methodology.

Future reviews of Part L will involve the identification of cost-optimal minimum energy performance requirements for buildings and building elements subject to major renovations as required in accordance with the recast EPBD.

3.3.3.3.4 Local Authority Housing Improvement Programme

As the social housing programme reorients itself to more flexible delivery mechanisms more in keeping with the life cycle approach of the Statement on National Housing Policy *Delivering Homes, Sustaining Communities,* there is an increasing emphasis on ensuring that the existing stock of local authority owned dwellings is maintained and improved to the highest standard possible. In 2009, this involved the significant expansion of the National Regeneration Programme, the approval of a three year programme of new remedial works projects, and the development of a national approach to the "greening" of the social housing stock. The exchequer contribution to this ambitious programme was some €201 million in the year.

3.3.3.3.5 National Regeneration Programme

The Department's investment in the national regeneration programme continues to increase significantly with the annual provision increasing from €74.5 million in 2006 to €107 million in 2009. This programme supports a range of projects from large area-based regeneration projects like Ballymun and Limerick City to smaller estate-wide project in regional towns and cities. However, regardless of the size of the project, each project requires a masterplan outlining a holistic approach to delivering the social, economic, and physical regeneration of the area with the involvement of a wide range of public, community, and private sector stakeholders.

3.3.3.3.6 Central Heating Scheme

Significant investment has also been made in recent years in improving the energy efficiency of the existing stock under the National Central Heating Programme. Although central heating has been provided in all new local authority dwellings as a matter of course since 1994, there were an estimated 36,000 dwellings constructed prior to this date without any form of central heating. To address this deficit, a special programme was introduced in 2004 for the installation of central heating, associated thermal insulation measures, and temperature controls in these dwellings. Under the programme, which ended in 2009, the Department has co-funded (with local authorities) the installation of central heating, and associated energy efficiency measures, in approximately 27,750 local authority dwellings at a

cost to the exchequer of some €140 million. This programme has been replaced by the new retrofitting initiatives outlined at 3.3.3.3.

3.3.3.3.7 Remedial Works Scheme

The Remedial Works Scheme, introduced in 1985 to assist local authorities in undertaking major structural works to their defective and pre-1940 houses. Subsequently, the Scheme was extended to include the general improvement of run-down and disadvantaged estates, as well as inner city flat complexes. Since its introduction almost €520 million has been allocated to projects under the scheme. Since 2006 the annual funding provision for these projects has increased from €34 million to €58 million in 2009 and demonstrates the Department's commitment to ensuring the ongoing viability of the stock as well as providing support for the development of sustainable communities within existing local authority estates. Within the 2009 programme, the Department supported some 50 projects ranging from the refurbishment of small rural cottages to broad programmes of estate improvements, house refurbishments, and infill developments in large local authority estates. In 2009, the Department also announced a further three year programme of over twenty projects around the country, eight of which will commence construction in 2010.

3.3.3.3.8 Low Income Housing Programme

SEI's Low-Income Housing programme (LIH) targets homes that experience fuel poverty. Low-income householders are often unable to afford the capital investment measures that would improve the energy quality of their homes. SEI's LIH programme was set up to help establish and implement a national plan of action to address this problem systematically. Core delivery is through SEI's Warmer Homes scheme, which is aimed at improving the energy efficiency and comfort conditions of the homes involved. The scheme includes substantial measures such as attic insulation, draught-proofing, lagging jackets, energy-efficient lighting, cavity-wall insulation and energy advice.

3.3.4 INDUSTRY, COMMERCIAL AND SERVICES SECTOR

3.3.4.1 Emissions Trading

Verified emissions of greenhouse gases in 2008 for companies covered by the Emissions Trading scheme are lower than 2007, continuing a well established downward trend in recorded emissions since the Emissions Trading Scheme commenced in 2005.

3.3.4.2 Investment Analysis

Ireland's first National Climate Change Strategy identified investment analysis as one of the tools to control greenhouse gas emissions (GHGs). As a result, the Department of Enterprise, Trade and Employment established an Inter Agency Group, comprising representatives of enterprise development agencies (Enterprise Ireland and the Industrial Development Agency), to explore the options for determining the impact of inward and indigenous investment proposals/ decisions by them on GHG emissions and to identify a means of incorporating the costs of GHG emissions in their investment decisions.

This Group, having considered various options for assessing the greenhouse gas impacts of investment proposals, decided that the best mechanism would be to adjust the economic

appraisal model to incorporate the environmental costs associated with Kyoto Protocol compliance of proposed enterprise investment projects. It was decided to incorporate a new emissions cost variable into the cost benefit analysis performed by the agencies on prospective investment projects.

Experts from ESRI were engaged to assist in the process and a pilot roll-out of the adjusted economic appraisal model was undertaken towards the end of 2007 into 2008. The adjusted model applies to expansion or "greenfield" developments which require an increase in a firm's power generating capacity or process emissions for which carbon allowances are required and have not yet been obtained by the company. The adjusted model more accurately reflects the true net benefits to the economy which can be expected to accrue from a given investment project because it accounts for the real costs to the state of excess GHG emissions from enterprise.

The adjusted economic appraisal model forms only a part of broader project assessment processes conducted by the agencies that apply not only quantitative but also qualitative analysis and strategic considerations.

3.3.4.3 IPPC Licensing

The 2003 Protection of the Environment Act introduced provisions enabling the EPA to consider greenhouse gas emissions as part of the Integrated Pollution Prevention and Control (IPPC) licensing regime. In addition, the European Commission adopted BREF (Best Available Techniques Reference Documents) documents on energy efficiency in the context of the IPPC Directive in February 2009. The BREF on energy efficiency techniques provides cross-sectoral generic guidance on how to approach, assess, implement and deal with energy related issues to promote energy efficiency in industrial installations. The issue of this BREF is a reflection of the increasing level of concern and urgency now being felt throughout Europe in the context of climate change, greenhouse gas emissions, rising energy and security of supply.

In December 2007, the EU Commission published a proposed Directive on Industrial Emissions. The proposal revises and merges seven separate existing Directives, including the IPPC Directive, related to industrial emissions which apply minimum standards for the prevention and control of industrial emissions across the EU into a single Directive. The recasting and revision of the seven pieces of existing EU legislation will inevitably result in a review of existing Irish legislation and amendments where appropriate in light of the final negotiated text of the Directive if and when adopted by the Council and the Parliament.

3.3.4.4 Fluorinated Greenhouse Gases

The most potent of all greenhouse gases comprise SF_6 and the families of gases known as HFCs and PFCs. Collectively known as F-Gases, their use has grown more then three-fold between 1995 (the base year for these gases) and 2007. Although accounting for only around 1% of total emissions in Ireland in 2007, there is an upward trend of emissions of F-gases, attributable in particular to increased growth of HFC as replacement refrigerants in refrigeration and air-conditioning. This has resulted from the phasing out of CFCs and HCFCs, for the purpose of complying with the Montreal Protocol on substances that deplete

the ozone layer. In some cases, the use of F-Gases is unavoidable given the lack of alternatives.

As part of the European Union's obligations under the Kyoto Protocol, the Community took action to regulate fluorinated greenhouse gases (F gases) through EC Regulation No 842/2006 fluorinated greenhouse gases (The F Gas Regulation) in order to contain, prevent and thereby reduce emissions of F gases. The Commission also adopted a further ten implementing Regulations which established certification requirements for companies and personnel working in five industry sectors covered by EC Regulation 842/2006 as well as dealing with other requirements relating to leakage checking, reporting and labelling. The ten European Commission Regulations are intended to support the objectives of the 2006 Regulation to contain, prevent and thereby reduce emissions of fluorinated greenhouse gases covered by the Kyoto Protocol, so as to help combat climate change.

Ireland is currently in the process of drafting national regulations prescribing offences and penalties applicable to infringements of EC Regulation 842/2006 and its implementing regulations on certain fluorinated greenhouse gases (F gases).

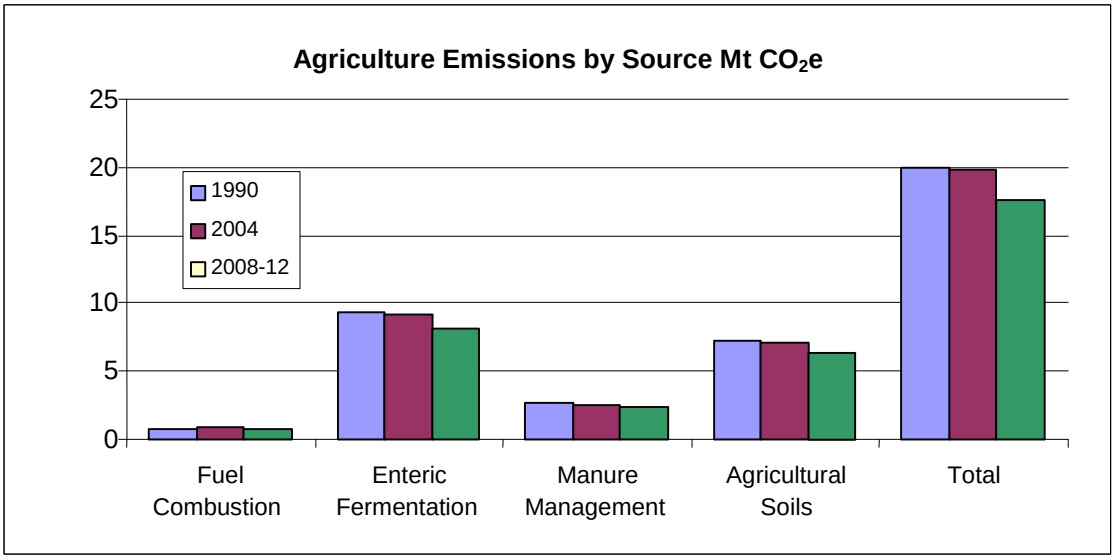
Mobile Air-Conditioning Directive: Vehicles with air-conditioning units use a refrigerant known as HFC-134a, which has a global warming potential of 1300 times that of CO_2. Because air-conditioning units in cars have the potential to leak, this Directive places restrictions on the types of units fitted to vehicles before they can be approved for sale. Gases with a global warming potential of greater than 150 will be prohibited from use in air-conditioning units from 1 January 2011 onwards. The Directive also provides for harmonised leak detection tests and limits on the retrofitting and refilling of mobile air conditioning units. The Directive amends the European Whole Vehicle Type Approval Directive, which sets out Member States' obligations to achieve compliance with technical requirements before vehicles are placed on the market. This Directive has been transposed into Irish law by Statutory Instruments 195, 196 and 197 of 2008.

3.3.5 AGRICULTURE SECTOR

Emissions from the sector consist mainly of non-CO_2 greenhouse gases, N_2O and CH_4, and arise from four distinct processes:

- Methane (CH_4) release during enteric fermentation - part of the digestion process in ruminant animals.
- Management and recycling of animal manures results in emissions of methane (CH_4) and Nitrous Oxide (N_2O).
- Nitrogen inputs to soils from the use of natural and synthetic fertilisers results in emissions of Nitrous Oxide (N_2O) from agricultural soils.
- Combustion of fossil fuels resulting in emissions of CO_2, CH_4 and N_2O.

Agricultural emissions of greenhouse gases are significant in the Irish context. Greenhouse gas emissions in 1990 from Ireland's agricultural sector were 35% of total national emissions, the highest of all sectors. By the end of 2007, this had fallen to 26.8 %.



Total emissions from the sector have fluctuated over the period 1990 (19.979 Mt CO_2e) to 2007 (18.6 Mt CO_2e). There was a sustained increase in emissions from 1990 to a peak of 21,840Mt CO_2e in 1998; however, substantial reductions have taken place in the period from 1999 to 2007. Emissions are closely linked to livestock numbers and sales of nitrogenous fertilisers and have tended to track these over the period. The latest EPA forecast, "Ireland's Greenhouse Gas Emission Projections 2008-2020 [2]" (Table 3.4[3] below) indicates a decrease in emissions from the agricultural sector in the period 2008 - 2020 to 17.8 Mt CO_2e which is 8.5% below 1990 levels. Agriculture emission projections were based on forecast animal numbers produced by Teagasc in November 2008.

This projected 8.5%% reduction in emissions, if realised, would represent a significant contribution from the agricultural sector to meeting the national Kyoto target of a maximum, 13% increase in greenhouse gas emissions over 1990 levels.

		Energy	Residential	Industry & Commercial	Agriculture	Transport	Waste	Carbon Sinks	Total (Without carbon sinks)	Total (With carbon sinks)
Historical	1990	11.7	7.4	9.8	19.9	5.2	1.5	-	55.4	-
	1995	14.0	6.4	10.0	20.9	6.3	1.7	-	59.2	-
	2000	16.7	6.6	12.7	20.5	10.8	1.6	-	69.0	-
	2005	16.3	7.4	12.2	19.6	13.0	1.8	-	70.3	-
	2006	15.5	7.3	12.0	19.3	13.7	1.8	-	69.7	-
	2007	14.9	7.1	12.4	18.6	14.4	1.9	-	69.2	-
Projected	*With Measures* Scenario									
	2008-12	14.5	7.4	11.0	18.2	14.4	2.0	-2.2	67.6	65.4
	2015	14.5	8.2	11.5	18.0	16.2	2.2	-3.4	70.6	67.1
	2020	15.0	9.1	12.8	17.8	18.1	2.3	-4.4	75.1	70.8
	With Additional Measures Scenario									
	2008-12	12.7	7.1	10.2	18.2	13.9	2.0	-2.2	64.1	61.8
	2015	10.7	6.9	9.7	18.0	14.8	1.8	-3.4	61.8	58.4
	2020	9.4	6.6	9.8	17.8	16.0	1.4	-4.4	61.0	56.7

Numbers may not sum exactly due to rounding

Table 3.4 Historical and projected emissions by sector (Mtonnes CO2e per annum) for With Measures and With Additional Measures scenarios

[2] http://www.epa.ie/downloads/pubs/air/airemissions/GHG_Emission_Proj_08_12_30032009.pdf
[3] http://www.epa.ie/downloads/pubs/air/airemissions/GHG_Emission_Proj_08_12_30032009.pdf

The positive contribution of farming and agricultural policy to reducing greenhouse gas emissions and increasing levels of carbon sequestration is an important element of Ireland's response to its greenhouse gas emissions reduction target for the purposes of the Kyoto Protocol.

The link between the production of agricultural output and public goods such as the rural landscape; cultural or heritage features; biodiversity and greenhouse gas absorption is reflected in what has been termed the European Model of Agriculture. This idea stresses the multifunctional character of European agriculture and provides a justification for Government's role in support of agriculture and its provision of public good outputs. The public good provided by agriculture also reinforces the role that agriculture will play in sustainable rural development. The development of tourism in Irish rural areas will be contingent on the continued environmental health of rural Ireland to which agriculture makes, and will continue to make, an important contribution.

A critical consideration in national climate change policy is to balance the environmental objective of greenhouse gas emissions reductions with the economic and social objective of promoting the sustainable development of a rural economy, which maintains the maximum number of farm families and rural households.

3.3.5.1 European Common Agricultural Policy

The decision by Government to adopt full decoupling of direct payments from production corresponded with the expectation that significant reductions in emissions from the sector would be achieved. A new direct payment scheme, the Single Farm Payment Scheme, was introduced on 1 January 2005 to replace the Livestock Premia and Arable Aid Schemes. The introduction of this scheme provides greater freedom to farmers to make production decisions that more closely correspond with market signals.

On 20 November 2008 EU agriculture ministers reached a political agreement on the Health Check of the Common Agricultural Policy. This is intended to modernise, simplify and streamline the CAP and remove restrictions on farmers, thus helping them to respond better to signals from the market and to face new challenges. It was agreed to increase modulation, whereby direct payments to farmers would be reduced and the money transferred to the Rural Development budget. This funding will enable Member States to respond to new challenges and opportunities and to reinforce programmes in the fields of climate change, renewable energy, water management, and biodiversity, as well as innovation linked to these four areas and for accompanying measures in the dairy sector. The impact of CAP reform will continue beyond 2012 and will be an important factor in Ireland's post-Kyoto strategy.

3.3.5.2 Methane and Nitrous Oxide Emissions

A number of measures have been taken to reduce stocking densities on land, encouraging less intensive farming methods and lower CH_4 and N_2O emissions.

3.3.5.2.1 The Single Payment Scheme

Since 1 January, 2005 direct payments to farmers under the Common Agricultural Policy (CAP) have been fully decoupled from production, i.e. the level of CAP direct payments to

farmers is now independent of the level of production of agricultural products. Under "cross compliance" farmers in receipt of the single payment must be in compliance with EU Statutory Management Requirements (SMR's) on the environment, public health, animal health, plant health, animal welfare and must also maintain land in good agricultural and environmental condition (GAEC).

3.3.5.2.2 Rural Environmental Protection Scheme (REPS)

REPS is a voluntary scheme designed to compensate and reward farmers for delivering environmental benefits. A new REPS scheme for the programming period 2007 to 2013 was approved by the European Commission in 2007 thereby assuring the continuation of the scheme. There were 46,500 farmers participating in REPS at the end of 2008 (34% of all farmers), each implementing a nutrient management plan. This is providing a more sustainable farming environment, improving the management of organic manures and chemical fertilisers and reducing nitrous oxide emissions. Nutrient Management Planning, a cornerstone of REPS, establishes farming practices that lead to greater efficiency in the use of nitrogenous fertiliser. This is achieved by minimising nutrient losses from agriculture and making better use of the nutrients in animal manures.

An analysis of the 2005 National Farm Survey (NFS) revealed that chemical nitrogen use on REPS farms was 63.8 kg/ha; the average for similar non-REPS farms being 95kg/ha. Use of organic nitrogen on REPS farms was 92.4kg/ha, less than similar non-REPS farms, which had an average of 97.3 kg/ha. The analysis shows an average decrease of circa 48% in chemical nitrogen use on extensive REPS farms using nutrient management planning. This points to the efficacy of nutrient management planning as a means of reducing chemical nitrogen. The Department of Agriculture and Food will continue to encourage farmers to join REPS.

REPS Planners are required to identify areas suitable for forestry during preparatory work for REPS plans, identifying farm areas appropriate for afforestation on environmental, agricultural, forestry and socio-economic grounds. The Department of Agriculture, Fisheries and Food introduced a new forestry scheme called FEPS in 2007 targeted exclusively at REPS farmers so that afforestation on REPS farms can be made more attractive and to further integrate forestry with REPS.

3.3.5.2.3 Organic Farming

Organic agriculture has considerable potential for reducing emissions of greenhouse gases[4]. Organic agriculture, in general, requires less fossil fuel per hectare and per kg of produce due to the avoidance of synthetic fertilisers and aims at improving soil fertility and nitrogen supply by using leguminous crops, crop residues and cover crops. The enhanced soil fertility leads to a stabilisation of soil organic matter and in many cases to a sequestration of carbon dioxide into the soils. This in turn increases the soil's water retention capacity, thus contributing to

[4] Source: "Organic Farming and Climate Change" - The International Trade Centre (UNCTAD / WTO) and FiBL (Research Institute of Organic Agriculture www.fibl.org). The study is based on a comprehensive review of peer reviewed scientific literature. The full report can be accessed at http://orgprints.org/13414/01/Organic_Farming_and_Climate_Change.pdf Note: The paper also recognises that organic agriculture has weaknesses, mainly related to productivity and yield losses in some crops and production areas.

better adaptation of organic agriculture under unpredictable climatic conditions with higher temperatures and uncertain precipitation levels. Organic production methods emphasising soil carbon retention are most likely to withstand climatic challenges particularly in those countries most vulnerable to increased climate change. Soil erosion, an important source of CO_2 losses, is effectively reduced by organic agriculture. Organic agriculture can also contribute substantially to agri-forestry production systems. Organic systems are highly adaptive to climate change due to the application of traditional skills and farmers' knowledge, soil fertility-building techniques and a high degree of diversity. At present, there are 1,450 organic operators in Ireland with 44,751 hectares of land under organic production methods. This equates to just over 1% of our agricultural land. The Programme for Government has a target to convert a minimum 5% of acreage to organic farmland by 2012.

3.3.5.2.4 Cross-Compliance

Cross-compliance is an integral part of the direct payment regime following the introduction of the CAP mid-term review changes in 2005. With the extension of cross-compliance to a number of other scheme areas from 2007, including the Disadvantaged Areas Scheme and REPS, the delivery of annual payments to Irish farmers of the order of €1.9 billion is now covered by the requirements of cross-compliance.

Cross compliance involves two key elements:

- A requirement for farmers to comply with 18 statutory management requirements (SMRs) set down in EU legislation on the environment, (including the Nitrates Directive) food safety animal health, welfare, and plant health, and
- A requirement to maintain the farm in good agricultural and environmental condition (GAEC).

If an applicant is found to be non-compliant sanctions are provided for in the governing EU regulations and those sanctions will be applied to the applicants Direct Payments.

3.3.5.2.5 Disadvantaged Areas Compensatory Allowance Scheme

Up to 2000, headage grants were paid on cattle, sheep, goats and horses in designated areas. Scheme payments altered from being based on the number of animals to an area-based payment system in 2001. Farmers are now paid a flat rate per hectare, removing the incentive to maximise stocking densities in order to maximise payments.

3.3.5.2.6 Lower Age at Slaughter

Younger animals produce less CH_4 emissions, and measures have been taken to reduce the age of cattle slaughtered. As a result of the BSE crisis, higher prices at slaughter are now paid for cattle under 30 months, leading to a reduction in the number of cattle retained for slaughter over 30 months and thereby reducing CH_4 emissions.

3.3.5.2.7 Commonage Framework Plans

Interim Commonage Framework plans introduced in 1998 reduced stock numbers by 30% on commonages in six western counties. Permanent destocking arrangements were put in place for commonages in the final Commonage Framework Plans introduced in 2002.

3.3.5.3 Animal Husbandry

One of the factors that influence methane emissions from the dairy herd is longevity of the cows, which is influenced by the health and fertility of the cows. As yields per cow increase there is a tendency for fertility to reduce, thereby leading to an increase in the number of replacements kept on farms. Teagasc has an ongoing research programme aimed at improving fertility levels in the dairy herd. Part of the animal breeding programme focuses on other important genetic parameters – increasing yield by cow, improving milk composition, etc. They are also focused on improving grazing techniques and pasture management (including increasing the use of clover) and manure management in both dairying and beef systems with a view to identifying the best and most environmentally sustainable management systems that facilitate increased productivity, improving output per unit of input. A further part of the research programme aims to reduce nitrous oxide emissions by using nitrification inhibitors. In addition, an important part of the Teagasc advisory programme focuses on improving the uptake of various technologies at farm level that will have the effect of increasing outputs and reducing inputs including transfer of information. Improvements in efficiencies, which flow from this work, are leading to reductions in GHG emissions per unit of output for both milk and meat production.

3.3.5.4 Animal Diet Research

Research is ongoing to evaluate a range of measures that could be used to reduce emissions per animal. Examples of such measures include increasing the level of oil in the diet, to study the impact on emissions and to establish the resultant changes in rumen microflora composition – this is important work in the context of developing the best animal feeding strategies to reduce emissions. Field scale research with beef cattle has shown that reductions of circa 20% in daily enteric methane output are possible when coconut oil is added to the diet at a rate of 250 grams per day. However this practice is likely to be feasible only in part of an animal's life (i.e. the finishing winter when concentrates are being fed which allow delivery of the oil), and thus the reduction in lifetime emissions would be 5-6%. Coconut oil is expensive and the measure will likely have some cost of implementation at farm level, depending on the relative costs of oil, other feedstuffs and the value of beef or milk output. The feasibility of using other cheaper oils e.g. soya oil is being explored. A range of commonly used concentrates are being examined to determine if one is more suitable than another in terms of reducing methane emissions.

Ongoing research will continue to contribute to further options to reduce emissions from agriculture. The Department of Agriculture, Fisheries and Food has committed €15.5m to climate change research projects since 2005 under the Research Stimulus Fund and continues to monitor ongoing research both nationally and internationally.

3.3.5.5 Manure Management and Agricultural Soils

3.3.5.5.1 Environmental Legislation

Agricultural activities in certain areas are already subject to local by-laws implemented by local authorities. In some instances, by-laws may include a requirement for nutrient management planning. Nutrient management planning is a compulsory feature of IPPC

licensing. IPPC licensing is implemented by the EPA, and applies to intensive pig and poultry units.

3.3.5.5.2 EU Nitrates Directive

Regulations placing limits on the amount of livestock manure that may be applied to land to further implement the EU Nitrates Directive were made by the Minister for the Environment, Heritage and Local Government in 2005. Amending Regulations were made in 2006 and early 2009. These regulations set down legal maximum limits for fertiliser applications (organic and chemical) based on stocking rate, crop requirements and soil type. The objective of the Regulations is to protect water quality from pollution or potential pollution through more efficient use of nitrogenous fertiliser. It is expected that these regulations will lead to a reduction in N_2O emissions.

3.3.5.5.3 Anaerobic Digestion

There is potential to supply energy through the use of animal manures as feedstock in anaerobic digestors. The Department of Agriculture, Fisheries and Food is committed to supporting the development of on-farm anaerobic digestion facilities and, under the Scheme of Investment Aid for Demonstration On-Farm Waste Processing Facilities, grant-aid of €4 million was made available to ten such projects in 2007. The environmental benefits of the technology will be assessed under the scheme including a full life cycle analysis of the potential of the technology to abate greenhouse gas emissions

3.3.5.6 Bio-energy

The Department of Agriculture, Fisheries & Food launched a Bioenergy Scheme in 2007 to provide farmers with establishment grants to plant willow and miscanthus (biomass crops) for use in the bioenergy market. The grant is payable on 50% of actual costs up to a maximum of €1,450 per hectare. By the end of 2009, some 3,000 hectares had been grant aided. Biomass crops can deliver meaningful CO_2 reductions associated with fossil fuel use and act as a carbon sink similar to afforestation. Analysis by Teagasc estimates that biomass crops could contribute net sequestration of up to 1 tonne of CO_2 per hectare per annum.

3.3.6 FORESTRY SECTOR

The Irish afforestation programme will play an important role in Ireland's climate change mitigation strategy. While the National Climate Change Strategy envisaged that sequestration under Article 3.3 would account for a total of 1.0 Mt CO_2, per annum between 2008 and 2012, it is now forecast that, with the levels of afforestation that have occurred since 1990, the average rate of sequestration in qualifying forests over the Kyoto first commitment period will be 2.236 Mt CO_2 per annum[5]. This revised forecast is based on approaches and methodologies for accounting of sequestration agreed to by Kyoto Protocol parties, particularly in the Marrakech Accords, the Good Practice Guidance of the Intergovernmental Panel on Climate Change, and on research and modelling of carbon sequestration in Irish forests undertaken by COFORD (National Council for Forest Research and Development). The current afforestation programme will have little effect on levels of sequestration during the first commitment period, as forests grow relatively slowly as they establish themselves over

[5] Source: projection of the national forest greenhouse gas balance for the period 2008 to 2020 (Black,K, COFORD, Feb 2009)

the first five years or so. However, in the period after 2012, they will make a substantial contribution to climate change mitigation.

3.3.6.1 Afforestation Programme

One of the aims of Ireland's forest policy is to encourage planting by private landowners. This is achieved by providing grants to cover the cost of afforestation, and an annual premium to land owners to compensate for income foregone by converting land from conventional farming to forestry and the long pay back period involved. Ireland has had, on a per capita basis, one of the most intensive afforestation programmes in the developed world since 1990, funded jointly by the Government and the EU, under successive accompanying measures to CAP reform. Since 1990, some 265,000 hectares have been afforested. Over the same period, the annual rate of deforestation is estimated to have been 500 hectares per year. Despite this rate of planting, however, Ireland remains one of the least forested countries in the EU. At the end of 2008, the national forest estate stood at over 730,000 ha. This represents about 10.60 % of the area of the country, compared to the 35% average throughout the European Union.

3.3.6.2 Integration of REPS and forestry

As mentioned above, forestry has been integrated with the Rural Environment Protection Scheme (REPS) through a new afforestation measure called the Forestry Environment Protection Scheme (FEPS). FEPS encourages farmers to combine the establishment of high-nature woodland with their participation in REPS. The FEPS measure encourages farmers to create new on-farm woodlands that will not only support rural communities by providing employment and a sustainable timber supply in the future, but will also contribute to enhancing and protecting landscape character, woodland amenities, biodiversity, water resources and assist in combating climate change through carbon sequestration.

3.3.6.3 Development of domestic forest energy markets

Policies aimed at promoting renewable energy (in the form of heat and electricity) from biomass will create a market for thinnings and residues (both in-forest and from saw-milling). Since 2006, COFORD has operated the Forest Energy Programme. The Programme included a number of trials aimed at developing effective woodchip production methods, along with a series of nationwide forest thinning and chipping demonstrations and workshops aimed at those wishing to become involved in the wood biomass supply chain. Recent developments on the policy front include a pilot grant scheme, administered by Department of Agriculture, Fisheries and Food, to assist investment by developing enterprises in self-propelled/self contained whole tree chippers. The Department has also supported a number of wood energy pilot projects, including a number of farm forest producer groups to encourage private forest owners to co-operate in areas of forest management and marketing of the timber. This support is aimed at, among other things, increasing the volume of wood fuel available to the local energy markets. These measures are intended to compliment other support measures for commercial wood-chip heating systems administered by Sustainable Energy Ireland.

3.3.7 WASTE SECTOR

Emissions from the waste sector consist mainly of methane (CH_4) from the anaerobic decomposition of solid waste that has been deposited in landfill sites. In addition small amounts of methane and nitrous oxide arise from wastewater treatment. With increased levels of waste generation, emissions rose steadily through the 1990s and this pattern would have continued without the introduction of landfill gas capture for power generation in 1997. Improved landfill gas management through flaring since 2001 is also contributing to a reduction in methane emissions. However, emissions again began to increase as the additional volumes of waste being sent to landfill over the period during which gas is produced through anaerobic decomposition overtook the incremental rate at which methane capture systems were being introduced. Consequently emissions in 2004 were 1.83 Mt CO_2e - 26% above their 1990 level. However preliminary figures for 2008 show a decrease in emissions from the waste sector. This reduction relates primarily to a revised calculation methodology for landfill gas emissions based on new research showing that the gas capture rate is approximately 80% in Ireland. These are preliminary findings and it will not be possible for them to be verified until March 2010.

National policy is to regard waste as a resource. This is reflected in our commitment to developing a recycling society. It is also reflected in the Government's priority on waste prevention, followed by minimisation, reuse, recycling, recovery and the least favoured option of disposal to landfill for dealing with residual waste. In examining the potential for waste management policies to contribute to emissions reductions, the Government is cognisant that climate change impacts are only one of a number of environmental impacts that derive from solid waste management options. Local factors, such as the availability of existing waste management facilities, markets for recyclables, as well as geographic, demographic and socio-economic factors, must also be considered. In overall terms, source segregation of municipal solid waste (MSW) followed by recycling (for paper, metals, textiles and plastics) and composting or anaerobic digestion of putrescible wastes, gives the lowest net generation of greenhouse gases, compared with other options for the treatment of bulk MSW.

3.3.7.1 Waste Licences

Waste Licences issued for landfill sites by the Environmental Protection Agency invariably require the preparation of evaluation reports by the licensee on the viability of landfill gas collection, flaring and / or energy production. Gas collection and energy generation is undertaken at high gas-yield sites and modern enclosed ground flares are installed at landfill facilities possessing sufficient gas potential to support combustion. In addition, the waste licensing system requires the modernisation of older facilities via the implementation of conditioning plans that are designed to increase the operational standards of landfill sites through a process of continuous improvement.

The generation of heat and electricity from waste in thermal treatment plants and landfill gas plants is targeted to displace CO_2 emissions from fossil fuel based plants. The contribution such an approach can make to energy and climate change policy is reflected in the projected outputs from the proposed Dublin waste to energy plant. This will have the capacity to produce 60Mw of electricity, which is enough to service the needs of 50,000 homes. In

addition it will be capable of meeting the heating needs of a further 60,000 homes by means of district heating.

3.3.7.2 Diversion of Biodegradable Waste from Landfill

The deposition of biodegradable waste in landfill produces methane, with the potential for generation of gas being determined by the amount of degradable organic carbon in wastes, which in turn depends on the quantity and composition of the waste material present. Gas production in landfill occurs predominantly over a 21-year period and is greater in well-managed landfill sites where the potential for aerobic decomposition is more limited. Ireland is obliged under the EU Landfill Directive to ensure that no more than 35% of 1995 levels of biodegradable municipal waste is landfilled by 2016.

Ireland's approach to achieving the targets is set out in the National Strategy on Biodegradable Waste, published in 2006. It sets out the Government's approach to reducing the amount of biodegradable municipal waste going to landfill and encouraging measures aimed at the prevention, recycling and recovery of biodegradable municipal waste. The Strategy requires that projected arisings of biodegradable municipal waste be diverted from landfill by 2016 and is based on the integrated waste management approach established as Government policy since publication of the national policy framework document Changing Our Ways in 1998. Under this approach, the preferred options for dealing with biodegradable municipal waste, based on the internationally recognised waste hierarchy are prevention, followed by minimisation, reuse, recycling, recovery and the least favoured option of disposal to landfill.

3.3.7.3 Renewable Energy from Waste - Landfill Gas Capture

Waste biomass encompasses not only the biodegradable fraction of municipal and industrial waste, but also the biodegradable fraction of products and residues from agriculture, forestry and related industries. There is potential within biodegradable municipal waste management to make a contribution to renewable energy generation through the development of active supply chains and from synergies with other biomass materials and fuels e.g. to co-fire peat power plants or cement kilns.

In addition, landfill gas accounts for the majority of the currently installed 28Mw of generation from biomass including 4Mw of capacity at the Ringsend waste water treatment plant, opened in 2004. The level of landfill gas capture has been increased to around 80% through the implementation of the technical requirements of the Landfill Directive, and utilisation for electricity generation is supported by Government policies and incentives aimed at increasing the penetration of renewable electricity in Ireland.

Chapter 4: PROJECTIONS AND THE TOTAL EFFECT OF POLICIES AND MEASURES

4.1 Introduction.

On foot of a commitment in the 2007 National Climate Change Strategy, national greenhouse gas emission projections are now published on an annual basis. The most recently published set of projections (March 2009)[1] were based on three scenarios. As is standard and required under EU Decision 280/2004/EC, 'with measures' and 'with additional measures' scenarios were created. However, at the time of publication, there was a great deal of uncertainty regarding the economic outlook as a result of the international financial crisis and GDP projections were being regularly revised. As a result, a sensitivity analysis which became known as the 'Economic Shock Analysis' was also published at this time although the granularity of results associated with the shock analysis was far less detailed than the other two scenarios. A 'without measures' scenario, which is optional under Decision 280/2004/EC was not produced at that time.

The projections in this chapter are based on the 'with measures' and 'with additional measures' scenarios. As stated earlier only aggregated results of the 'Economic Shock Analysis' were published and these are referred to in the previous chapter. It is important to note that subsequent to the publication of these projections that historical data for the years 1990-2007 has been restated due to changes in methodologies. In order to avoid step changes in any charts or other analysis **the inventory data as at the date of publication of the projections** are used in this chapter.

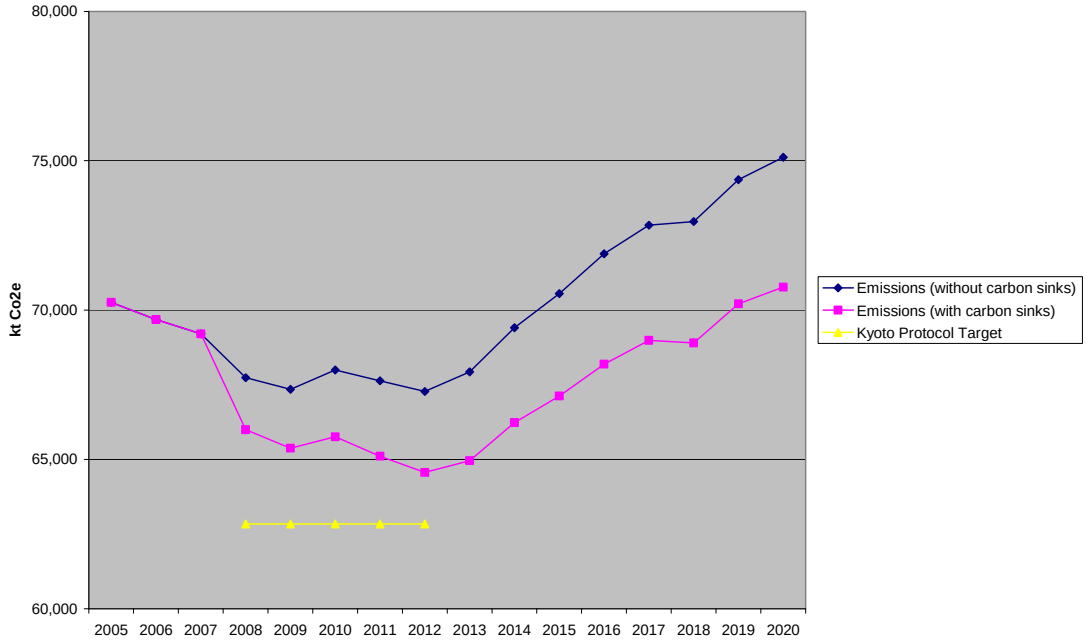
The various models used to develop the projections are discussed in Annex 3.

4.2 Overall Projected Trends.

Overall emissions are projected to dip in the years 2008-2012 before resuming upward growth from 2013 onwards. This trend is somewhat in line with the expectations for the economy. An upturn in activity is expected in late 2010, but the effects of existing measures will start to have made an impact by that stage. Stronger economic growth resumes towards the end of the Kyoto commitment period and emissions increases begin to outstrip the effects of the 'existing measures'. Figure 4.1 illustrates total emissions for the 'with measures' scenario from 2008 to 2020.

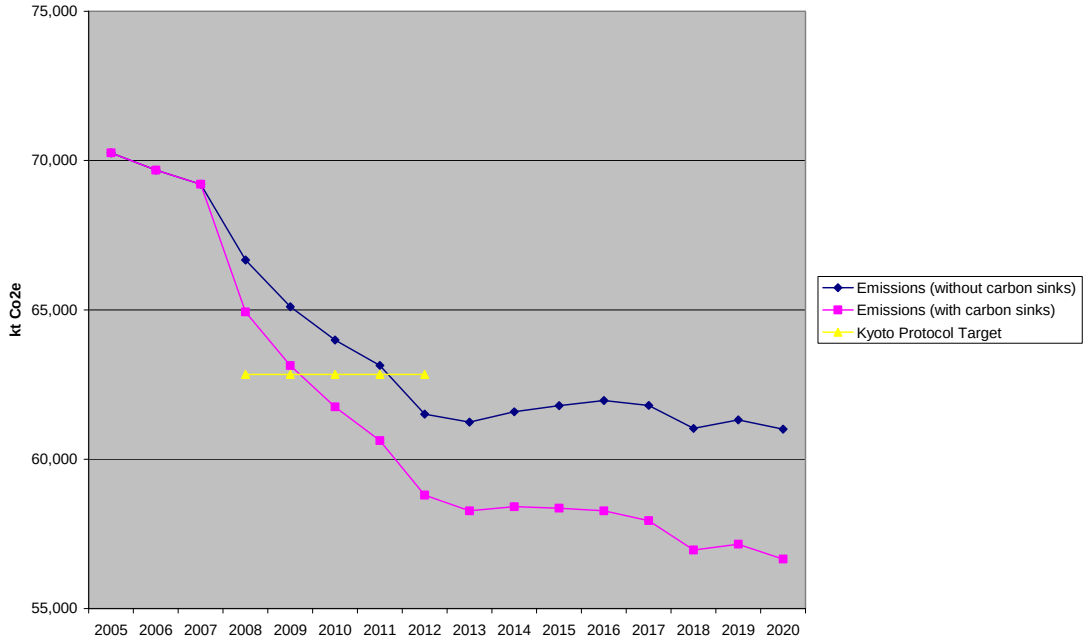
[1] http://www.epa.ie/whatwedo/climate/emissionsinventoriesandprojections/nationalemissionsprojections/

Fig. 4.1 'With Measures' Scenario - GHG Emissions Projections 2005-2020



The effects of the 'additional measures' are obvious in Figure 4.2. It gives the impression that the Kyoto target is almost achieved without recourse to flexible mechanisms but the ETS sector is making a significant contribution to the meeting of targets. It is projected that total emissions remain on a downward trajectory even after the recovery of the economy, the effects of policies and measures outweighing the upward pull of increased economic activity.

Fig. 4.2 'With Additional Measures' Scenario - GHG Emissions Projections 2005-2020



4.3.1 Sectoral Share of Emission Projections (With Measures Scenario)

The largest single source of emissions in 2007 was from agriculture when it contributed just under 27% of total emissions. Over the Kyoto commitment period this sectoral dominance will remain. As a share of gross emissions agriculture is expected to contribute an average of 27% over the course of the commitment period. By 2020 this share will be 24%.

Energy is the second largest source over the commitment period with 22% of emissions and its share is projected to fall slightly to around 21% for 2008-2012 and 20% in 2020.

The Transport sector is the third largest source with just under 21% of emissions in 2007. This sector has experienced rapid growth since 1990 at which stage it represented less than 10% of gross emissions. This sector continues to grow but very slowly over the commitment period rising to just over 21% before resuming strong growth to 2020 when it will contribute 24% of gross emissions.

The Industry and Commercial sectors are collectively responsible for 18% of emissions in 2007, falling to 16% in the commitment period before recovering slightly to 17% by 2020.

The share of emissions from the residential sector is set to grow slowly between 2007 and 2020 from 10 to 12%.

The share of emissions from the waste sector is projected to remain broadly stable at around 3% of total emissions out to 2020. (It is worth noting that this sector is the one most impacted by the methodological changes mentioned in the introduction to this chapter)

In 2007 emissions in the ETS accounted for 30% of Ireland's emissions. It is expected that this proportion would fall slowly to 28% over the period to 2020.

4.3.2 Sectoral Share of Emission Projections (With Additional Measures Scenario)

The largest single source of emissions in the 'With Additional Measures' scenario for the Kyoto Protocol commitment period is agriculture. During that period it will contribute 28% of gross emission and by 2020 this share will be 29%.

The Transport sector is the second largest source over the commitment period with 22% of emissions and its share is projected to increase strongly to around 26% in 2020. The limited availability of abatement opportunities in these two sectors is strongly reflected by these sectoral shares.

The Energy sector is the third largest source with just under 20% of emissions projected for the Kyoto Protocol commitment period. This share is projected to fall over the period to 2020 to 15% reflecting the strong emphasis on renewables in Irish energy policy and the greater availability of cost effective mitigation opportunities.

The Industry and Commercial sectors are collectively responsible for 16% of emissions in the Kyoto Protocol commitment period. This share remains stable out to 2020.

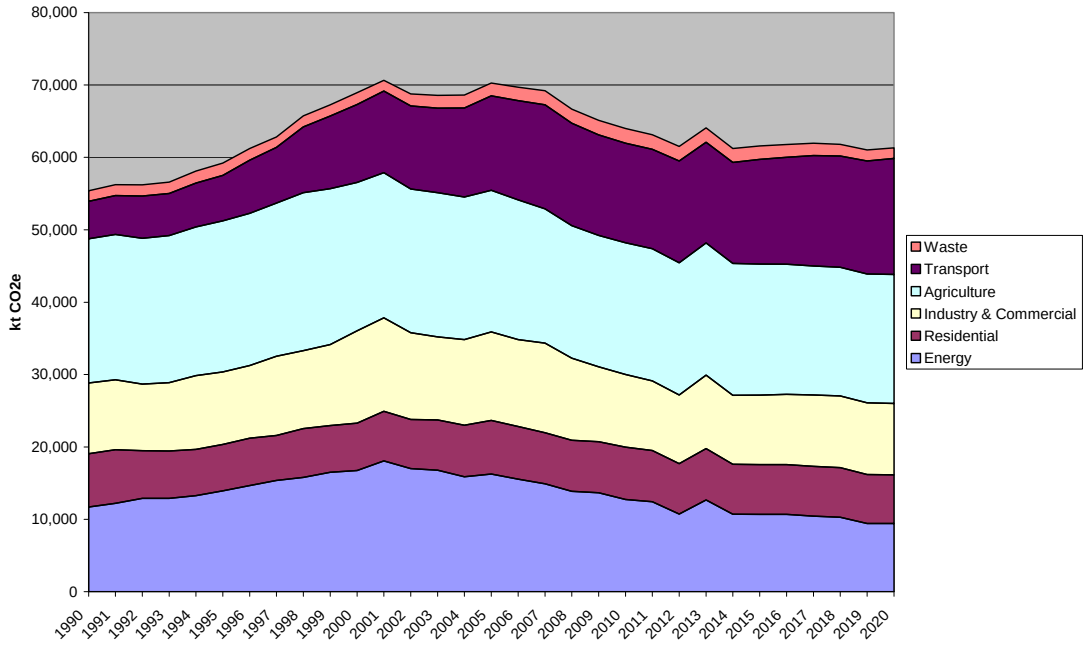
Similarly the share of emissions from the residential sector is set to remain stable at about 11%.

The share of emissions from the waste sector is projected to fall very gradually to about 2% of gross emissions by 2020.

ETS emissions are expected to fall to about 28% of total in 2008-2012, and fall further to about 25% of gross emissions by 2020.

Figure 4.3 below illustrates the progression in the shares of gross emissions, using inventory data to 2007 and the 'with additional measures' projection out to 2020. Tables 4.7 and 4.8 at the end of this chapter give the full tabular breakdown for the two scenarios by sector.

Fig. 4.3 Historical and Projected Gross Emissions (WAM) 1990 -2020



4.4 Sectoral Analysis

In each of the following subsections the projected data referred to relates to the 'With Additional Measures' scenario. Tabular output for each sector will list equivalent results for both scenarios.

4.4.1 Energy Industries

Greenhouse gas emissions from the energy industries are predominantly derived from fossil fuel derived electricity generation. Since 1990, the share of high carbon content fuels such as coal and peat used for electricity generation has reduced and been replaced with relatively low carbon natural gas or zero carbon renewables, predominantly wind and hydro. This fuel switching has been reinforced by a substantial improvement in generation efficiency due to the commissioning of new CCGT plant. This has resulted in a decoupling of CO_2 emissions from electricity generation and a drop of 37% in the carbon intensity of electricity generation

between 1990 and 2007, from 896 g CO_2/kWh to 565 g CO_2/kWh. The trend is projected to continue to the Kyoto period and towards 2020.

Greenhouse gas emissions are projected for four separate source categories in the energy sector, the first three from energy production and the last by way of fugitive emissions from distribution. These are namely,

- Public electricity and heat generation;
- Petroleum Refining;
- Manufacture of Solid Fuels and other Energy Industries;
- Natural gas distribution.

Electricity production accounted for 96% of emissions from this sector in 2007 and is projected to account for 95% over the Kyoto commitment period. Between 2007 and 2020 CO_2 emissions from power generation are projected to fall by an average of 3.7% per annum, whereas all other GHG emissions in the sector are projected to fall over the same period by an average rate of 0.7% per annum.

Overall emissions from the energy sector are projected to fall by 15% between 2007 and the average of the values from 2008-2012, by a further 16% between then and 2015 and a further 12% between 2015 and 2020. The table below provides summary details for the overall greenhouse gas emissions from the sector under the 'With Measures' and 'With Additional Measures' scenarios.

Table 4.1 Energy Sector Emissions - Historical and Projected (kt CO_2e)

Energy Emissions by source and year	Historical Data			With Measures				With Additional Measures			
	1990	2007	Annual Rate of Change 1990-2007	2008-2012	2015	2020	Annual Rate of Change 2007-2020	2008-2012	2015	2020	Annual Rate of Change 2007-2020
Public Electricity and Heat Generation	11,288	14,369	1%	13,895	13,707	14,219	0%	12,114	10,011	8,747	-4%
Petroleum Refining	186	368	4%	410	495	495	2%	410	495	495	2%
Manufacture of Solid Fuels and Other Energy Industries	102	116	1%	123	127	127	1%	123	127	127	1%
Natural Gas	131	60	-5%	57	143	151	7%	40	43	31	-5%
Total	11,707	14,913	1%	14,486	14,471	14,991	0%	12,688	10,675	9,399	-3%

4.4.2 Industry, Commercial and Services Sector.

Greenhouse gas emissions from this sector result predominantly from the combustion of fossil fuel for heating requirements. In addition the production of cement, lime and periclase result in significant process emissions of CO_2. The production of fertiliser ceased in Ireland in 2003 and has resulted in a sharp fall in process emissions from the sector.

Emissions from industry, commercial and services sector are projected for four separate categories, namely,

- fossil fuel combustions(split into industrial and commercial);
- process emissions;
- solvent use in industry;
- F-gas use in industry.

Fossil fuel combustion in manufacturing and construction accounted for 51% of GHG emissions from the sector in 2007 and this will remain unchanged in the Kyoto commitment period and will change little up to 2020. Fossil fuel combustion in Commercial and Services accounted for 22% in 2007, remain constant in the Kyoto commitment period, and then fall to 11% in 2020. Taken together fossil fuel combustions currently accounts for 73% of emissions in the sector with industrial process emissions from cement, lime and periclase manufacture accounting for 21% of emissions. The remaining 6% is made up of emissions from solvent and F-gas use. The use of F-gases rose dramatically between the base year (1995) and 2007, up 257% from 0.2 Mt CO_2e to 0.7 Mt CO_2e mainly due to increases in semiconductor production and the use of refrigeration and air conditioning, it now accounts for just over 1% of gross emissions. Overall, emissions from the sector are projected to decrease during the Kyoto period and beyond to 2020. Emissions are expected to fall at an annual average rate of 2% between 2007 and 2020. The table below provides summary details for overall greenhouse gas emissions from the sector.

Table 4.2 Industrial and Commercial Services Emissions – Historical and Projected (kt CO_2e)

Energy Emissions by source and year	Historical Data			With Measures				With Additional Measures			
	1990	2007	Annual Rate of Change 1990-2007	2008-2012	2015	2020	Annual Rate of Change 2007-2020	2008-2012	2015	2020	Annual Rate of Change 2007-2020
Manufacturing Industries and Construction	4,108	6,301	3%	5,553	6,009	6,750	1%	5,165	5,056	5,047	-2%
Commercial/Institutional	2,423	2,693	1%	2,417	2,030	2,093	-2%	2,119	1,425	1,039	-7%
Industrial Processes	3,129	2,580	-1%	2,128	2,443	2,723	0%	2,128	2,443	2,723	0%
Solvent and Other Product Use	79	83	0%	85	89	93	1%	85	89	93	1%
Consumption of Halocarbons and SF6	36	701	19%	782	913	1,118	4%	697	727	907	2%
Total	9,775	12,359	1%	10,966	11,484	12,777	0%	10,194	9,741	9,809	-2%

4.4.3 Agriculture.

Agriculture is the largest single source of emissions in Ireland, accounting for 26.8% of greenhouse gas emissions in 2007. Projections for the Kyoto commitment period indicate that agriculture will remain the largest source, with 28.5% of emissions. This share will continue to grow slowly, with an expected value of 29.2% by 2020. Emissions for agriculture are projected for four separate sources, namely,

- fossil fuel combustion
- enteric fermentation from ruminants;
- manure management;
- soil management.

Since the 4th National Communication, the National Inventory Report of 2007 referred to major methodological changes in the area of agricultural emissions. Specifically this related to 'the adoption of tier 2 methodologies for methane emissions from enteric fermentation in cattle and robust improvements in estimates of manure management based on the results of major research and an extensive farm facilities survey'. This has resulted in a change to the relative shares of emissions by source.

Enteric fermentation accounted for 47.6% of agriculture emissions in 2007 and is projected to account for 47.9% in the Kyoto commitment period, dropping only marginally in time to 47.3%

in 2020. The share of emissions from agriculture soils and manure management also remain essentially stable at around 28% and 20% respectively. The remaining 4.4% results from fossil fuel derived energy in the sector.

Emissions in the Agriculture Sector peaked at 21.8 Mt CO_2e in 1998, since when they have been declining slowly. Emissions for the sector will continue to fall slowly during the Kyoto period, and beyond to 2020. In 2020 emissions are expected to reach 17.8 Mt CO_2e. All sectors of emissions except fossil fuel combustion are expected to fall slowly in the period to 2020. The table below provides summary details of overall greenhouse gas emissions from the sector. There is only a single scenario for Agricultural emissions – this is a With Measures scenario based on forecast animal numbers produced by Teagasc in November 2008.

Table 4.3 Agricultural Emissions – Historical and Projected (kt CO_2e)

Energy Emissions by source and year	Historical Data			With Measures				With Additional Measures			
	1990	2007	Annual Rate of Change 1990-2007	2008-2012	2015	2020	Annual Rate of Change 2007-2020	2008-2012	2015	2020	Annual Rate of Change 2007-2020
Fossil fuel combustion	689	809	1%	791	855	888	1%	791	855	888	1%
Enteric Fermentation	9,494	8,841	0%	8,735	8,521	8,405	0%	8,735	8,521	8,405	0%
Manure Management	5,528	5,222	0%	5,178	5,029	4,860	-1%	5,178	5,029	4,860	-1%
Soils Management	4,207	3,684	-1%	3,540	3,581	3,633	0%	3,540	3,581	3,633	0%
Total	19,918	18,557	0%	18,244	17,987	17,786	0%	18,244	17,987	17,786	0%

4.4.4. Residential.

Greenhouse gas emissions arise primarily from the combustion of fossil fuel for space and water heating. Only direct emissions from residential units are included in the sector, emissions from residential electricity consumption are included in the energy industries sector. Emissions fell by 4% between 1990 and 2007 from 7.4 Mt CO_2e to 7.1 Mt CO_2e as a result of a significant switch from carbon intensive solid fuels (coal, peat) to natural gas, and improved building standards. Emissions had fallen as low as 6.2 Mt CO_2e in 1997, but a significant growth in the housing stock since then has masked the improvements from fuel switching. The number of permanent private households, as recorded by the Census of Population, increased by 31% between 1996 and 2006. Emissions per household fell from 5.87 t CO_2e to 4.99 t CO_2e during this time.

In terms of fuel consumption (as measured in ktoe) solid fuel use fell from 71% of the market in 1990 to 21% in 2007, driven in part by the ban on the sale and marketing of bituminous coal in certain urban areas and increased availability of natural gas as the grid was extended in the 1990s. This share will fall further in the years to 2020, by which time solid fuels will only have an 8% share. The equivalent share for natural gas increased from 6% to 27% in the same period and this is expected to fall slightly to 24% by 2020. Oil, which represented only 20% of the fuel mix in 1990, has experienced considerable growth. In 2007 the share had reached 48% and by 2020 this is expected to reach 64%.

The improvements in energy efficiency in homes are expected to continue. Improving the standard of new and existing buildings is a major focus of the Government. A series of new build regulations are scheduled for the domestic sector and increased funding is being given to the retrofitting of existing properties through schemes such as the Home Energy Saving

Scheme. Given this level of attention emissions are expected to stabilise and then fall over the coming years. By 2020 it is expected that emissions in the sector will have fallen to 6.6 Mt CO_2e despite forecasts of a considerably increased housing stock. The combined effect of all measures will reduce emissions by 27% in 2020 when comparing the two scenarios. The table below lists the key historical and projected data for this sector.

Table 4.4 Residential Sector Emissions – Historical and Projected (kt CO_2e)

Energy Emissions by source and year	Historical Data			With Measures				With Additional Measures			
	1990	2007	Annual Rate of Change 1990-2007	2008-2012	2015	2020	Annual Rate of Change 2007-2020	2008-2012	2015	2020	Annual Rate of Change 2007-2020
Fossil fuel combustion	7,350	7,062	-0.2%	7,444	8,201	9,137	2.0%	7,073	6,881	6,646	-0.5%

4.4.5 Waste.

Emissions from this sector derive predominantly from anaerobic decomposition of organic waste in landfills which produces methane. The process occurs over a twenty-one year period and is greater in newer, well-managed landfills with more anaerobic conditions. Emissions of N_2O also result from waste water treatment.

Methane derived from landfilled waste accounted for 91% of methane emissions in 2007 and is projected to account for 91% of emissions over the Kyoto period before falling to 86% over the period to 2020. N_2O emissions from wastewater treatment account for the remainder. Emissions from waste are projected to increase marginally between 2007 and the end of the Kyoto period and to fall thereafter. As noted elsewhere the revisions to inventory data will have a significant effect on this sector. The table below provides summary details of overall greenhouse gas emissions from the sector.

Table 4.5 Waste Sector Emissions – Historical and Projected (kt CO_2e)

Energy Emissions by source and year	Historical Data			With Measures				With Additional Measures			
	1990	2007	Annual Rate of Change 1990-2007	2008-2012	2015	2020	Annual Rate of Change 2007-2020	2008-2012	2015	2020	Annual Rate of Change 2007-2020
Solid Waste Disposal on land	1,332	1,771	2%	1,865	2,016	2,083	1%	1,835	1,599	1,195	-3%
Waste Water Handling	129	166	1%	172	182	192	1%	172	182	192	1%
Total	1,461	1,937	2%	2,037	2,198	2,275	1%	2,007	1,781	1,387	-3%

4.4.6 Transport.

The transport sector has been the fastest growing sector in Ireland with overall reportable emissions up 178% over the period from 1990 to 2007. Emissions from the sector are dominated by road transport (97% in 2007), and though the significant growth reflects both increased mobility and vehicle stock, the figure is also inflated by the phenomenon of so called ‘tank tourism’ or ‘fuel tourism’ which results in a net outflow of fuel from the state in recent years. This is caused by the differential in exchange rate adjusted after tax prices between the Republic of Ireland and Northern Ireland.

In 1990, the phenomenon was reversed with significant net inflow of fuel into the state, thus further inflating growth estimates between 1990 and 2007. Had emissions been calculated on the basis of domestic consumption rather than sales then estimates indicate that total Road Transport emissions would have increased by 131% between 1990 and 2007. (Measuring Road Transport by Sales, which is how GHG emissions are calculated shows a growth rate of 192%). Notwithstanding the issue of fuel tourism the primary drivers behind the growth in

emissions is economic activity. The vehicle stock, both commercial and personal, has experienced substantial growth since 1990, rising by 138% in aggregate. Improving fuel efficiency of new vehicles due to European Legislation, backed up by local incentives will counteract the growth in emissions due to renewed economic activity. Overall emissions from the sector are projected to grow by 3% between 2007 and 2015 and a further 8% between then and 2020. The table below provides summary details of overall greenhouse gas emissions from the sector.

Table 4.6 Transport Sector Emissions- Historical and Projected (kt CO_2e)

Energy Emissions by source and year	Historical Data			With Measures				With Additional Measures			
	1990	2007	Annual Rate of Change 1990-2007	2008-2012	2015	2020	Annual Rate of Change 2007-2020	2008-2012	2015	2020	Annual Rate of Change 2007-2020
Civil Aviation	60	123	4%	110	114	129	0%	110	114	129	0%
Road Transportation	4,803	13,968	6%	13,995	15,752	17,663	2%	13,494	14,322	15,558	1%
Railways	150	149	0%	151	160	160	1%	151	160	160	1%
Navigation	95	5	-16%	5	5	5	0%	5	5	5	0%
OtherTransportation	63	132	4%	158	179	192	3%	148	156	158	1%
Total	5,171	14,378	6%	14,419	16,210	18,149	2%	13,908	14,757	16,009	1%

4.4.7 Forestry.

Projections of sequestration from sinks relate only to sequestration activities under Article 3.3 of the Kyoto Protocol. Based on the national plantation rate to date and a projected afforestation rate of 8000 hectares per annum up to 2020, the projected net estimate for carbon sequestration over the Kyoto commitment period is 2.236 Mt CO_2 per year and sequestration in 2020 is expected to be 4.350 Mt CO_2e. The estimates have been provided by COFORD – the National Council for Forest Research and Development, which is based in the Department of Agriculture, Fisheries and Food.

Table 4.7 Summary of Greenhouse Gas Emissions Inventories and 'With Measures' Projections 1990-2020

Sector	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Energy	11,707	13,950	16,733	16,276	15,530	14,913	14,450	14,849	15,098	14,509	13,522	13,774	14,207	14,471	14,732	14,980	14,274	14,673	14,991
Residential	7,350	6,404	6,552	7,384	7,290	7,062	7,167	7,255	7,545	7,596	7,660	7,818	8,001	8,201	8,404	8,596	8,782	8,962	9,137
Industry & Commercial	9,776	10,007	12,746	12,212	12,007	12,359	11,620	10,891	10,831	10,744	10,743	10,936	11,177	11,484	11,811	12,120	12,366	12,598	12,777
Agriculture	19,918	20,868	20,493	19,567	19,296	18,557	18,317	18,143	18,198	18,284	18,277	18,216	18,119	17,987	17,818	17,779	17,801	17,822	17,786
Transport	5,171	6,284	10,783	13,045	13,728	14,378	14,221	14,207	14,281	14,427	14,960	15,042	15,731	16,210	16,898	17,130	17,491	18,048	18,149
Waste	1,461	1,689	1,643	1,774	1,831	1,936	1,961	2,001	2,044	2,069	2,109	2,143	2,173	2,198	2,219	2,237	2,252	2,264	2,275
Carbon sinks							- 1,740	- 1,970	- 2,240	- 2,520	- 2,710	- 2,970	- 3,180	- 3,430	- 3,690	- 3,860	- 4,070	- 4,160	- 4,350
Total (without carbon sinks)	55,383	59,203	68,951	70,258	69,682	69,205	67,736	67,345	67,996	67,629	67,270	67,928	69,408	70,550	71,881	72,843	72,966	74,367	75,115
Total (with carbon sinks)	55,383	59,203	68,951	70,258	69,682	69,205	65,996	65,375	65,756	65,109	64,560	64,958	66,228	67,120	68,191	68,983	68,896	70,207	70,765

Table 4.8 Summary of Greenhouse Gas Emissions Inventories and 'With Additional Measures' Projections 1990-2020

Sector	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Energy	11,707	13,950	16,733	16,276	15,530	14,913	13,864	13,668	12,732	12,435	10,739	10,721	10,691	10,675	10,437	10,297	9,424	9,428	9,399
Residential	7,350	6,404	6,552	7,384	7,290	7,062	7,062	7,046	7,232	7,081	6,943	6,900	6,882	6,881	6,883	6,832	6,776	6,714	6,646
Industry & Commercial	9,776	10,007	12,746	12,212	12,007	12,359	11,336	10,353	10,040	9,603	9,487	9,508	9,577	9,711	9,864	9,909	9,893	9,863	9,779
Agriculture	19,918	20,868	20,493	19,567	19,296	18,557	18,317	18,143	18,198	18,284	18,277	18,216	18,119	17,987	17,818	17,779	17,801	17,822	17,786
Transport	5,171	6,284	10,783	13,045	13,728	14,378	14,130	13,896	13,752	13,709	14,056	13,953	14,459	14,757	15,265	15,370	15,605	16,036	16,009
Waste	1,461	1,689	1,643	1,774	1,831	1,936	1,961	2,001	2,036	2,031	2,005	1,944	1,862	1,781	1,		1,531	1,453	1,387
Carbon sinks							- 1,740	- 1,970	- 2,240	- 2,520	- 2,710	- 2,970	- 3,180	- 3,430	- 3,690	- 3,860	- 4,070	- 4,160	- 4,350
Total (without carbon sinks)	55,383	59,203	68,951	70,258	69,682	69,205	66,671	65,107	63,989	63,142	61,507	61,240	61,589	61,791	61,962	61,800	61,031	61,316	61,006
Total (with carbon sinks)	55,383	59,203	68,951	70,258	69,682	69,205	64,931	63,137	61,749	60,622	58,797	58,270	58,409	58,361	58,272	57,940	56,961	57,156	56,656

Chapter 5: VULNERABILITY ASSESSMENT, CLIMATE CHANGE IMPACTS AND ADAPTATION MEASURES

5. Introduction

Ireland recognises the need for understanding of future climate conditions in order to assess impacts and to identify associated vulnerability. A suite of adaptation measures will be needed to address the adverse impacts of climate change and to reduce risks. The provision of information on future climate conditions and potential impacts is crucial to the development and implementation of adaptation actions and measures. This is an ongoing process involving analysis, information provision and development of knowledge and capacity. In this chapter an analysis of ongoing and future climate change, vulnerability assessments, and processes to inform adaptation, to reduce vulnerability and risk, are outlined.

5.1 Background

The Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (IPCC, 2007) represents the most authoritative international scientific assessment of climate change produced to date. Changes in Ireland's climate during the last century are in line with global and regional trends identified in the AR4. These changes are projected to continue and increase over the coming decades and to continue at least to the end of this century. Such changes will result in a range of impacts that are likely to increase vulnerabilities and require adaptation measures.

Research is the primary source of information on climate change impacts for Ireland. The Environmental Protection Agency's Climate Change Research Programme (CCRP) aims to advance understanding of a range of climate change issues and to provide information to support action to address climate change. Climate change impacts and adaptation is a key thematic area of the CCRP. The objective is to provide information on future climate impacts and vulnerability in order to support actions on adaptation and risk management.

Current research advances analysis carried out during the 2000-2006 period and builds on the capacity and understanding that was developed during that period. This included analyses of climate change indicators and projections of future climate change and its impacts for Ireland. Reports published to date include Climate Change: Scenarios and impacts for Ireland[1], Climate change Indicators for Ireland[2] and Climate Change: Regional climate model predictions for Ireland[3].

[1] 'Climate Change: Scenarios and Impacts for Ireland.' Report for the Environmental Protection Agency by the Department of Geography, NUI Maynooth and the Department of Botany, TCD, under the Environmental RTDI Programme 2000 – 2006.

[2] 'Climate Change Indicators for Ireland.' Report for the Environmental Protection Agency by the Department of Geography, NUI Maynooth and the Department of Botany, TCD, under the Environmental RTDI Programme 2000 – 2006.

[3] 'Climate Change: Regional climate model predictions for Ireland.' Environmental Protection Agency by Community Climate Change Consortium for Ireland, under the Environmental RTDI Programme, 2000-2006.

5.2. Climate Change Indicators for Ireland

An updated analysis of climate change indicators was produced by McElwain and Sweeney in 2007[4]. The report provides a detailed analysis of climate change signals from meteorological data.

Key findings include:

- Mean annual temperature records closely resemble global trends, with warming evident in 2 periods, 1910 to the mid-1940s, and 1980 to 2004. The warming in the latter period occurred at a much greater rate than the global temperature increase.
- Nearly all stations reveal increases in annual and seasonal mean maximum and minimum temperatures.
- Changes to precipitation patterns are more spatially and seasonally variable than temperature changes.
- The number of days where daily precipitation is greater than or equal to 10mm (extreme precipitation events) reveals significant annual increases on the west coast.

As outlined in the initial indicators report, changes are also evident in ecosystems, such as early budding of leaves and longer growing seasons, some changes in migratory species have also been reported. In order to further investigate these changes, a large scale investment has been made in the development of phenological observation systems (www.tcd.ie/Botany/phenology/). This is contributing to European and global indicator analyses.

The Marine Institute is also carrying out a major study of changes that are occurring in the oceans around Ireland. This is based on analysis of both instrumental data and changes in marine ecosystems.

5.3. Climate Change: Scenarios and Impacts for Ireland

Global climate models provide information on likely future climate conditions. However, the outputs from such models are spatially coarse, for example Ireland is typically represented by a small number of grid squares. More detailed outputs and analyses are required to inform planning requirements at smaller regional and local scales.

Two approaches have been used to assess the potential impact of climate change in Ireland. These are “Regional Climate Modelling” and “Statistical Downscaling”. The methodologies are complementary approaches to translate the output from Global Climate Models to high resolution spatial information.

Ireland’s geographic location means that the Atlantic Ocean exerts a dominant climatic influence. There has been significant investment in ocean modelling in both the Marine Institute and in the university sector. Full coupling of these atmospheric and ocean models has yet to achieved on a regional scale.

[4] Key Meteorological Indicators of Climates Change in Ireland, ERC Report series No. 6, mcElwain and Sweeney, 2007

5.3.1. Regional Climate modelling

Regional climate modelling capacity, based on dynamic modelling of climate, has been developed in Met Eireann. This is based on the development of the HIRLAM numerical forecast model, to function as a regional climate model. Outputs form this model have been published in two reports, with the most recent report being produced in 2008[5]. This work has also been linked to the European Ensembles project which brings together regional climate modelling groups from a wide range of European countries (http://ensembles-eu.metoffice.com/).

Research is ongoing to couple the HIRLAM based "Rossby Centre regional atmospheric model (RCA)" with a regional ocean model, NEMO. Preliminary results are promising, with better representation of the spatial patterns of precipitation, especially in the winter months.

5.3.2. Statistical Downscaling of Global Models

Statistical downscaling of outputs from global models can provide very high resolution information on climate conditions. The EPA has continued to support this work e.g. Refining the Impacts for Ireland[6] also used outputs from a number of models and provided a type of probalistic analysis of likely changes and associated impacts.

Outputs from these studies have been applied to assess the impact of climate change on river discharge and local flooding which is regarded as a key vulnerability These studies have also identified areas of vulnerability in key sectors such as agriculture, ecosystems, and water resources. These results have also been used in a preliminary climate check in relation to the implementation of the EU Water Framework Directive in Ireland. Further development of this application is required.

5.3.3. Synthesis and impacts assessment

The EPA Environmental Research Centre has produced a synthesis report on the state of knowledge of climate change impacts[7] for Ireland based on the material from these published studies and expert input. The report outlines information on future climate conditions with associated confidence levels that are based on the approach used by the IPCC in the AR4. The report also outlines key sectoral impacts associated with future climate conditions. Examples from this work are shown in the following tables.

[5] Ireland in a Warmer World, Met Eireann, McGrath et al (2008)
[6] Climate change in Ireland, Refining the Impacts for Ireland, STRIVE report No.12, Sweeney et al 2008
[7] Desmond, M., et al, 2009. A summary of the State of Knowledge on Climate Change Impacts for Ireland

Table 5.1 Observed and projected changes for temperature variables.

Climate Variable	Observed Changes	Scientific Confidence	Projected Changes	Confidence Projection
Air temperature	Temperatures increased by 0.7°C since 1890, i.e. an average of 0.06°C per decade. The increase was 0.4°C during the period 1980-2008, i.e. equivalent to 0.14°C per decade.	High	1–3°C to 2100, compared to the 1961–2000 average.	Medium (depends on scenario), medium for extremes
	All seasons are warmer but more so in winter.	High	Continued night-time heating.	Medium
Heat waves	Only one station recorded a significant increase in the heat wave duration index.	High	Increased frequency of heat waves.	Medium
Cold snaps/frost days/nights	Less frost; trend of decreasing frost nights and decrease in duration. 14 to 88% decrease in number (median of 30–40%).	High	Decreased frequency.	Medium

Table 5.2 Observed and projected changes for precipitation variables.

Climate Variable	Observed Changes	Scientific Confidence	Projected Changes	Confidence Projection
Precipitation	There has been a significant increase in total rainfall in the north and west; many stations also show increases in March and October.	Medium (low confidence for local detail and very low confidence for extremes)	Wetter winters in the west, drier summers in the south-east.	Medium
	Less snow days	High	Less snow throughout.	Medium/ High
	Drier summers	Medium (2007 and 2008 were anomalous but did not reverse trend)	Drier summers: 5–10% less rainfall in 2021 to 2060 compared to 1961 to 2000. Drier summers: 5–25% less summer rainfall.	Low

Table 5.3 Sectoral impacts for agriculture, biodiversity and forests and peatlands.

Climate Variable	Agricultural	Biodiversity	Forests and Peatlands
Air temperature	Warmer temperatures will impact on pest survival and arrival of new pests. Improved conditions for plant growth; may increase yields, especially in spring and autumn. However autumn droughts may reduce this potential. Potential benefits for animal husbandry related to shorter housing periods in some areas.	Phenological studies across Europe suggest both animals and plants respond to temperature changes in a variety of ways; but this is species dependent and thus complex. Interrelationships may be disrupted causing stresses to viability. Opportunities for invasive species may increase.	**Peatlands**: increased evaporation and transpiration during summer is likely to increase CO_2 emissions. The growing season is likely to be extended. **Forestry:** increased growth but also increased threat of pests and pathogens, timber quality impacted due to rapid growth. **Soil-carbon:** potential for sequestration might be decreased due to changes in the balance between anaerobic and aerobic activity. **Cross cutting issue:** Increases in Dissolved Organic Carbon in run off in peatland is a projected impact of drier, warmer conditions.

This report is a key communications tool for engagement with information users and decision makers in key sectors. It also provides an important basis for development of more refined climate change information system.

In addition to this communication process, a number of sectoral studies have been advanced e.g. in forestry and tourism “Climate Change, Heritage and Tourism; Implications for Ireland’s Coast and Inland Waterways”[8].

To date analysis of the vulnerability of key infrastructure has focused on water and energy, for example in the report Ireland at risk: “Critical Infrastructure; adaptation for climate change”[9]. These studies show how analysis of climate change has been advanced at key sectoral levels, and have used climate information resulting from investment in climate projections to assess impacts and inform planning.

5.3.4. Coastal studies

As an island, Ireland has a key interest in sea-level rise and associated increased vulnerability to coastal flooding and coastal erosion. The Office of Public works has carried out an extensive lidar study of Ireland’s coast. This provides high resolution topographical data for analysis of vulnerability. There is ongoing work on river and coastal flooding (storm surges). A number of studies have focused on the coastal zone and coastal zone management. A project titled ‘Coastal Climate and Adaptation Tool’ (CLAD) aims to study the feasibility of applying an adaptive co-management model for participatory governance in planning for climate change adaptation. This includes local authorities who have responsibility for these areas.

[8] Kelly, B and Stack, M (2009). The Heritage Council of Ireland Series: Dublin
[9] Irish Academy of Engineers (2009), : Dublin

5.3.5. Extreme events

Increasing attention is also being given to the occurrence of extreme events. The impacts of extreme floods, storms and heat waves have been observed globally in recent years. They can be more damaging than gradual or average changes, which are more easily predicted by climate models.

5.4 Adaptation

5.4.1 Climate Change vulnerability and Adaptation

Appropriate adaptive response to climate change requires effective assessment and communication of the potential impacts at all levels of governance and planning. A large scale project, "Co-ordination, Communication and Adaptation for Climate Change in Ireland", aims to identify an effective integrated approach to vulnerability assessment and adaptation. The project is addressing vulnerability assessment and adaptation responses in key sectors including biodiversity, water, tourism, economy, the construction industry and the provision of information for local authorities.

Adaptation planning is ongoing. This is linked to the developments at EU levels and is following a similar phased approach to that outlined in the EU White Paper on Adaptation (April 2009). This envisages a preliminary phase up to 2013, during which information systems and analysis tools will be used to provide decision-making capacity at sector levels. This mainstreaming process will enable actions on climate change adaptation to be taken as required in phase 2 and subsequent phases.

5.4.2 National Adaptation Framework

The National Climate Change Strategy 2007-2012 contains a commitment to develop a national response to the inevitable impacts of climate change. The Department of the Environment, Heritage and Local Government is currently in the process of developing a National Climate Change Adaptation Framework. It is intended that this work will progress in parallel with the development of the announced primary legislation, and that the Climate Change Bill will include provisions on national adaptation policy.

The planned adaptation framework and proposed legislation will provide a framework for integration of adaptation issues into decision-making at both national and local level. Statutory requirements will be placed on public bodies to assess the risks of current and predicted impacts of climate change and to then develop and implement adaptation strategies.

The EPA has published a report on the impacts of climate change which will input into the development of the adaptation strategy. Subsequent steps will be informed by the findings of this report. The strategy must be informed by the best available scientific research in order to enable the various sectors to plan ahead and develop policies and strategies to enable Ireland cope with the likely impacts of climate change.

5.4.3 Flood Policy

Potential climate change impacts are already being addressed in a number of policy areas. The 2004 report of the Flood Policy Review Group, established following serious flooding in parts of the country over the previous decade, recognised the need to devise a clearly defined and comprehensive policy approach to flooding nationally and a precise definition of the roles and responsibilities of the various stakeholders involved. Climate change is identified as one of the key elements that need to be addressed when assessing future flood relief measures in Ireland.

Following the report, the Government appointed the Office of Public Works (OPW) as the lead agency to implement flooding policy in Ireland and the OPW is now coordinating the implementation of a strategy to manage flood risk in conjunction with other relevant state agencies. The strategy involves non-structural measures such as raising awareness of flood risk, including through the flood mapping website (www.floodmaps.ie), and promoting preparedness and effective emergency response planning as well as better flood forecasting and warning. It also includes structural works, such as flood relief schemes, particularly where flooding is already a problem.

Consideration of the potential impacts of climate change on flooding and flood risk forms an integral part of all of the work programmes that have been established to implement the flood risk management strategy. The national Catchment-based Flood Risk Assessment and Management Programme, which is central to the strategy and will deliver on the principal requirements of the EU 'Floods' Directive (2007/60/EC), involves the consideration of two potential future scenarios in both the assessment and management of flood risk, with flood maps being produced for a future scenario as well as for existing conditions. Climate change is considered in the design of measures under this programme and of flood relief schemes through the adoption of either an adaptive approach to design or with design being based on an assumption of change, as appropriate to the local context, and with a long-term view of projected changes in risk being taken in the planning of potential flood risk management interventions.

Draft guidelines on the planning system and flood risk management have recently been published jointly by the Department of Environment, Heritage and Local Government and the OPW, to promote the integration of flood risk management into the planning and development management processes, with a view to avoiding or minimising the potential increase of flood risk in the future. The precautionary approach, with careful consideration of possible future changes in flood risk, is a core principle of the guidelines.

5.4.4 Integrated Coastal Zone Management

Integrated costal zone management is supported by the planning system. Since its inception, the planning system has had a broad remit, not only in the proper planning of land resources but also in environmental protection. While specialised environmental legislation has been introduced over the years, the planning system still complements environmental legislation and will continue to play a major part in relation to coastal zone management. The Planning and Development Act, 2000 was introduced to ensure that the Irish planning system can face the challenges meeting the country as it continues to grow and prosper. Under the Act new

requirements for forward and strategic planning were introduced and a sustainable development ethos has been explicitly incorporated into the planning system. Under the provisions of the Act, each local planning authority must prepare a development plan setting out an overall strategy for the proper planning and sustainable development of the area. The Act provides that a planning authority's development plan may include objectives for, inter alia:

- regulating, restricting or controlling development in areas at risk of flooding (whether inland or coastal), erosion and other natural hazards;
- regulating, restricting and controlling the development of coastal areas and development in the vicinity of inland waterways;
- regulating, restricting and controlling development on the foreshore, or any part of the foreshore.

The transfer of certain foreshore functions to the Minister for the Environment, Heritage and Local Government effective from the 15th January 2010 will provide an opportunity to begin a process of modernisation of the foreshore consent process.

Chapter 6: FINANCIAL RESOURCES AND TRANSFER OF TECHNOLOGY

6.1 Overseas Development Assistance Programme

Ireland's Overseas Development Assistance (ODA) has continued to grow since the publication of the fourth national communication. In 2006, total ODA stood at €813.962million, rising to an estimated €918.275million in 2008, representing 0.58% of GNP. In 1998 total ODA was €177,262. Despite the recent economic downturn, and as announced at the UN general assembly meeting in September 2008 Ireland remains committed to reaching the UN target of 0.7% ODA by 2012.

Table 6.1: ODA Volumes 2006-2008

ODA Volumes 2006-2008 €m			
Year	TOTAL ODA	Of which Vote 29	ODA as % GNP
2006	813.963	595.406	0.54%
2007	870.870	725.753	0.55%
2008✸	918.275	767.578	0.58%

✸2008 provisional figure

Ireland's development assistance is focused on the Least Developed Countries, particularly those in sub-Saharan Africa. Ireland has bilateral development programmes with Ethiopia, Mozambique, Tanzania, Uganda, Zambia, Lesotho, South Africa, Sierra Leone, Liberia and Malawi. Ireland also has a programme in Timor Leste and Vietnam.

The bulk of Ireland's assistance to developing countries is administered by Irish Aid, located in the Department of Foreign Affairs. The Departments of Agriculture, Environment and Revenue also contribute to Ireland's ODA.

Ireland is committed to improving its aid effectiveness. In the last number of years since the publication of Ireland's Fourth National Communication, Ireland, like a number of other donors, has been working towards a more programmatic and harmonised approach to development cooperation. In line with an agreement reached between the Ministers of developing and donor countries, heads of multilateral and bilateral development institutions, in Accra, Ghana in September 2008, Ireland is committed to the Accra Agenda for Action (AAA). This involves the strengthening of each partner country's ownership over their development processes, building more effective and inclusive partnerships, and improving the delivery of, and accounting for, development results.

In practical terms, commitment to aid effectiveness involves aligning bilateral assistance with the national poverty reduction strategies of partner governments. This often results in providing financial support to sectors such as health, education and agriculture, or directly to the government's central budget through direct budget support. The very essence of the approach is that developing countries should prioritise their development needs and that donors should respond to these rather than their own priority issues. This new approach has obvious implications for reporting on bilateral climate related funding in two key ways:

1) Climate change must be stated as a national priority in order to receive bilateral funds; and
2) It is often difficult to segregate spending on climate change as it may be disbursed through support to the central budget or to a key sector such as agriculture or water.

Given the shortage of references to climate change in the development policies and poverty reduction strategies of Ireland's partner countries, there are a limited number of bilateral climate change programmes to report. The OECD has suggested that more than 60% of ODA could be considered as relating to adaptation. Ireland thus supports a wide range of activities, programmes and sectors which have benefits for countries addressing climate change. Many activities related to agriculture, health, infrastructure, water resource management and recovery and disaster prevention have positive impacts in terms of adaptation to climate change. For example, Ireland spent over US$25 million on agriculture in its programme countries in 2007. Many of the activities supported such as crop diversification, irrigation and the introduction of new crop varieties can make a positive contribution to adaptation to climate change. As it is not possible to put an accurate figure on Ireland's total bilateral contribution to climate change in developing countries, this report focuses on presenting illustrative examples of the types of initiatives supported. It also tries to capture main areas within the programme that are of most relevance to climate change adaptation.

Irish Aid has started to raise awareness of climate change and the risks to development posed by the impacts of climate change in the countries where it works. It also supports programmes which build the capacity of policy makers to integrate mitigation and adaptation to climate change into national development plans. Through these efforts Irish Aid hopes to create further awareness of the need to raise the policy profile of climate change in developing countries.

Within its bilateral programme, Ireland supports a range of activities which promote sustainable management of natural resources. Many of these contribute directly to adaptation to climate change, for example agriculture diversification, water resource management, vulnerability assessment and risk reduction. Irish Aid is committed to the EU Action Plan on Climate Change in the Context of development cooperation and in its *Environment Policy for Sustainable Development,* (April 2007) it commits to engage with key multilateral environment agreements to demonstrate its commitment to resolving global environmental problems, and to assist developing countries to prepare for and adapt to changing environmental conditions, protecting the most vulnerable members of society.

Ireland also supports climate change activities through multilateral programmes and through support to international agencies. Funding administered through these channels has continued to rise on an annual basis since the third national communication. Ireland continues to provide funds to the GEF and in 2008 it also contributed to the Least Developed Countries Fund (US$2 million) and the Special Climate Change Fund (US$.525 million). Ireland committed to the Bonn Declaration and has assigned funds towards the agreed US$410 million contribution (2005 to 2008), with an average assigned contribution of US$3.25 million per annum.

As part of Ireland's ODA, the following contributions were made to the Global Environment Facility in the years 2006-2008

Table 6.2: Financial Contributions to the Global Environment Facility

Contribution US $ million			
	2006	**2007**	**2008**
GEF	€1.469	€1.420	**€1.420**
Special Climate Change Fund (SCCF)	$0.525	$0.525	$0.525
Least Developed Countries Fund (LDCF)	$2.0	$2.0	$2.0
Trust Fund for Participation	$0.10	$0.10	$0.15

Table 6.3: Financial contributions to multilateral institutions and programmes

Institution or Programme	Contributions US $m		
	2006	2007	2008
1. World Bank	IDA13 and IDA14 €38.53m	IDA13 and IDA14 €28.43	IDA13 and IDA14 €24.23m
2.IFC	€0.38m	€1.05m	€1.05m
3. ADB	-	-	-
4. Asian Development Bank	€15.6m	€7.63m	€7.4m
5. EBRD	€0.41	€0.30m	€0.20m
6. I-A DB			
7. UNDP	€16.5m	€22.5m	€22.5
8. UNEP (PEI)	€1.23	nil	€1.193
9. UNFCCC Funds LDCF SCCF	 $2.0m $0.525m	 $2.0m $0.525m	 $2.0m $0.525m
10. Others LEG Caribbean Climate risk Insurance Fund (CCRIF)		 €.04 2.25	 €.05
Multilateral - Scientific, Technological, Training Programmes			
UNITAR	€.15	€.15	€.15
REEEP	$0.25m	$0.25m	$0.296
CGIAR	€4.0	€7.147	€7.78

6.2 Support for climate change related activities in developing countries

6.2.1 Bilateral cooperation

Over the reporting period interventions designed to improve environmental sustainability were implemented in a number of Irish Aid's programme countries. Many of these contribute directly to preparing for and adapting to climate change.

For example in Ethiopia Irish Aid supports the national Productive Safety Nets Programme – €21.875 million was contributed in 2008. The programme targets the most vulnerable members of society who suffer from chronic food insecurity due to drought, soil erosion and degradation and unviable land holdings. The programme addresses hunger, malnutrition and destitution through the provision of cash and food for work. A central focus of the programme is on improving the natural environment, primarily through soil and water conservation activities. Ultimately, the programme hopes to assist chronically poor households to climb out of poverty and to have access to the natural resources they need to survive. Finding ways to cope with vulnerability under current conditions will help communities to adapt to the increasingly harsh conditions expected due to climate change.

Also in Ethiopia, Irish Aid supports the Ethiopian Bale Eco-region Sustainable Management Programme in collaboration with the Norwegian and Dutch Governments. The programme supports improved planning and management of the largest area of Afroalpine habitat on the African Continent. This area forms the watershed of the Bale Massif, which is critical for the livelihoods and well-being of hundreds of thousands of people in the lowlands of southeast Ethiopia and Somalia. The Herenna Forest, covering the southern part of the mountains, is the second largest stand of moist tropical forest in Ethiopia. The forests together with the Afro-alpine plateaux are host to a globally unique and diverse fauna and flora, including several rare and endemic species. With support from the International Institute for Environment and Development (IIED) the program is now preparing to tap potential carbon markets, and has made good progress in developing sustainable bamboo harvesting and processing initiatives. By putting in place measures to sustainably manage the Eco-region, the programme will reduce the vulnerability of the ecosystem and its plant, animal and human inhabitants to the impacts of climate change. Ireland Aid has committed €2 million to this program for the period 2005-2010.

In 2008 Irish Aid, in its newest partner country Malawi, using a vulnerabilities approach, advanced its plans to focus on a number of areas that have a strong environment and climate change relevance, these include Disaster Risk Reduction, Social Safety Nets Programmes, Sustainable Agriculture and improved nutrition.

6.2.2 Support to environmental organisations

UNEP / UNDP Poverty Environment Initiative

The UNDP-UNEP Poverty - Environment Initiative (PEI) is a joint programme to provide financial and technical support to countries to build capacity for mainstreaming poverty - environment linkages, including climate change, into national development planning processes, such as PRSP's (Poverty Reduction Strategy Papers) and MDG (Millennium Development Goal) Achievement Strategies. The PEI programme, working with partner

governments and institutions makes the economic arguments for mainstreaming poverty-environment linkages into national development planning processes. Irish Aid has supported the above programme since 2005, and in 2008 allocated €1.19 million to PEI programmes in Mozambique and Rwanda.

International Institute for Environment and Development (IIED)

Irish Aid is a framework donor for IIED, providing programmatic support for the implementation of the Institute's strategic plan. In 2007/08 Irish Aid supported a study assessing the impacts of climate change on economic growth in Tanzania. The results were shared with donors and government to highlight the need to plan for and adapt to climate change within the national development planning and budgeting process

Irish Aid also supported IIED activities related to biodiversity, climate change and capacity building. For example the Poverty and Conservation Learning Group focuses on bringing the conservation and development communities together to better face the challenges posed to biodiversity conservation, including climate change.

Consultative Group on International Agricultural Research (CGIAR)

Irish Aid supports the work of CGIAR, with its 64 constituent members and 15 international agricultural research centres. In efforts to achieve its goal of sustainable food security and reducing poverty in developing countries through scientific research and research-related activities in the fields of agriculture, forestry, fisheries, policy, and environment, CGIAR has identified climate change as a critical challenge. It has prioritised climate change in its research work. Irish Aid provides both core support and direct support to CGIAR Centres. Irish Aid has funded the work of the agro forestry research centre (ICRAF) in Malawi, and its roll out of the use of nitrogen fixing trees as a tool to address serious soil degradation. Also in Malawi, Irish Aid has supported the work of the International Potato Centre (CIP) and its work on drought resistant potatoes and improved sustainable agriculture practises.

Support to CGIAR centres was complemented by a contribution of €1 million in 2007 and again in 2008 to the Global Crop Diversity Trust, the objective of which is to ensure the conservation and availability of crop diversity for food security worldwide. Conserving the vast diversity of crop varieties is essential if farmers and plant breeders are to have the raw materials needed to improve and adapt their crops to meet future challenges, including climate change.

6.2.3 Multilateral and international initiatives

Adaptation and Mitigation

Caribbean Catastrophe Risk Insurance Facility (CCRIF)

In 2007 Irish Aid supported the CCRIF with a once off contribution of US$2.5 million. The Caribbean Catastrophe Risk Insurance Facility was set up by the World Bank in June 2007 as a regional disaster insurance fund to provide participating Caribbean Governments with immediate liquidity in the event of natural disaster. It allows the Caribbean countries to pool risk and reduce their individual insurance premiums by 40%. The launch of the CCRIF represents an important shift from disaster response to disaster management and mitigation.

It is intended to serve as a pilot programme for possible extension to other regions with many small island developing states (SIDS) such as the South Pacific.

Least Developed Countries Expert Group

Irish Aid provides annual funding to the UNFCCC's Least Developed Countries Expert Group (LEG) to facilitate the provision of technical guidance and advice to LDCs on adaptation strategies and plans to address Climate Change. The LEG plays an important role in supporting LDCs to address climate change in their own countries.

UNITAR –Climate Change Capacity Development Programme

Over the period 2006 to 2008 Ireland granted €450,000 to the United Nations Institute for Research and Training (UNITAR) for its Climate Change Capacity Development Programme. This programme objective is to improve the participation of Developing Countries in the UNFCCC process and more specifically:

- to support the timely implementation of the UNFCCC and the Kyoto Protocol by Developing Countries
- to enable better coordination and integration of national climate policies with sustainable development policies
- to contribute to the sound implementation of donor-funded climate initiatives in Developing Countries.

The programme has met with considerable success in developing methodologies and training programmes to build capacity to climate proof development, thus safeguarding donor investments. It has focussed on south-south collaboration and on training for trainers to ensure lasting capacity development in the field of Climate Change. Decision makers, high-level government officials and technical staff have been targeted to increase their capacity to integrate Climate Change policies into the overall dimensions of sustainable development.

Renewable Energy and Energy Efficiency Programme (REEEP)

Ireland began its support to REEEP (Renewable Energy and Energy Efficiency Partnership) in 2005. Following the decision by the Irish Government in 2007 to offset all its carbon emissions from official travel, REEEP was chosen as its implementing partner. REEEP is a Public-Private partnership and was launched by the United Kingdom along with other partners at the Johannesburg World Summit on Sustainable Development in August 2002.

By providing opportunities for concerted collaboration among its partners, REEEP aims to accelerate the marketplace for renewable energy and energy efficiency. Funding from Ireland is to be prioritised for projects in its programme countries of Ethiopia, Lesotho, Mozambique, Tanzania, Uganda, Zambia and Malawi. Funding of approximately €0.25 million per annum has been provided to REEEP during the reporting period.

6.2.4 Civil Society partnerships

Ireland provides a substantial amount of ODA through partnership with Civil Society Organisations. In 2008 expenditure through civil society partnerships exceeded €117 million. In recent years more strategic, programmatic cooperation with civil society organisations has increased the effectiveness of spending. The Multi-Annual Programme Scheme (MAPS) is an

arrangement begun in 2003 which provides longer term programmatic funding to five NGOs. Two of these, in particular, focus on sustainable natural resource management and disaster risk reduction. Through their programmes these NGOs and the local civil society organisations that they work with in developing countries carry out a wide range of activities which address livelihood vulnerability and disaster preparedness. In the absence of a clear agreed definition of adaptation in development, the MAPS partners in 2008, by their own estimates expended approximately €16.5 million on activities that had a climate change adaptation dimension.

Some examples include: a drought management programme in Kenya; an agricultural recovery and diversification programme in Angola; an emergency preparedness programme in Ethiopia; and capacity building to address natural disasters in West Africa.

6.2.5 Emergency and Recovery

Irish Aid's Emergency and Recovery Programme addresses disaster risk reduction and disaster preparedness. Funds are provided to multilateral institutions and civil society organisations to build community and government capacity to respond to and plan for disasters. It is not possible to give an accurate value for funding to climate change related activities but a growing awareness of climate change is reflected in the projects and programmes supported.

6.3 Technology Transfer

Ireland provides development assistance in line with the priorities expressed by partner countries. To date requests for assistance in the area of technology are primarily in connection with water supply, transport infrastructure and agriculture. An innovative programme in Ethiopia carries out operational participatory research with farmers, extension workers and government officials to identify, develop, and disseminate new agricultural technologies. Some of the successful technologies are based on traditional practices, for example soil conservation techniques. Other new technologies are related to new crop varieties and irrigation.

In addition to ODA, private companies also provide technology and advice to developing countries, particularly in the energy sector. Due to the range of funding sources no precise figure is available for funding attributed to technology development and transfer. Ireland's support to REEEP is worth mentioning again here as an example of Ireland's support for technology transfer. REEEP brings the private and public sectors together to facilitate the financing, development and transfer of renewable energy technologies. Ireland believes that this type of public-private collaboration is essential for the development of appropriate and environmentally sound technologies and to facilitate their application and use in developing countries.

Chapter 7: RESEARCH AND SYSTEMATIC OBSERVATION

7.1 General policy on Funding of Research & Systematic Observations

In Ireland funding for climate change research, systematic observations and related activities is provided though a number of state agencies and organisations. The budgetary allocations are provided via relevant Government Departments. Since 2007 research funding at a national level has been provided through the National Development Plan (NDP) 2007-20013. This is a follow up programme to the NDP 2000-2006 under which a substantial investment in development of climate change research was also made. Climate related systematic observations are funded as a component of the operational activities of a number of state bodies. Other observations carried out by research institutions are funded through research programmes.

Direct funding for environmental research is the responsibility of the Department of Environment, Heritage and Local Government (DEHLG) who have mandated the Environmental Protection Agency (EPA) undertake the task of management of this research allocation. The NDP 2007-2013 also included additional funding for climate change research and allowed for the development of the more structured Climate Change Research Programme (CCRP) with improved co-ordination structures and processes. The CCRP is structured along thematic areas as shown in Figure 1.

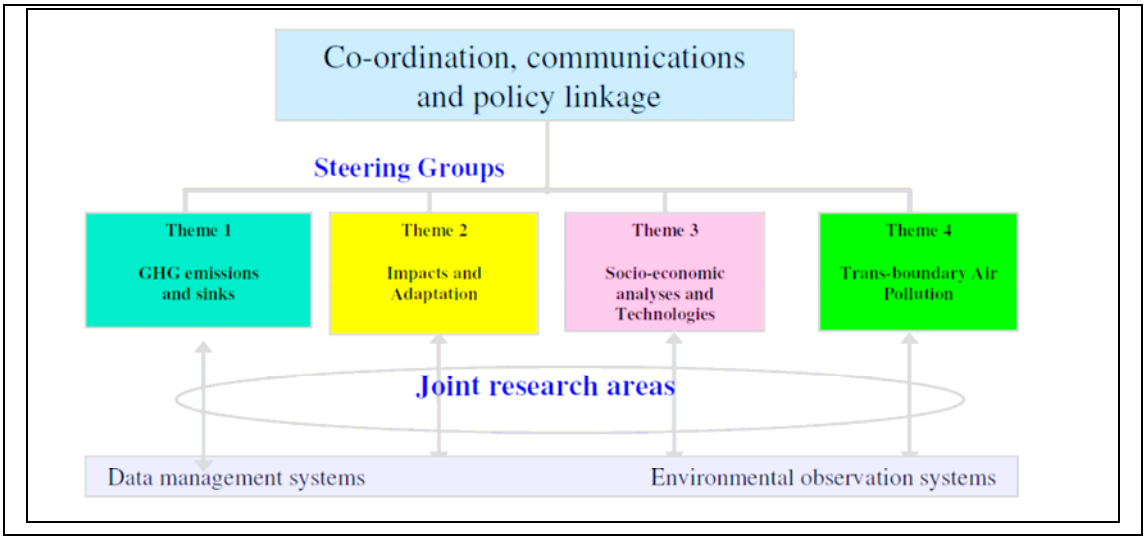


Figure1. Organisational structure of the Climate Change Research Programme *(CCRP)* across key thematic areas. Theme 1; Greenhouse gas (GHG) emissions and sinks aims to provide key support for national inventory development and projections of future emissions. Theme 2; Impacts and Adaptation: Provides support on adaptation and identification of vulnerability to the adverse impacts of climate change, risk assessment and management. Theme 3; Socio-economic analysis and Technologies: Solution is focussed on approaches and analysis of mitigation and adaptation options including technologies. Theme 4 on trans-boundary Air Pollution advances analysis of air pollution issues and linked CLTRAP and EU Café processes historic and synergies between these and climate issues. Cross cutting research includes observation systems, data and information provision, integrated modelling as well as studies of fundamental processes.

The objective of the CCRP is to advance research or a cross sectoral basis through enhanced coordination, avoiding duplication and increasing overall use and value of research. A key aim is to coordinate climate change related research funded by the EPA and through other Government Departments who have similarly devolved responsibility for research funding. This includes: energy research funded by Sustainable Energy Ireland; agriculture research and soil carbon analysis funded through DAFF and Teagasc (www.teagasc.ie);, forest research funded by the National Council for Forest Research and Development (COFORD, www.coford.ie); marine research funded by the Marine Institute (www.marine.ie); and socio-economic and enterprise orientated research being advanced by Forfas (www.forfas.ie) and Enterprise Ireland (www.enterprise-ireland.com).

Climate change related studies are also indirectly supported by other bodies e.g. groups who have invested in research infrastructure. These include the Higher Education Authority (HEA) (www.hea.ie) which provides funding for university and other educational institutions.

The national meteorological service, Met Éireann, operates a climate analysis section from within its own budget and has primary responsibility for systematic observations of meteorological parameters. Individual NGOs have also been engaged in research initiatives.

7.2 Exchange of data and information

Meteorological data for climate change related research are provided on request by Met Éireann. All such data are provided free, or at cost, for research purposes. The EPA has provided online access to its archive of non-meteorological climate change related data. This is accessible from www.safer.ie which is a development under the EPA Environmental Research Centre of Excellence (http://coe.epa.ie/). This includes data on national greenhouse gas emissions and sinks. These data are open access. Further use of research data is subject to standard publication protocols.

7.3 Climate Change Research

Climate change research has developed significantly under the current and previous National Development Plan. The planned EPA investment in climate research over the 2007-2013 period is of the order of €15m. In addition, relevant sectoral research is funded in the areas of energy, agriculture, forestry and marine research. Research projects are largely carried out in the university sector, but also in specialised state bodies and by consultants. This investment has enabled development of national capacity and provided information on a range of climate issues.

7.3.1 Climate Process and Climate Systems Studies including Paleoclimate

Climate processes and systems studies are an important element of the CCRP which supports a broad spectrum of research as is outlined in the following sections.

7.3.2 Greenhouse gases (GHG) Emissions and Sinks

This work is being advanced under Theme 1 of the CCRP. The main objective is to support improvement of the national emissions inventory and projections of future emissions. The aim is to ensure that the national inventory is based on the best possible science and, where

feasible, subject to independent scientific verification. The types of projects in this area include:

- Emissions from Enteric fermentation (livestock);
- Emissions from other agriculture sources e.g. fertilizer use, manure storage and land application technologies and practices;
- Land fill gas management and utilisation;
- Land use and land use change and forestry;

In addition to the EPA programme, research in these areas is funded by, the Department of Agriculture, Fisheries and Food (DAFF), TEAGASC, SEI and COFORD.

Due to Ireland's GHG emissions profile there is a significant focus on the agricultural sector and land use land use change issues. Work has focused on enteric fermentation and options to reduce these emissions e.g. dietary supplements. This work has been initiated through EPA funding and progressed under the DAFF stimulus projects.

A number of research initiatives have been undertaken to help quantify carbon stock changes in response to land use management. Field scale, flux measurement experiments have been carried out on grasslands, croplands, peatland and forest land (using both chamber and eddy covariance methodologies). The sites have been in operation for a number of years and are contributing to the production of country specific emissions profiles. These studies have been linked to European projects such as CarboEurope, NitroEurope. An important development has been the application of process models, such as the DNDC model to analyse N_2O emissions. This is seen as vital to emissions analysis and determination of mitigation options for this complex area.

The EPA funded SOILC project, has made detailed measurements of soil carbon at 60 representative sites across the country identified from analysis of the National Soil Database. The COFORD funded FORESTC provides data for 60 additional forest sites using the same sampling methodology. COFORD funded research has significantly advanced forest studies. These have examined carbon sequestration by Irish forest ecosystems. These studies have focused on commercial species and development of high resolution measurements and systems models.

Quantification of land use and land use change is being addressed through on-going engagement with the CORINE 2006 system, with additional research on adapting existing national land parcel information systems data for land use tracking purposes. This work informs national inventory analysis for UNFCCC reporting purposes as well as providing information for decision making.

All efforts to quantify carbon stock change are being included in Irish Soil Information System (ISIS) project. This project will provide a 1:250,000 soils map of Ireland and an associated Soil Information System which will be fully open and accessible to all.

7.3.3 Peatlands

Peatlands make up 14-17% of national land cover and are a major carbon reservoir. The need to ensure their sustainability has been recognised through the establishment of a large scale integrated sustainable development project in 2005. This project will build on and enhance completed and ongoing studies e.g. on carbon fluxes, systems and process models, though integration of these with areas such as sociology, economics, archaeology etc. in-order to develop a strategy for sustainable management of Irish peatlands.

There may be carbon emission mitigation, and sequestration options available with the adoption of policies related to peatland restoration and re-vegetation. A first step in the assessment of such options is the mapping and classification of the state of national peatlands, and also the response of peatland to active restoration management and additional studies have been undertaken to assess usage of cutaway and degraded peatland.

7.3.4 Top down analysis

At a macro-scale, work on the application of inverse modelling techniques has been applied to ambient measurements of greenhouse gases at the Mace Head atmospheric research station. These methods have been applied to estimate Irish emissions and sinks for certain greenhouse gases including industrial gases. The general approach is to develop complementary bottom-up, top-down and intermediate scale analyses in order to provide cross-validation of research outputs. The EPA has advanced work in this area through the establishment of GHG measurements at sites in the North and South East of the country. This effectively triangulates Ireland and is a part of the Irish contribution to the EU Integrated Carbon Observing System, ICOS. This is a large-scale European infrastructure development.

7.4 Modelling and Prediction, Impacts and Adaptation

Research in this area is advanced under Theme 2 of the CCRP, Impacts and Adaptation. The objective is to improve climate model prediction for Ireland and utilise these predictions to provide information on impacts in support of decision making on adaptation. This also involves identification of vulnerabilities to the adverse impacts of climate change, associated risk assessment and risk management options. The aim is to ensure that actions taken to adapt to climate change are informed by best available scientific analysis. The types of projects in this area include:

- Analysis of changes and trends in climate data, including ecosystems;
- Provision of future climate scenarios and associated impacts;
- Analysis of past climate conditions, paleo-climate;
- Development of information systems and supports for policy and decision making.

In addition to the EPA funded research work in this area is supported by OPW, the Marine Institute, Forfás and Met Eireann.

A regional climate modelling facility was established in Met Éireann in 2003 to provide forecasts of the future climate and to examine the impacts of climate change at regional scale. A comprehensive report[1] was released in 2008, describing the expected changes in a

[1] Ireland in a Warmer World. Scientific Predictions of the Irish Climate in the Twenty-First Century (available at http://www.c4i.ie)

variety of climate parameters and the likely impacts for water resources, flooding potential, wind energy, etc.

Climate modelling is now a core activity in Met Éireann. It is a partner in the EU-funded ENSEMBLES project and has run centennial climate simulations for the European area. Together with UCD and the Irish Centre for High-End Computing (ICHEC), it is also a partner in EC-EARTH, an international consortium established to develop a new global climate model. Met Éireann plans to make extensive use of the EC-EARTH model for climate research and will also contribute simulation outputs to the coupled model intercomparison project (CMIP5) in support of IPCC AR5. The primary objective of its research is to provide up-to-date information on the future Irish climate to planners and developers in support of national initiatives to tackle climate change.

Met Éireann also part-supervises climate related EPA STRIVE Fellowships in collaboration with the universities.

7.4.1 Indicators of Climate Change

Analysis of climate change indicators is ongoing. An updated report on analysis of climate change indicators was produced in 2007[2]. This report provided a detailed analysis of signals of climate change from meteorological records. New research on ecosystem indicators and impacts has been advanced with a large scale investment in development of phenological observation systems. This study also contributed to Europe wide indicators analysis. A study of changes in extreme events has also been established, which also explores paleoclimatic data and unique historical archives.

7.4.2 Projections of Climate Change

Research investment has lead to the development of regional modelling and forecasting capacity within Met Eireann[3]. This work is linked to European projects such as Ensembles (www.ensembles-eu.org). Statistical downscaling approaches to analysis of future climate conditions have also been developed in the university sector. The output from this work informs impacts analysis which aims to quantify regional and sectoral impacts of future climate conditions.

Ireland's coastline and waterways may be particularly vulnerable to climate change impacts. Targeted research has been established to look at coastal zone issues and management options. This work is also linked to other regional studies in Europe (www.imcore.eu). Links between development of river modelling tools and climate impacts modelling have also been advanced.

7.4.3 Paleoclimateology

Irish peatland and lake systems provide a rich source of information on long-term climate change. The NUIG based Paleoenvironmental Research Unit (www.nuigalway.ie/pru/) has a very active research programme on the late-glacial period c. 15,000 to 11,500 years Before

[2] Key Meteorological Indicators of Climate Change, in Ireland, McElwain and Sweeney, 2007 ERC Report Series No. 6.
[3] Ireland in a warmer world, McGrath et al 2008, Met Eireann.

Present and Holocene environments in Ireland. Studies in TCD have advanced the application of statistical methods to reconstruction of past climate, based on pollen analysis (www.tcd.ie/Statistics/). A summary analysis of paleoclimate research has been provided in an analysis of the implications of the EU's two degree climate protection target for Ireland[4].

The recently completed national sea-bed survey by the Geological Survey Ireland (www.gsi.ie) and the Marine Institute has provided a detailed morphology of seabed features and information on composition creating a framework for future paleoclimate studies (www.gsiseabed.ie).

7.4.4 Information systems and supports for policy and decision making

Impacts of climate change for Ireland have been outlined in a number of research reports[5]. The EPA has also provided a synthesis report on climate change and its impacts based on material from various national reports[6]. This research is increasing focus on the provision of user orientated information and analysis to support decision making on adaptation actions at sectoral and local levels.

7.5 Socio-Economic Analysis and Technologies

Research on socio-economic analysis and technologies is advanced under Theme 3 of the CCRP. Work in this area is solution focussed. It aims to identify new approaches and analysis to mitigation and adaptation. A key aim is to identify pathways for achievement of a carbon/GHG neutral Ireland by 2050. This provides a framework for integrated analysis of solutions including new and emerging technologies. The types of projects in this area include:

- Socio-economic studies and analysis of national and international targets
- Mitigation technologies including Carbon Capture and Storage
- Sectoral (energy, transport) and integrated assessment modelling

In addition to the EPA's research, work in this area is advanced by DCENR/SEI, Forfás, SFI, DAFF, and the Department of Transport.

7.5.1 Socio-economic analysis

Studies have been developed to determine economic and social impacts of climate change. These have principally been focused on impacts of energy/carbon taxes, lifestyles, business and competitiveness during transformation to a low carbon economy. Ongoing analysis is focused on EU targets and issues arising from differentiation of the ETS and non-ETS sectors.

7.5.2 Mitigation Technologies

The EPA has engaged in the promotion of the EC Environmental Technologies Action Plan (ETAP) within Ireland, which includes low emission technologies. There is ongoing research in relation to energy efficiency and sustainability mainly funded by SEI. This includes work on research on the efficient use of energy, CHP and renewable energy sources including biofuels. Ocean energy research is promoted by SEI and the Marine Institute. This is considered to have considerable long term potential for Ireland. However, significant technical and other barriers exist in relation to this potential.

[5] Implications of the EU climate protection target for Ireland McElwain and Sweeney, 2007 ERC Report Series No. 5
[5] Climate Change, Refining the Impacts , Sweeney et al. 2008, Climate Change,
[6] A summary of state of know Desmond et al 2009

The potential for geological storage of carbon dioxide has been explored in two studies. The first study based on existing data, was carried out on an all-island basis. This identified a significant theoretical potential for CCS, particularly in relation to depleted gas fields off the south coast of Ireland. A more detailed second study is ongoing. This is targeted at a region of specific interest and involves the provision of new geological data and analysis.

7.5.3 Model development

The EPA and SEI are supporting the development of new energy modelling capacity for Ireland based on the international TIMES model (www.etsap.org/Tools/TIMES.htm). This aims to provide analysis of energy pathways for achievement of medium term targets for renewable energy and GHG emissions, and longer term emission mitigation targets i.e. up to 2050.

The EPA is supporting integrated assessment modelling which is a powerful tool for provision of sectoral and cross sectoral analysis of targets and cost effectiveness of policies and measures to meet these targets. This approach has been applied to trans-boundary pollutants and greenhouse gas emissions using the GAINS model (http://gains.iiasa.ac.at/) and applying it to Ireland.

7.6 Cross cutting issues

Cross cutting studies aim to address synergies and trade-offs between policy objectives and sectors and include some fundamental atmospheric processes. These include work on integrated assessment modelling, development of integrated approaches to mitigation and adaptation as well as areas such as aerosols which impact on climate and air quality.

7.6.1 Aerosol Radiative Impacts

Historically Irish scientists have made important contributions to the development of atmospheric sciences. In recent years national research has focused on aerosol science and aerosol cloud inter-actions. Aerosol radiative forcing provides most of the uncertainty in relation to anthropogenic forcing of climate. An extensive range of aerosol measurements and other atmospheric composition studies are carried out at the Mace Head Atmospheric Research Station operated by the National University of Ireland, Galway. Mace Head is a Global Atmospheric Watch site. These are funded through national and international sources. Process studies are considered to include work on GHG emissions and sinks, analysis of peatlands, studies of aerosol radiative impacts and paleoclimate analysis. Aerosol climate studies have been largely focused on aerosol air sea exchange processes, and linked changes in direct and indirect radiative focusing by aerosols. The aim is to improve paramerterisation of these in climate models.

7.7 International Participation

Ireland recognises the international nature of climate change and the need to participate in global efforts. Research groups have strong links to research group in Europe and beyond. The Royal Irish Academy Committee on Climate Change (CCC) coordinates activities in relation to international bodies such as the International Geosphere -Biosphere Programme (IGBP) and World climate Research Programme (WCRP).

The development of national climate research capacity has enabled greater national participation in IPCC activities. A number of Irish scientists were lead or review authors in the IPCC fourth assessment report (AR4). Ireland hosted an IPCC workshop on uncertainty and risk. Irish scientists are contributing to the forthcoming IPCC special report on renewable energy.

Ireland supports the European Union/European Space Agency (ESA) Global Monitoring for the Environment and Security (GMES) activities and influences and is part of the ESA Earth Observation research programme. Ireland is a member of the Intergovernmental Group on Earth Observations (GEO) and supports its development. Both GMES and GEO contribute to the development of sustained observations systems as required and in support of Global Atmospheric Observing Systems (GCOS).

7.8 Systematic Observation

A number of national bodies/organisations are engaged in systematic observations including contributions to the Global Atmospheric Observing System (GCOS). Met Éireann has primary responsibility for the atmospheric observations listed below, although the National University of Ireland, Galway also co-ordinates upper-air and composition observations at the Mace Head facility. Responsibility for terrestrial and oceanographic observations is divided among a number of State agencies including the EPA, Marine Institute, universities and other academic institutions.

In order to respond to the GCOS implementation plan (GIP), the Environmental Protection Agency (EPA) (www.epa.ie) the Marine Institute (MI) (www.marine.ie) and Met Éireann (www.met.ie) established an assessment group to review the GIP and its implementation in Ireland. It also aimed to determine and prioritise those steps necessary for full implementation of the GCOS plan. The outcome from this process was published in 2008 (Dwyer, 2008)[7].

As the GIP does not capture adequately the full observational needs for smaller countries and local areas, there was a further in-depth review of Ireland's existing observational infrastructure, data accessibility and analysis capacity. The report published (Dwyer, 2009)[8] identifies strategic directions and sets out a detailed and costed action plan for Ireland for the establishment, maintenance and further development of an integrated national climate observing system. It was based on the outcomes of extensive consultation with Ireland's climate observation and research community.

7.8.1 Atmospheric Observations

Ireland has three main groupings of meteorological observing stations:

- 16 Synoptic stations
- 70 Climate stations

[7] Dwyer, N., 2008, Climate Change - Implementation of the Global Climate Observing System in Ireland , Environmental Research Centre Report 8, Environmental protection Agency, Johnstown Castle, http://www.epa.ie/downloads/pubs/research/climate/name,24240,en.html

[8] Dwyer, N., 2009, Current Status and Required Actions for National Climate Observing Systems, Environmental Research Centre Report 14, Environmental protection Agency, Johnstown Castle.

• 495 Rainfall stations

The synoptic station network consists of one Observatory (Valentia) manned 24 hours, five airport stations manned 24 hours, two Coastal stations manned 24 hours, one inland station manned part time but with an Automatic Weather Station (AWS), and seven unmanned Automatic Weather Stations. The manned synoptic stations operated by Met Éireann provide hourly observations of the standard meteorological parameters, while most of the Automatic Weather Stations provide observations of the standard meteorological parameters by the minute.

The climate station network consist of 70 stations which return daily values of Dry-bulb, Wet-bulb, Max and Min temperatures and rainfall; 15 of these also report daily sunshine. Approximately 50% of these stations report soil and earth temperatures at different depths. The daily readings are taken at 0900 GMT. Readings are taken by private individuals, Government bodies, local authorities, schools and colleges, etc.

The rainfall station network consists of 452 stations which report daily rainfall at 0900 GMT and 39 stations which report monthly falls. Readings are provided by a variety of bodies and private individuals in the same way as for climate stations. In addition, there are 40 daily and 4 weekly Dines Tilting Syphon Rain Recorders in operation at various locations.

There are also 15 evaporation stations using Class A pan evaporimeters.

Data from all the above networks are archived by Met Éireann. These data are quality controlled and kept under continuous scrutiny by the Climatology and Observations Division. The stations are visited regularly by inspectors to ensure, as much as possible, that the siting of instruments and the accuracy of records conform to WMO standards. Records from some stations span more than 100 years. Much of the data since 1941 from the above stations are held in electronic form.

7.8.2 Oceanic Observations

A number of ocean surface variables are measured by the fixed buoy network. The first buoy was installed in 2000. Since then five more have been deployed. The weather buoys return hourly information on:

- Wind speed and direction
- Atmospheric pressure and tendency
- Air temperature
- Relative humidity
- Sea surface temperature
- Wave height and period

New instrumentation is being installed on the buoys to record sea water conductivity and salinity from 1m below the surface.

The tide gauge network has expanded significantly over the last number of years.

A number of sub-surface variables are measured by the two national research vessels annually. Four Argo floats have been deployed and funding is in place to deploy additional floats until 2010.

Table 7.1 Participation in the Global Oceanographic Observing Systems

	VOS	SOOP	TIDE GUAGES	SFC DRIFTERS	SUB-SFC FLOATS	MOORED BUOYS	ASAP
For how many platforms is the Party responsible?	15	0	17	0	4	6	0***
How many are providing data to international datacentres?	15	0	2	0	0	6	0
How many are expected to be operating in 2010?	15	0	17	0	12	6	0
* Reports to GTS only. ** Part of EUCOS SURFMAR.							

7.8.3 Terrestrial Observations

Activities related to the collection of information on hydrological variables are coordinated through a Hydrology working group, whose members are made up of the key agencies involved in this sector, the Environmental protection Agency and the Office of Public Works. Selection of flow measurement stations in a number of the hydrometric areas in order to determine an appropriate network for long-term climate monitoring purposes is underway.

A land cover interest group has met regularly in relation to the production of the European land cover map (CORINE) for 2006 and is now exploring a range of issues in order to improve collection of land cover related information.

Chapter 8 – EDUCATION, TRAINING AND PUBLIC AWARENESS

8.1 Climate change Awareness Campaign

A key element of the Department of the Environment, Heritage and Local Government's *Climate Change Strategy 2007 – 2012* is the Climate Change Awareness Campaign. The campaign, which commenced in December 2007, was designed to raise public awareness of climate change, its causes, impacts and implications for Ireland. The focus in 2008 was to raise public awareness ('Know your number') and the focus in 2009 was to take action to reduce your carbon number ('Cut Carbon. Cut Costs').

As part of the campaign, the change.ie website was established and it provides information on climate change, its causes and implications, actions that can be taken to reduce emissions at individual and sectoral level and information on policy measures that are being taken by Government at local, national and international level. The website features a carbon calculator for individuals as well as a calculator for organisations to enable them analyse their emissions and offers advice on how to better carbon manage their operations. There have been 246,126 unique visitors and 1,477,981 Page Views since the site launched last April up to October 31st 2009.

Phase 1 of the campaign included significant advertising, PR and sponsorship elements as well as a range of competitions and sub-campaigns, including support for Earth Hour. The campaign also included the development of climate change educational resources in partnership with St Patrick's Teacher Training College, which will be rolled out in all primary schools in late 2010.

Phase 1 of the campaign concluded in October 2009 and the next phase of the campaign will have a more community-based focus and will be managed by the Department of the Environment, Heritage and Local Government in conjunction with other State and Non Government bodies.

8.2 Environmental Protection Agency

The EPA continues to generate public discussion through its research programmes and publications. As part of its programme of increasing public awareness of climate change issues, the EPA hosted a seven part lecture lectures which took place in Dublin from November 2007 and concluded in April 2008. The speakers included international experts who discussed key aspects of climate change, including the basic science, predictions, impacts and options for actions to deal with this global challenge. The impressive array of speakers included influential experts from the Intergovernmental Panel on Climate Change (IPCC), the UN Framework Convention on Climate Change (UNFCCC), the British Antarctic Survey and the Potsdam Institute in Germany. The series concluded with a presentation by Mr John Gormley, Minister for Environment Heritage and Local Government.

The lecture series was very well attended, with audiences of almost 400 people per event. With the permission of the invited speakers, each lecture was recorded live and is available on the EPA's website (www.epa.ie). The video broadcasts include a lively question and answer session at the end of each lecture.

8.3 Teacher Training - Education for Sustainable Development

The National Education for Sustainable Development Strategy being prepared by the Department of Education and Science is expected to be published in the near future. The priority will be to ensure that ESD becomes a core value in education and public awareness strategies and that there is coherent national approach supported by local community actions.

The strategy will have four main objectives under which a range of specific actions will be taken. The objectives are to:

- Embed Education for Sustainable Development at every level of the education system.
- Promote public awareness of ESD designed to provide the knowledge, skills and values to encourage individuals, businesses and organisations to take action in support of a sustainable and just society, care for the environment, and responsible global citizenship.
- Promote capacity building in support of ESD.
- Promote high standards of environmental management in education institutions.

8.4 Environment Information Service (ENFO)

The ENFO office in Dublin has provided public access to environmental information for almost 20 years. In light of a number of factors, including technological advances, people's expectations of instant access to up-to-date information, the number of State and other bodies now providing environmental information, the growing interest in such information and the State's obligation to facilitate access to such information in an integrated manner, a review of this service was undertaken in 2008. This review led to the establishment, in September 2009, of a new enhanced ENFO service to be provided through the public library system. It includes an online service, hosting of environmental exhibitions with associated school trips in libraries countrywide; countrywide access to ENFO library stock and online reference databases through the library system, online access to Environmental Impact Statements, and an information query service.

8.5 COMHAR Sustainable Development Council

Comhar was established by the Government in 1999 in order to promote sustainable development across economy and society. Comhar's 25 members are appointed by the Minister for the Environment, Heritage and Local Government from the state/public sector, economic sectors, environmental NGOs, social/community NGOs and the professional/academic sector. Comhar agreed Principles for Sustainable Development in 2002 which inform its work programme. The Principles address seven themes: satisfaction of human needs by the efficient use of resources, equity among generations, respect for ecological integrity and biodiversity, equity among countries and regions, social equity, respect for cultural heritage/ diversity, and good decision-making.

Comhar's advice and recommendations to Government are informed by policy analysis and evidence based research. Comhar provides a mechanism for stakeholder input to the policy-making process and, in this context, acts as an important forum for dialogue on climate-related issues among various stakeholders. Since 2002, Comhar has had a working group on

climate change, and Comhar has published reports on climate change addressing issues such as:

- A Study in Personal Carbon Allocation: Cap and Share
- Subsidies and emissions of greenhouse gases from fossil fuels, and
- Options for carbon taxation expenditure in favour of renewable energy and against fuel poverty in Ireland.

Comhar has also made recommendations to Government on the National Climate Change Strategy and on the introduction of carbon/energy taxation. Comhar actively cooperates with other councils for sustainable development in Europe – see www.eeac-net.org. Further information on Comhar is available at www.comharsdc.ie.

8.6 Sustainable Energy Ireland

Sustainable Energy Ireland was established as Ireland's national energy agency under the Sustainable Energy Act 2002. SEI's mission is to promote and assist the development of sustainable energy. This encompasses environmentally and economically sustainable production, supply and use of energy, in support of Government policy, across all sectors of the economy including public bodies, the business sector, local communities and individual consumers. Its remit relates mainly to improving energy efficiency, advancing the development and competitive deployment of renewable sources of energy and combined heat and power, and reducing the environmental impact of energy production and use, particularly in respect of greenhouse gas emissions.

SEI is charged with implementing significant aspects of government policy on sustainable energy and climate change abatement, including:

- Assisting deployment of superior energy technologies in each sector as required;
- Raising awareness and providing information, advice and publicity on best practice;
- Stimulating research, development and demonstration;
- Stimulating preparation of necessary standards and codes;
- Publishing statistics and projections on sustainable energy and achievement of targets.

SEI is funded by the Government through the National Development Plan, with programmes part-financed by the European Union.

SEI is responsible for developing and maintaining comprehensive national and sectoral statistics for energy production, transformation and end-use. For this purpose, SEI established the Energy Policy Statistical Support Unit (EPSSU) as a specialist team with responsibility for collecting, processing and publishing energy statistics to support policy analysis and development in line with national needs and international obligations. In doing so, EPSSU conducts statistical and economic analyses of energy services and sustainable energy options so as to inform policy advice and underpin programme prioritisation.

8.6.1 Energy Policy Statistical Support Unit

SEI is responsible for developing and maintaining comprehensive national and sectoral statistics for energy production, transformation and end-use. This policy service is being

augmented by an independent national energy-modelling capacity which will provide an evidence base for public policy-making on energy/environment and in particular the energy-related greenhouse-gas axes.
The role of the SEI's Energy Policy Statistical Support Unit (EPSSU) is to:

- Collect, process and publish energy statistics to support policy analysis and development in line with national needs and international obligations
- Conduct statistical and economic analyses of energy services and sustainable-energy options so as to inform policy advice and support programme prioritisation
- Contribute to the development and promulgation of appropriate sustainability indicators, including participation in national and international working groups

8.6.2 Sustainable Energy Communities

The Sustainable Energy Communities (Dundalk 2020) project aims to stimulate a paradigm shift in communities towards the use of more sustainable energy. The project mission is to demonstrate and promote the range of technologies, techniques, policies and behaviours that will realise a sustainable energy future for Ireland.

8.6.3 National Smart Metering Programme

Up to 21,000 electricity customers will get a Smart Meter installed in their home for free as they participate in the behavioural and technology trial to inform the national roll-out.

Under this scheme, electricity was generated via small-scale technologies, such as wind turbines and solar power, with the potential to sell excess power back to suppliers.

8.6.4 Consumer Awareness

The objective of SEI's Consumer Information Programme is to engage and motivate consumers to actively play their role in greater energy sustainability. This is achieved by building an understanding of the relevance of sustainable energy to consumers. The ultimate aim is to influence attitudes, values and beliefs in relation to energy, sustainable energy and energy efficiency. Consumers are becoming increasingly aware of the importance of sustainable energy, influenced by the fluctuating cost of home heating and price of electricity and a heightened media interest in energy issues and climate change. SEI's Consumer Information Programme informs consumers of the practical steps on how to become more energy-efficient in the home. By encouraging more energy-efficient practices and promoting the switch to renewable-energy options where possible, the programme can help consumers to enjoy lower home energy costs and increased comfort, while also benefiting the environment.

8.6.5 Education programme for primary and secondary schools

SEI's schools programme supports learning and teaching about energy in the classroom. Energy is already included in the primary Social, Environmental and Scientific Education (SESE) curriculum and in many subjects at second level. Schools can use SEI's resources to expand on these topics in a relevant, engaging way. In 2008, SEI's schools programme continued seeking to educate the young people who are the future energy users and decision-makers. The schools programme provides information via the website and curriculum-linked resources for schools. This is complemented by an extensive outreach

programme, including energy workshops for schools, exhibitions and attendance at teacher and student events.

8.6.6 Renewable Energy Information Office (REIO)

SEI's Renewable Energy Information Office (REIO) promotes the use of renewable-energy resources and provides independent advice and information nationwide on financial, social and technical issues relating to renewable-energy development (wind, solar, biomass, geothermal and hydropower). Programme elements include publishing regular newsletters and information brochures, organising conferences and workshops, and providing an advice service on renewable energy.

8.6.7 Participation in International Activities

Ireland participates in a number of international organisations and activities in the area of sustainable energy. These include: European Union programmes, the International Energy Agency, the Seventh Framework Energy Committee, the United Nations Sustainable Energy Finance Alliance (UNSEF), the Renewable Energy and Energy Efficiency Partnership, and the European Energy Network.

8.7 Environmental Non-Governmental Organisations

Environmental NGOs play an important role in raising public awareness of climate change and are active during the preparation of national policy on climate change. The Environmental NGO sector is less developed than those in some other member states of the EU. The Department of the Environment, Heritage and Local Government has been engaged in helping such NGOs to build capacity through the provision of core and capacity building funding through a company established by the ENGOs as well as through funding to individual organisations for various initiatives, project research and to support them in participating in social partnership.

In April 2009 it was announced that an Environment Pillar would be established under Social partnership which will ensure that environmental considerations are fully reflected in Social Partnership discussions. The Pillar will be represented by a range of environmental NGOs groups who operate at national level.

The Department also provides financial support for specific programmes and initiatives undertaken by NGOs to raise awareness of environmental issues, including climate change. The Green Schools Programme is one such initiative, which is sponsored by An Taisce and has engaged almost 80% of schools in the state. Its focus has been on sustainable waste management but also covers sustainable energy use, water management, transport and climate change.

The Department provides on-going support for anti-litter awareness raising and educational initiatives carried out by ENGOs. The Department supports An Taisce in operating a National Spring Clean programme each year which promotes local anti-litter activities such as litter picking and includes the sorting of the waste collected for recycling.

8.8 Local Agenda 21 Environmental Partnership Fund

At local level the Local Agenda 21 Environmental Partnership Fund promotes sustainable development by assisting small scale, non-profit environmental projects at local level. It is an approach, based on greater participation by communities in local decision making for sustainable development. Supported projects focus on environmental awareness initiatives which complement national environmental policies such as those on Waste, Biodiversity, Climate Change and Sustainable Development.

8.9 TidyTowns

The TidyTowns environmental development programme continues to be very successful with over 700 entrants each year. A new climate change award has been added to raise awareness among community groups of how they can reduce the carbon footprint of their activities. The programme also includes a Tree Planting Award and criteria which promote waste minimisation, biodiversity and recycling.

Annex 1: Greenhouse Gas Emissions 1990-2007

I. CO_2 Emissions Trends 1990-2007

II. CH_4 Emissions Trends 1990-2007

III. N_2O Emissions Trends 1990-2007

IV. HFCs, PFCs, SF_6 Emissions Trends 1990-2007

V. All GHG Summary Emissions Trends 1990-2007

I. Carbon Dioxide (CO_2) 1990-2007 Pt 1

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
1. Energy	**30,226.6920**	**31,136.2034**	**31,104.5910**	**31,269.5402**	**32,273.9576**	**33,138.8621**	**34,737.5371**	**35,894.1454**	**38,100.7837**	**39,843.3578**
A. Fuel Combustion (Sectoral Approach)	30,226.6920	31,136.2034	31,104.5910	31,269.5402	32,273.9576	33,138.8621	34,737.5371	35,894.1454	38,100.7837	39,805.0928
1. Energy Industries	11,158.6150	11,617.3422	12,279.7392	12,297.5906	12,634.2763	13,317.4709	14,031.8593	14,692.8730	15,080.5246	15,732.9828
2. Manufacturing Industries and Construction	3,969.7667	4,084.6194	3,768.6341	3,978.0204	4,243.3128	4,349.0178	4,155.7445	4,571.7016	4,583.2125	4,798.1607
3. Transport	5,039.3923	5,242.1097	5,685.5108	5,646.5047	5,880.6049	6,106.5491	7,144.8509	7,482.3948	8,826.5989	9,783.8032
4. Other Sectors	10,058.9179	10,192.1321	9,370.7070	9,347.4244	9,515.7635	9,365.8243	9,405.0824	9,147.1759	9,610.4477	9,490.1460
5. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive Emissions from Fuels	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	38.2650
1. Solid Fuels	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NO	NO	NO
2. Oil and Natural Gas	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	38.2650
2. Industrial Processes	**2,093.9751**	**2,009.9881**	**1,924.2785**	**1,885.1245**	**2,126.3567**	**2,046.0003**	**2,109.9570**	**2,446.9459**	**2,336.0633**	**2,285.8532**
A. Mineral Products	1,103.7416	979.6716	920.7171	938.9378	1,069.7311	1,072.5630	1,187.1065	1,373.8214	1,277.2577	1,343.0355
B. Chemical Industry	990.2335	1,030.3165	1,003.5615	946.1868	1,056.6256	973.4373	922.8505	1,073.1246	1,058.8057	942.8176
C. Metal Production	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Other Production	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
E. Production of Halocarbons and SF_6										
F. Consumption of Halocarbons and SF_6										
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	79.4306	81.1293	81.6178	81.9120	82.9246	84.5777	84.5488	85.1128	85.7606	82.1152
4. Agriculture										
A. Enteric Fermentation										
B. Manure Management										
C. Rice Cultivation										
D. Agricultural Soils										
E. Prescribed Burning of Savannas										
F. Field Burning of Agricultural Residues										
G. Other										
5. Land Use, Land-Use Change and Forestry[(2)]	**235.0784**	**334.7171**	**395.4896**	**224.0182**	**45.8902**	**271.8495**	**373.3069**	**305.0869**	**-89.2329**	**-126.6056**
A. Forest Land	-336.4884	-300.7993	-96.6853	-188.8249	-124.8254	-128.0530	-124.5178	-266.6647	-455.6532	-561.5070
B. Cropland	19.9993	21.1943	16.7795	11.2593	-59.5890	-34.9043	48.6282	25.0274	5.9977	-18.4571
C. Grassland	493.5345	556.9822	431.6256	345.0354	174.9199	379.4017	415.2924	497.4249	310.9736	399.4791
D. Wetlands	46.4744	45.6228	45.0844	44.3810	42.0078	39.5958	36.8627	34.3935	31.9192	29.1428
E. Settlements	12.8032	11.7170	11.9446	12.7350	15.6901	15.8093	19.8565	21.6571	23.1224	24.7368
F. Other Land	-1.2446	NE,NO	-13.2592	-0.5677	-2.3132	NE,NO	-22.8151	-6.7513	-5.5926	NE,NO
G. Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
6. Waste	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**
A. Solid Waste Disposal on Land	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
B. Waste-water Handling										
C. Waste Incineration	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
D. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Total CO_2 emissions including net CO_2 from LULUCF	**32,635.1760**	**33,562.0379**	**33,505.9770**	**33,460.5949**	**34,529.1291**	**35,541.2896**	**37,305.3498**	**38,731.2910**	**40,433.3747**	**42,084.7206**
Total CO_2 emissions excluding net CO_2 from LULUCF	**32,400.0976**	**33,227.3208**	**33,110.4874**	**33,236.5767**	**34,483.2389**	**35,269.4401**	**36,932.0429**	**38,426.2041**	**40,522.6076**	**42,211.3261**
Memo Items:										
International Bunkers	**1,117.3835**	**1,130.0509**	**942.9126**	**1,486.2453**	**1,290.7039**	**1,505.2522**	**1,541.6625**	**1,739.0322**	**1,794.2112**	**2,083.7468**
Aviation	1,060.6078	1,023.0107	889.4331	1,315.6341	1,167.7101	1,135.8649	1,042.4456	1,261.6716	1,294.6697	1,539.7623
Marine	56.7757	107.0402	53.4795	170.6112	122.9938	369.3872	499.2169	477.3606	499.5415	543.9845
Multilateral Operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO_2 Emissions from Biomass	496.1146	476.5726	422.0989	430.0174	429.5386	422.8117	468.0343	493.0379	586.7673	558.0174

I. Carbon Dioxide (CO_2) 1990-2007 Pt 2

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
1. Energy	**41,888.6352**	**44,028.7114**	**42,827.5373**	**42,622.1367**	**43,307.9429**	**45,006.7185**	**44,622.9026**	**44,835.2472**	**48.3300**
A. Fuel Combustion (Sectoral Approach)	41,888.6352	43,972.6654	42,827.5373	42,622.1367	43,307.9429	45,006.7185	44,622.9026	44,835.2472	48.3300
1. Energy Industries	16,050.3789	17,266.5649	16,345.3434	15,643.4389	15,283.5051	15,657.2918	14,906.9837	14,406.6337	29.1077
2. Manufacturing Industries and Construction	5,665.7070	5,644.5885	5,355.0783	5,371.0872	5,758.4103	5,836.5448	5,733.7755	6,088.7894	53.3790
3. Transport	10,512.6599	11,017.1756	11,215.6396	11,396.5358	12,027.8362	12,792.1544	13,483.3421	14,143.8713	180.6662
4. Other Sectors	9,659.8895	10,044.3364	9,911.4759	10,211.0748	10,238.1912	10,720.7276	10,498.8012	10,195.9529	1.3623
5. Other	NO	NO	NO	NO	NO	NO	NO	NO	0.0000
B. Fugitive Emissions from Fuels	IE,NE,NO	56.0460	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	0.0000
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO	0.0000
2. Oil and Natural Gas	IE,NE,NO	56.0460	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	IE,NE,NO	0.0000
2. Industrial Processes	**2,780.8446**	**3,092.2032**	**2,869.0171**	**2,342.4564**	**2,506.8841**	**2,552.5849**	**2,538.5666**	**2,580.2831**	**23.2242**
A. Mineral Products	1,898.7212	2,051.9279	2,058.7359	2,342.1591	2,506.8841	2,552.5849	2,538.5666	2,580.2831	133.7760
B. Chemical Industry	882.1233	1,040.2753	810.2811	0.2973	NO	NO	NO	NO	-100.0000
C. Metal Production	NO	NO	NO	NO	NO	NO	NO	NO	0.0000
D. Other Production	NE	NE	NE	NE	NE	NE	NE	NE	0.0000
E. Production of Halocarbons and SF_6									
F. Consumption of Halocarbons and SF_6									
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	0.0000
3. Solvent and Other Product Use	78.9614	78.6070	76.9655	76.5324	76.7783	78.6535	81.3279	83.1869	4.7290
4. Agriculture									
A. Enteric Fermentation									
B. Manure Management									
C. Rice Cultivation									
D. Agricultural Soils									
E. Prescribed Burning of Savannas									
F. Field Burning of Agricultural Residues									
G. Other									
5. Land Use, Land-Use Change and Forestry[(2)]	**117.7020**	**45.3329**	**-177.4420**	**-277.0940**	**-231.5603**	**-523.6815**	**-528.7007**	**-1,018.5702**	**-533.2895**
A. Forest Land	-437.9712	-566.2724	-773.5392	-1,033.2013	-692.6743	-908.5901	-958.1071	-1,517.6864	351.0367
B. Cropland	22.8691	104.7944	94.8915	140.0033	100.2688	126.4425	72.9426	96.9425	384.7298
C. Grassland	469.6414	453.5702	458.7243	554.1289	336.5515	199.0629	300.5552	334.8712	-32.1484
D. Wetlands	37.0821	32.9722	28.8593	24.7472	20.6372	20.2337	19.8415	12.5009	-73.1016
E. Settlements	26.0806	34.3382	30.5091	37.2279	39.1939	46.0567	48.2953	54.8017	328.0315
F. Other Land	NE,NO	-14.0697	-16.8869	NE,NO	-35.5374	-6.8872	-12.2282	NE,NO	-100.0000
G. Other	NE	NE	NE	NE	NE	NE	NE	NE	0.0000
6. Waste	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**NA,NE,NO**	**0.0000**
A. Solid Waste Disposal on Land	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.0000
B. Waste-water Handling									
C. Waste Incineration	NE	NE	NE	NE	NE	NE	NE	NE	0.0000
D. Other	NO	NO	NO	NO	NO	NO	NO	NO	0.0000
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**0.0000**
Total CO_2 emissions including net CO_2 from LULUCF	**44,866.1432**	**47,244.8545**	**45,596.0779**	**44,764.0314**	**45,660.0450**	**47,114.2753**	**46,714.0965**	**46,480.1470**	**42.4235**
Total CO_2 emissions excluding net CO_2 from LULUCF	**44,748.4411**	**47,199.5216**	**45,773.5198**	**45,041.1254**	**45,891.6053**	**47,637.9569**	**47,242.7972**	**47,498.7172**	**46.6005**
Memo Items:									
International Bunkers	**2,264.6516**	**2,661.5658**	**2,749.2442**	**2,783.9396**	**2,592.7178**	**2,787.9637**	**3,247.1520**	**3,356.9342**	**200.4281**
Aviation	1,786.8041	2,151.9328	2,294.2267	2,243.6977	2,118.5317	2,457.7159	2,843.0400	3,000.0930	182.8655
Marine	477.8475	509.6331	455.0174	540.2419	474.1861	330.2478	404.1120	356.8412	528.5100
Multilateral Operations	NO	NO	NO	NO	NO	NO	NO	NO	0.0000
CO_2 Emissions from Biomass	595.3340	652.5827	640.8229	614.6080	716.7679	897.7197	914.9965	987.0092	98.9478

II. Methane (CH4) 1990-2007 Pt 1

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
1. Energy	14.2564	14.2992	12.8439	12.6014	11.5315	11.2557	11.5270	10.8597	10.4301	9.6971
A. Fuel Combustion (Sectoral Approach)	8.0143	8.2337	6.9957	6.8031	5.9153	5.8188	6.2844	5.8360	6.0448	5.4417
1. Energy Industries	0.0411	0.0325	0.0283	0.0287	0.0329	0.0299	0.0299	0.0214	0.0354	0.0344
2. Manufacturing Industries and Construction	1.1780	1.2370	0.7370	0.8344	0.5473	0.6570	0.7749	0.7920	0.7466	0.7054
3. Transport	2.2722	2.3507	2.5343	2.2926	2.1998	2.3774	2.4516	2.3699	2.4337	2.3605
4. Other Sectors	4.5229	4.6136	3.6960	3.6475	3.1352	2.7545	3.0280	2.6527	2.8291	2.3413
5. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive Emissions from Fuels	6.2421	6.0655	5.8482	5.7982	5.6162	5.4369	5.2426	5.0237	4.3853	4.2554
1. Solid Fuels	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NO	NO	NO	NO
2. Oil and Natural Gas	6.2421	6.0655	5.8482	5.7982	5.6162	5.4369	5.2426	5.0237	4.3853	4.2554
2. Industrial Processes	**NE,NO**	**NE,NO**	**NE,NO**	**NE,NO**	**NE,NO**	**NE,NO**	**NE,NO**	**NE,NO**	**NE,NO**	**NE,NO**
A. Mineral Products	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
B. Chemical Industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Metal Production	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Other Production										
E. Production of Halocarbons and SF_6										
F. Consumption of Halocarbons and SF_6										
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use										
4. Agriculture	**562.9625**	**568.1444**	**572.0781**	**574.2307**	**571.2368**	**570.7039**	**585.0941**	**598.1585**	**607.2938**	**590.9217**
A. Enteric Fermentation	452.0832	456.2584	459.1166	461.0408	458.8263	458.7231	469.1972	479.4472	486.9847	475.1146
B. Manure Management	110.8793	111.8861	112.9616	113.1898	112.4105	111.9808	115.8969	118.7112	120.3090	115.8071
C. Rice Cultivation	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Agricultural Soils	NE,NO	NE,NO	NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
E. Prescribed Burning of Savannas	NO	NO	NE	NO	NE	NE	NE	NE	NO	NO
F. Field Burning of Agricultural Residues	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5. Land Use, Land-Use Change and Forestry	**0.0859**	**0.0859**	**0.0859**	**0.0811**	**0.0907**	**0.0989**	**0.0952**	**0.0608**	**0.0126**	**0.0118**
A. Forest Land	0.0859	0.0859	0.0859	0.0811	0.0907	0.0989	0.0952	0.0608	0.0126	0.0118
B. Cropland	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
C. Grassland	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Wetlands	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
E. Settlements	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
F. Other Land	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
G. Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
6. Waste	**64.1427**	**65.7365**	**67.6733**	**69.9745**	**72.4645**	**75.1095**	**72.1329**	**62.6883**	**66.2477**	**68.0369**
A. Solid Waste Disposal on Land	63.4414	65.0312	66.9622	69.2595	71.7472	74.4111	71.4298	61.7213	65.2705	66.9979
B. Waste-water Handling	0.7013	0.7053	0.7111	0.7150	0.7174	0.6984	0.7032	0.9670	0.9772	1.0390
C. Waste Incineration	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
D. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Total CH_4 emissions including CH_4 from LULUCF	**641.4474**	**648.2661**	**652.6812**	**656.8877**	**655.3234**	**657.1680**	**668.8492**	**671.7673**	**683.9841**	**668.6676**
Total CH_4 emissions excluding CH_4 from LULUCF	**641.3616**	**648.1802**	**652.5954**	**656.8066**	**655.2328**	**657.0691**	**668.7540**	**671.7064**	**683.9716**	**668.6558**
Memo Items:										
International Bunkers	0.0309	0.0301	0.0267	0.0237	0.0248	0.0254	0.0284	0.0285	0.0303	0.0327
Aviation	0.0309	0.0301	0.0267	0.0237	0.0248	0.0254	0.0284	0.0285	0.0303	0.0327
Marine	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
Multilateral Operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO_2 Emissions from Biomass										

II. Methane (CH4) 1990-2007 Pt 2

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
1. Energy	9.7316	10.1169	8.6685	35.2066	8.4589	8.1314	9.9682	7.9568	-44.1875
A. Fuel Combustion (Sectoral Approach)	5.6816	5.7504	5.3852	5.3847	5.3186	5.4373	5.1152	5.1141	-36.1881
1. Energy Industries	0.0380	0.0506	0.0640	0.0721	0.0655	0.0462	0.0392	0.0470	14.2410
2. Manufacturing Industries and Construction	1.0866	1.2966	1.2232	1.2836	1.4090	1.5486	1.3835	1.5112	28.2910
3. Transport	2.1434	2.0409	1.8291	1.7018	1.5900	1.4926	1.4140	1.3406	-40.9990
4. Other Sectors	2.4136	2.3623	2.2690	2.3272	2.2541	2.3500	2.2785	2.2152	-51.0232
5. Other	NO	NO	NO	NO	NO	NO	NO	NO	0.0000
B. Fugitive Emissions from Fuels	4.0501	4.3665	3.2833	29.8219	3.1403	2.6941	4.8530	2.8428	-54.4580
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO	0.0000
2. Oil and Natural Gas	4.0501	4.3665	3.2833	29.8219	3.1403	2.6941	4.8530	2.8428	-54.4580
2. Industrial Processes	**NE,NO**	**NE,NO**	**NE,NO**	**NE,NO**	**NE,NO**	**NE,NO**	**NE,NO**	**NE,NO**	**0.0000**
A. Mineral Products	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	0.0000
B. Chemical Industry	NO	NO	NO	NO	NO	NO	NO	NO	0.0000
C. Metal Production	NO	NO	NO	NO	NO	NO	NO	NO	0.0000
D. Other Production									
E. Production of Halocarbons and SF_6									
F. Consumption of Halocarbons and SF_6									
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	0.0000
3. Solvent and Other Product Use									
4. Agriculture	**562.6038**	**557.8892**	**554.8165**	**549.1534**	**547.8373**	**544.7297**	**541.6595**	**523.7893**	**-6.9584**
A. Enteric Fermentation	452.5345	447.8672	444.7875	440.8736	440.2156	437.4846	435.3572	421.0083	-6.8737
B. Manure Management	110.0693	110.0220	110.0290	108.2798	107.6217	107.2451	106.3023	102.7811	-7.3036
C. Rice Cultivation	NO	NO	NO	NO	NO	NO	NO	NO	0.0000
D. Agricultural Soils	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	0.0000
E. Prescribed Burning of Savannas	NE	NE	NE	NE	NO	NO	NO	NO	0.0000
F. Field Burning of Agricultural Residues	NO	NO	NO	NO	NO	NO	NO	NO	0.0000
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	0.0000
5. Land Use, Land-Use Change and Forestry	**0.0606**	**0.1531**	**0.0561**	**0.2048**	**0.1581**	**0.0312**	**0.0898**	**0.0448**	**-47.7958**
A. Forest Land	0.0606	0.1531	0.0561	0.2048	0.1581	0.0312	0.0898	0.0448	-47.7958
B. Cropland	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	0.0000
C. Grassland	NO	NO	NO	NO	NO	NO	NO	NO	0.0000
D. Wetlands	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	0.0000
E. Settlements	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	0.0000
F. Other Land	NE	NE	NE	NE	NE	NE	NE	NE	0.0000
G. Other	NE	NE	NE	NE	NE	NE	NE	NE	0.0000
6. Waste	**72.2253**	**64.5772**	**72.6014**	**79.3155**	**79.0809**	**78.0629**	**80.6509**	**85.4897**	**33.2805**
A. Solid Waste Disposal on Land	71.1684	63.4809	71.4851	78.2503	77.9616	76.9256	79.4956	84.3165	32.9045
B. Waste-water Handling	1.0568	1.0964	1.1163	1.0653	1.1194	1.1373	1.1553	1.1733	67.2858
C. Waste Incineration	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	0.0000
D. Other	NO	NO	NO	NO	NO	NO	NO	NO	0.0000
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**0.0000**
Total CH_4 emissions including CH_4 from LULUCF	**644.6213**	**632.7363**	**636.1425**	**663.8804**	**635.5353**	**630.9552**	**632.3684**	**617.2807**	**-3.7675**
Total CH_4 emissions excluding CH_4 from LULUCF	**644.5607**	**632.5833**	**636.0864**	**663.6755**	**635.3772**	**630.9240**	**632.2786**	**617.2359**	**-3.7616**
Memo Items:									
International Bunkers	0.0350	0.0347	0.0321	0.0330	0.0331	0.0361	0.0378	0.0405	31.2600
Aviation	0.0350	0.0347	0.0321	0.0330	0.0331	0.0361	0.0378	0.0405	31.2600
Marine	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	0.0000
Multilateral Operations	NO	NO	NO	NO	NO	NO	NO	NO	0.0000
CO_2 Emissions from Biomass									

III. Nitrous Oxide (N_2O) 1990-2007 Pt 1

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
1. Energy	**2.9758**	**3.1486**	**3.1632**	**3.1947**	**3.4178**	**3.4682**	**3.5560**	**3.7537**	**4.0694**	**4.2128**
A. Fuel Combustion (Sectoral Approach)	2.9758	3.1486	3.1632	3.1947	3.4178	3.4682	3.5560	3.7537	4.0694	4.2128
1. Energy Industries	1.3449	1.4661	1.5765	1.5434	1.6216	1.6692	1.7016	1.7870	1.9502	2.0202
2. Manufacturing Industries and Construction	0.3647	0.3749	0.3817	0.3919	0.4637	0.4683	0.4258	0.4845	0.4875	0.5200
3. Transport	0.2706	0.2755	0.2896	0.3461	0.3983	0.4124	0.4814	0.5556	0.6624	0.6804
4. Other Sectors	0.9957	1.0321	0.9154	0.9132	0.9341	0.9183	0.9472	0.9266	0.9693	0.9922
5. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive Emissions from Fuels	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and Natural Gas	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
2. Industrial Processes	**3.3400**	**2.6208**	**2.6208**	**2.6208**	**2.6208**	**2.6208**	**2.6208**	**2.6208**	**2.6200**	**2.6200**
A. Mineral Products	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
B. Chemical Industry	3.3400	2.6208	2.6208	2.6208	2.6208	2.6208	2.6208	2.6208	2.6200	2.6200
C. Metal Production	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Other Production										
E. Production of Halocarbons and SF_6										
F. Consumption of Halocarbons and SF_6										
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE
4. Agriculture	**23.8915**	**23.9312**	**23.8665**	**24.3143**	**24.9542**	**25.5894**	**25.6753**	**25.1517**	**26.7799**	**26.7909**
A. Enteric Fermentation										
B. Manure Management	1.2808	1.3198	1.3323	1.3471	1.3456	1.3674	1.3837	1.4129	1.4535	1.4688
C. Rice Cultivation										
D. Agricultural Soils	22.6107	22.6114	22.5342	22.9671	23.6086	24.2220	24.2916	23.7388	25.3264	25.3221
E. Prescribed Burning of Savannas	NO	NO	NE	NO	NE	NE	NE	NE	NO	NO
F. Field Burning of Agricultural Residues	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5. Land Use, Land-Use Change and Forestry	**0.0487**	**0.0499**	**0.0520**	**0.0619**	**0.0631**	**0.0647**	**0.0720**	**0.0724**	**0.0728**	**0.0731**
A. Forest Land	0.0371	0.0384	0.0397	0.0406	0.0420	0.0437	0.0451	0.0456	0.0461	0.0467
B. Cropland	NA,NE,NO	NA,NE,NO	0.0010	0.0100	0.0100	0.0100	0.0161	0.0161	0.0161	0.0161
C. Grassland	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Wetlands	0.0116	0.0114	0.0114	0.0112	0.0112	0.0110	0.0108	0.0107	0.0105	0.0103
E. Settlements	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
F. Other Land	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
G. Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
6. Waste	**0.3677**	**0.3727**	**0.3876**	**0.3788**	**0.3702**	**0.3589**	**0.3627**	**0.3736**	**0.3813**	**0.3921**
A. Solid Waste Disposal on Land										
B. Waste-water Handling	0.3677	0.3727	0.3876	0.3788	0.3702	0.3589	0.3627	0.3736	0.3813	0.3921
C. Waste Incineration	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
D. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Total N_2O emissions including N_2O from LULUCF	**30.6238**	**30.1232**	**30.0901**	**30.5704**	**31.4261**	**32.1020**	**32.2869**	**31.9722**	**33.9233**	**34.0890**
Total N_2O emissions excluding N_2O from LULUCF	**30.5750**	**30.0733**	**30.0382**	**30.5086**	**31.3630**	**32.0373**	**32.2148**	**31.8999**	**33.8506**	**34.0159**
Memo Items:										
International Bunkers	**0.0365**	**0.0352**	**0.0307**	**0.0438**	**0.0392**	**0.0383**	**0.0356**	**0.0426**	**0.0438**	**0.0517**
Aviation	0.0365	0.0352	0.0307	0.0438	0.0392	0.0383	0.0356	0.0426	0.0438	0.0517
Marine	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
Multilateral Operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO_2 Emissions from Biomass										

III. Nitrous Oxide (N_2O) 1990-2007 Pt 2

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
1. Energy	**4.2434**	**4.5092**	**4.2412**	**4.0187**	**4.0542**	**4.2232**	**4.0008**	**3.7221**	**25.0766**
A. Fuel Combustion (Sectoral Approach)	4.2434	4.5092	4.2412	4.0187	4.0542	4.2232	4.0008	3.7221	25.0766
1. Energy Industries	1.9256	2.1264	1.9319	1.6965	1.7060	1.8111	1.6774	1.4389	6.9913
2. Manufacturing Industries and Construction	0.5944	0.5882	0.5557	0.5555	0.5778	0.5899	0.5567	0.5806	59.2212
3. Transport	0.7260	0.7585	0.7253	0.7077	0.7164	0.7144	0.6942	0.6628	144.9792
4. Other Sectors	0.9974	1.0360	1.0283	1.0590	1.0539	1.1077	1.0726	1.0397	4.4169
5. Other	NO	NO	NO	NO	NO	NO	NO	NO	0.0000
B. Fugitive Emissions from Fuels	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	0.0000
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO	0.0000
2. Oil and Natural Gas	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	0.0000
2. Industrial Processes	**2.6208**	**1.8850**	**0.9425**	**NE,NO**	**NE,NO**	**NE,NO**	**NE,NO**	**NE,NO**	**-100.0000**
A. Mineral Products	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	0.0000
B. Chemical Industry	2.6208	1.8850	0.9425	NO	NO	NO	NO	NO	-100.0000
C. Metal Production	NO	NO	NO	NO	NO	NO	NO	NO	0.0000
D. Other Production									
E. Production of Halocarbons and SF_6									
F. Consumption of Halocarbons and SF_6									
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	0.0000
3. Solvent and Other Product Use	NA,NE	NA	NA	NA	NA,NE	NA,NE	NA,NE	NA,NE	0.0000
4. Agriculture	**25.2266**	**24.0047**	**23.6646**	**24.2717**	**23.6934**	**23.3172**	**22.7735**	**21.7686**	**-8.8852**
A. Enteric Fermentation									
B. Manure Management	1.3922	1.3433	1.3094	1.2984	1.2905	1.2898	1.2819	1.2373	-3.3936
C. Rice Cultivation									
D. Agricultural Soils	23.8344	22.6614	22.3552	22.9732	22.4029	22.0275	21.4916	20.5313	-9.1963
E. Prescribed Burning of Savannas	NE	NE	NE	NE	NO	NO	NO	NO	0.0000
F. Field Burning of Agricultural Residues	NO	NO	NO	NO	NO	NO	NO	NO	0.0000
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	0.0000
5. Land Use, Land-Use Change and Forestry	**0.0741**	**0.0871**	**0.0940**	**0.1056**	**0.1056**	**0.1051**	**0.1057**	**0.1055**	**116.4359**
A. Forest Land	0.0478	0.0492	0.0493	0.0507	0.0508	0.0504	0.0511	0.0512	37.8524
B. Cropland	0.0161	0.0279	0.0348	0.0452	0.0452	0.0452	0.0452	0.0452	100.0000
C. Grassland	NO	NO	NO	NO	NO	NO	NO	NO	0.0000
D. Wetlands	0.0102	0.0100	0.0099	0.0098	0.0096	0.0095	0.0094	0.0091	-21.7184
E. Settlements	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	0.0000
F. Other Land	NE	NE	NE	NE	NE	NE	NE	NE	0.0000
G. Other	NE	NE	NE	NE	NE	NE	NE	NE	0.0000
6. Waste	**0.4087**	**0.4053**	**0.4105**	**0.4170**	**0.4238**	**0.4329**	**0.4443**	**0.4547**	**23.6580**
A. Solid Waste Disposal on Land									
B. Waste-water Handling	0.4087	0.4053	0.4105	0.4170	0.4238	0.4329	0.4443	0.4547	23.6580
C. Waste Incineration	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	0.0000
D. Other	NO	NO	NO	NO	NO	NO	NO	NO	0.0000
7. Other ***(as specified in Summary 1.A)***	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**0.0000**
Total N_2O emissions including N_2O from LULUCF	**32.5736**	**30.8913**	**29.3528**	**28.8130**	**28.2769**	**28.0784**	**27.3244**	**26.0509**	**-14.9323**
Total N_2O emissions excluding N_2O from LULUCF	**32.4995**	**30.8042**	**29.2588**	**28.7074**	**28.1714**	**27.9733**	**27.2187**	**25.9454**	**-15.1417**
Memo Items:									
International Bunkers	**0.0597**	**0.0712**	**0.0755**	**0.0739**	**0.0700**	**0.0810**	**0.0933**	**0.0985**	**170.2562**
Aviation	0.0597	0.0712	0.0755	0.0739	0.0700	0.0810	0.0933	0.0985	170.2562
Marine	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	0.0000
Multilateral Operations	NO	NO	NO	NO	NO	NO	NO	NO	0.0000
CO_2 Emissions from Biomass									

IV. HFCs, PFCs, SF_6 1990-2007 Pt 1

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
Emissions of HFCs[3] - (Gg CO_2 equivalent)	**0.6930**	**5.2732**	**6.1678**	**9.4449**	**19.9738**	**44.8468**	**76.1086**	**132.2777**	**190.7119**	**197.1335**
HFC-23	0.0000	0.0001	0.0001	0.0001	0.0001	0.0002	0.0003	0.0004	0.0003	0.0008
HFC-32	NO	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001	0.0006	0.0017	0.0019
HFC-41	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-43-10mee	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-125	NO	0.0002	0.0002	0.0003	0.0003	0.0003	0.0008	0.0023	0.0048	0.0058
HFC-134	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-134a	0.0000	0.0019	0.0020	0.0039	0.0112	0.0291	0.0500	0.0849	0.1200	0.1152
HFC-152a	0.0000	0.0001	0.0001	0.0002	0.0006	0.0021	0.0038	0.0064	0.0083	0.0062
HFC-143	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-143a	NO	0.0002	0.0002	0.0002	0.0003	0.0003	0.0005	0.0014	0.0028	0.0037
HFC-227ea	0.0001	0.0002	0.0004	0.0005	0.0007	0.0009	0.0011	0.0013	0.0016	0.0018
HFC-236fa	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-245ca	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Unspecified mix of listed HFCs[4] - (Gg CO_2 equivalent)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Emissions of PFCs[3] - (Gg CO_2 equivalent)	**0.0931**	**7.6220**	**15.1509**	**30.2087**	**45.2664**	**75.3820**	**103.0850**	**130.8232**	**61.8700**	**195.9330**
CF_4	0.0000	0.0002	0.0004	0.0008	0.0012	0.0019	0.0028	0.0036	0.0023	0.0041
C_2F_6	0.0000	0.0007	0.0014	0.0027	0.0041	0.0068	0.0092	0.0117	0.0051	0.0184
C_3F_8	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C_4F_{10}	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
c-C_4F_8	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C_5F_{12}	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C_6F_{14}	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Unspecified mix of listed PFCs[4] - (Gg CO_2 equivalent)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Emissions of SF6[3] - (Gg CO_2 equivalent)	**35.4045**	**40.6353**	**45.8658**	**55.3504**	**64.8347**	**82.8272**	**102.0624**	**132.1001**	**94.2818**	**69.0086**
SF_6	0.0015	0.0017	0.0019	0.0023	0.0027	0.0035	0.0043	0.0055	0.0039	0.0029

IV. HFCs, PFCs, SF_6 1990-2007 Pt 2

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
Emissions of HFCs[3] - (Gg CO_2 equivalent)	**230.2224**	**251.4852**	**276.5185**	**349.9763**	**386.4432**	**435.0554**	**506.9554**	**497.6156**	**71,707.7586**
HFC-23	0.0011	0.0003	0.0002	0.0003	0.0002	0.0003	0.0004	0.0004	942.6081
HFC-32	0.0018	0.0012	0.0019	0.0019	0.0019	0.0027	0.0064	0.0042	100.0000
HFC-41	NO	NO	NO	NO	NO	NO	NO	NO	0.0000
HFC-43-10mee	NO	NO	NO	NO	NO	NO	NO	NO	0.0000
HFC-125	0.0065	0.0064	0.0085	0.0128	0.0177	0.0197	0.0270	0.0242	100.0000
HFC-134	NO	NO	NO	NO	NO	NO	NO	NO	0.0000
HFC-134a	0.1331	0.1531	0.1633	0.1931	0.1982	0.2230	0.2462	0.2475	5,038,420.9372
HFC-152a	0.0068	0.0073	0.0066	0.0072	0.0066	0.0068	0.0070	0.0071	1,304,377.4042
HFC-143	NO	NO	NO	NO	NO	NO	NO	NO	0.0000
HFC-143a	0.0048	0.0055	0.0070	0.0124	0.0166	0.0185	0.0228	0.0218	100.0000
HFC-227ea	0.0021	0.0027	0.0031	0.0035	0.0040	0.0046	0.0051	0.0057	8,187.3061
HFC-236fa	NO	NO	NO	NO	NO	NO	NO	NO	0.0000
HFC-245ca	NO	NO	NO	NO	NO	NO	NO	NO	0.0000
Unspecified mix of listed HFCs[4] - (Gg CO_2 equivalent)	NO	NO	NO	NO	NO	NO	NO	NO	0.0000
Emissions of PFCs[3] - (Gg CO_2 equivalent)	**305.4059**	**295.9841**	**212.4033**	**228.7945**	**182.4274**	**168.3399**	**148.3200**	**130.5790**	**140,156.7132**
CF_4	0.0059	0.0067	0.0062	0.0085	0.0056	0.0051	0.0042	0.0034	112,566.6667
C_2F_6	0.0290	0.0274	0.0186	0.0186	0.0157	0.0143	0.0127	0.0111	138,837.5000
C_3F_8	NO	NO	NO	NO	NO	NO	NO	NO	0.0000
C_4F_{10}	NO	NO	NO	NO	NO	NO	NO	NO	0.0000
c-C_4F_8	NO	NO	0.0001	0.0003	0.0002	0.0005	0.0005	0.0007	100.0000
C_5F_{12}	NO	NO	NO	NO	NO	NO	NO	NO	0.0000
C_6F_{14}	NO	NO	NO	NO	NO	NO	NO	NO	0.0000
Unspecified mix of listed PFCs[4] - (Gg CO_2 equivalent)	NO	NO	NO	NO	NO	NO	NO	NO	0.0000
Emissions of SF6[3] - (Gg CO_2 equivalent)	**55.9619**	**69.4850**	**70.3057**	**118.6870**	**67.0898**	**95.9582**	**68.5958**	**73.2003**	**106.7541**
SF_6	0.0023	0.0029	0.0029	0.0050	0.0028	0.0040	0.0029	0.0031	106.7541

V. Greenhouse Gases 1990-2007 Pt 1

GREENHOUSE GAS EMISSIONS	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)
CO_2 emissions including net CO_2 from LULUCF	32,635.1760	33,562.0379	33,505.9770	33,460.5949	34,529.1291	35,541.2896	37,305.3498	38,731.2910	40,433.3747	42,084.7206
CO_2 emissions excluding net CO_2 from LULUCF	32,400.0976	33,227.3208	33,110.4874	33,236.5767	34,483.2389	35,269.4401	36,932.0429	38,426.2041	40,522.6076	42,211.3261
CH_4 emissions including CH_4 from LULUCF	13,470.3963	13,613.5874	13,706.3059	13,794.6412	13,761.7920	13,800.5288	14,045.8338	14,107.1128	14,363.6665	14,042.0186
CH_4 emissions excluding CH_4 from LULUCF	13,468.5928	13,611.7839	13,704.5025	13,792.9382	13,759.8881	13,798.4509	14,043.8341	14,105.8354	14,363.4029	14,041.7709
N_2O emissions including N_2O from LULUCF	9,493.3678	9,338.1838	9,327.9435	9,476.8303	9,742.0901	9,951.6105	10,008.9237	9,911.3975	10,516.2335	10,567.5779
N_2O emissions excluding N_2O from LULUCF	9,478.2588	9,322.7220	9,311.8273	9,457.6523	9,722.5240	9,931.5596	9,986.5972	9,888.9557	10,493.6727	10,544.9193
HFCs	0.6930	5.2732	6.1678	9.4449	19.9738	44.8468	76.1086	132.2777	190.7119	197.1335
PFCs	0.0931	7.6220	15.1509	30.2087	45.2664	75.3820	103.0850	130.8232	61.8700	195.9330
SF_6	35.4045	40.6353	45.8658	55.3504	64.8347	82.8272	102.0624	132.1001	94.2818	69.0086
Total (including LULUCF)	**55,635.1308**	**56,567.3395**	**56,607.4109**	**56,827.0703**	**58,163.0862**	**59,496.4849**	**61,641.3632**	**63,145.0024**	**65,660.1386**	**67,156.3921**
Total (excluding LULUCF)	**55,383.1399**	**56,215.3573**	**56,194.0017**	**56,582.1711**	**58,095.7260**	**59,202.5066**	**61,243.7301**	**62,816.1962**	**65,726.5471**	**67,260.0913**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)
1. Energy	31,448.5813	32,412.5379	32,354.9144	32,524.5143	33,575.6288	34,450.3702	36,081.9588	37,285.8554	39,581.3323	41,352.9741
2. Industrial Processes	3,165.5657	2,875.9667	2,803.9110	2,792.5765	3,068.8797	3,061.5043	3,203.6609	3,654.5950	3,495.1271	3,560.1282
3. Solvent and Other Product Use	79.4306	81.1293	81.6178	81.9120	82.9246	84.5777	84.5488	85.1128	85.7606	82.1152
4. Agriculture	19,228.5655	19,349.7068	19,412.2599	19,596.2629	19,731.7702	19,917.4896	20,246.3283	20,358.3610	21,054.9236	20,714.5383
5. Land Use, Land-Use Change and Forestry[5]	251.9909	351.9823	413.4092	244.8992	67.3602	293.9783	397.6331	328.8062	-66.4085	-103.6992
6. Waste	1,460.9967	1,496.0167	1,541.2985	1,586.9054	1,636.5227	1,688.5648	1,627.2332	1,432.2720	1,509.4034	1,550.3355
7. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total (incl. LULUCF)[5]	**55,635.1308**	**56,567.3395**	**56,607.4109**	**56,827.0703**	**58,163.0862**	**59,496.4849**	**61,641.3632**	**63,145.0024**	**65,660.1386**	**67,156.3921**

V. Greenhouse Gases 1990-2007 Pt 2

GREENHOUSE GAS EMISSIONS	2000	2001	2002	2003	2004	2005	2006	2007	Change from base to latest reported year
	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	(%)
CO_2 emissions including LULUCF	44,866.1432	47,244.8545	45,596.0779	44,764.0314	45,660.0450	47,114.2753	46,714.0965	46,480.1470	42.4235
CO_2 emissions excluding LULUCF	44,748.4411	47,199.5216	45,773.5198	45,041.1254	45,891.6053	47,637.9569	47,242.7972	47,498.7172	46.6005
CH_4 emissions including LULUCF	13,537.0468	13,287.4630	13,358.9915	13,941.4876	13,346.2407	13,250.0595	13,279.7366	12,962.8946	-3.7675
CH_4 emissions excluding LULUCF	13,535.7740	13,284.2488	13,357.8140	13,937.1861	13,342.9209	13,249.4038	13,277.8507	12,961.9532	-3.7616
N_2O emissions including LULUCF	10,097.8272	9,576.3104	9,099.3603	8,932.0340	8,765.8534	8,704.3068	8,470.5664	8,075.7907	-14.9323
N_2O emissions excluding LULUCF	10,074.8501	9,549.3084	9,070.2206	8,899.2869	8,733.1186	8,671.7267	8,437.7882	8,043.0893	-15.1417
HFCs	230.2224	251.4852	276.5185	349.9763	386.4432	435.0554	506.9554	497.6156	71,707.7586
PFCs	305.4059	295.9841	212.4033	228.7945	182.4274	168.3399	148.3200	130.5790	140,156.7132
SF_6	55.9619	69.4850	70.3057	118.6870	67.0898	95.9582	68.5958	73.2003	106.7541
Total (including LULUCF)	**69,092.6073**	**70,725.5823**	**68,613.6572**	**68,335.0109**	**68,408.0994**	**69,767.9951**	**69,188.2707**	**68,220.2274**	**22.6208**
Total (excluding LULUCF)	**68,950.6554**	**70,650.0331**	**68,760.7819**	**68,575.0562**	**68,603.6052**	**70,258.4409**	**69,682.3072**	**69,205.1546**	**24.9571**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	Change from base to latest reported year
	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	CO_2 eq. (Gg)	(%)
1. Energy	43,408.4573	45,639.0206	44,324.3354	44,607.2775	44,742.3679	46,486.6603	46,072.4836	46,156.1797	46.7671
2. Industrial Processes	4,184.8827	4,293.5075	3,720.4196	3,039.9142	3,142.8445	3,251.9384	3,262.4378	3,281.6781	3.6680
3. Solvent and Other Product Use	78.9614	78.6070	76.9655	76.5324	76.7783	78.6535	81.3279	83.1869	4.7290
4. Agriculture	19,634.9262	19,157.1283	18,987.1657	19,056.4356	18,849.5360	18,667.6663	18,434.6410	17,747.8563	-7.7006
5. LULUCF[5]	141.9518	75.5491	-147.1247	-240.0454	-195.5057	-490.4457	-494.0365	-984.9272	-490.8582
6. Waste	1,643.4279	1,481.7696	1,651.8957	1,794.8966	1,792.0785	1,773.5224	1,831.4169	1,936.2537	32.5296
7. Other	NA	NA	NA	NA	NA	NA	NA	NA	0.0000
Total (including LULUCF)[5]	**69,092.6073**	**70,725.5823**	**68,613.6572**	**68,335.0109**	**68,408.0994**	**69,767.9951**	**69,188.2707**	**68,220.2274**	**22.6208**

Annex 2 Institutional Arrangements for Compilation of Inventories

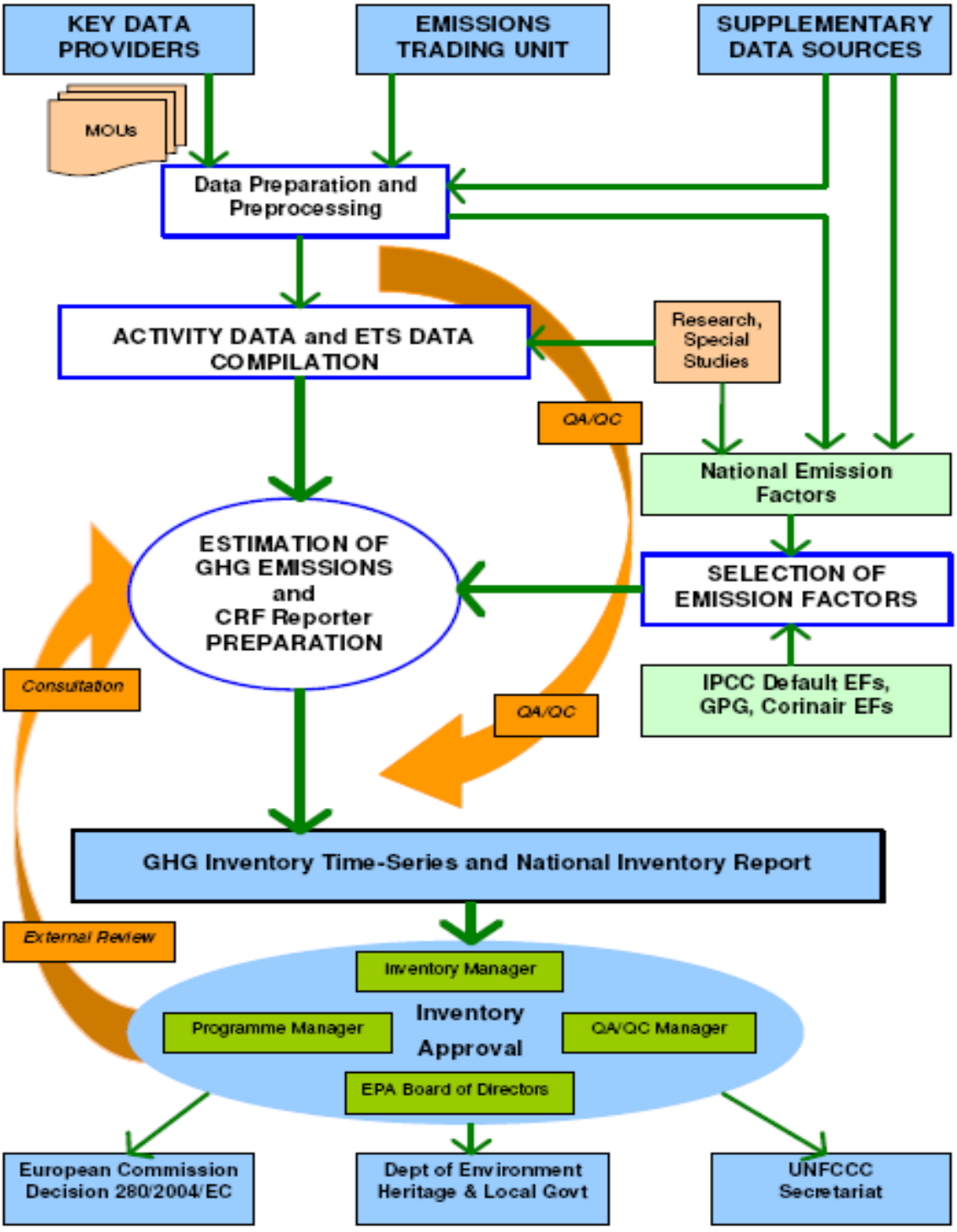


Figure 1.1. National Inventory System Overview

Annex 2 Inventory QA/AC Plan

QA/QC Plan

Version: 1.2
Project: Ireland GHG inventory
Date: 0-Jan-00
Inventory Year: 2007

Paul Duffy: Has overall responsibility for the coordination of the activities below:

The tables below provides the overarching QA/QC plan for Ireland's emissions inventory. There are three types of activity presented separately:
- General activities which cover the general compilation practices and procedures which need setting up and maintaining
- Annual Activities which should be undertaken on an annual basis
- Periodic Activities which should be undertaken in response to specific events in the inventory activities

The status column shows the current status of the QA/QC activities in the plan
The Guidance and records column in the tables below provides links to more detailed guidelines and templates for recording QA/QC information relevant to the specific headings
This file with its associated sheets can be used to track QA/QC activities as they are undertaken throughout the year and should be archived at the end of each inventory year and a new file started. Where QA/QC procedures are changed, modifications should be made and the file updated to a new version.

Activities that should be ongoing throughout the Inventory Process

General Inventory QA/QC Management Activities

QA/QC Activity	Deadline	Status	Trigger	Activity Type	Responsibility	Guidance, records and templates	Output & Link to output
Definition and Maintenance of Terms of Reference for Responsibilities for inventory planning, preparation and management.	31/12/2008	Annual activity Started for 2007 Inventory		Documentation	Michael McGettigan	see Responsibilities	see "Responsibilities"
Improve and maintain good data management practices including archiving. E.g. file naming and use of defined and shared directory structure, documentation and archiving	31/12/2008	In place	Update as necessary to track progress. Use as reference for consistent working practice	Procedure to follow	All, Paul Duffy, Michael McGettigan, Bernard Hyde	See DataManagement	See DataManagement
Use of QA/QC forms for inventory spreadsheet tools and outputs & transparant documentation of inventory methodologies	31/12/2008	In place	Creation of a new spreadsheet or update of methodology	Documentation	All, Paul Duffy, Michael McGettigan, Bernard Hyde	See QA/QC TemplateSheet	
List (routemap) of calculation spreadsheets/tools & status monitor	31/12/2008	In place	Update as necessary to track progress	Documentation	All, Paul Duffy, Michael McGettigan, Bernard Hyde	See CalculationSheetsList	
Development and maintenance of Inventory Improvement log & co-ordinate annual improvements	ongoing (amend/review as necessary)	In place	update as improvement needs or possibilities are identified	Documentation	Paul Duffy	See ImprovementLog	Inventory Reference manual
Development and maintenance of Training and Induction procedures and material	ongoing (amend/review as necessary)	In place	New Staff or new activities	Procedure to follow	All, Paul Duffy, Michael McGettigan, Bernard Hyde	see Training	
Verification Activities	ongoing (amend/review as necessary)	In place	Identification of new data, inventories, measurements.	Review	Michael McGettigan	See Verification	

Planning Annual Inventory

Annual Inventory Complete

Annual QA/QC Activities: Lists the annual activities in order of appearance (Planning and Preparation Activities)

QA/QC Activity	Deadline	Status	Trigger	Activity Type	Responsibility	Guidance, records and templates	Output & Link to output
Inventory planning, preparation and management review. Are procedures and guidelines in place for data quality review and checking on the inventory. Review the data quality objectives in the "DataQualityObjectives" sheet	**April**	Annual activity Started for 2007 Inventory	Completion of previous inventory	Review	Michael McGettigan	Document review and record actions required for new inventory preparation year. (Amend QA/QC documents as necessary)	Revised QA/QC documents & updated Data Quality Objectives
Review the data supplied last year and the data compilation needs this year	**April**	QA/QC Under Development	Planning the annual inventory update	Review/Check	Michael McGettigan	0-DataReview	Prioritised plan for data collection
Planning review and agree on inventory improvements to be undertaken including timings and resources necessary	**April**	QA/QC Under Development	Planning the annual inventory update	Review	Michael McGettigan	see InventoryImprovement	
Check all requests have been made	**July**	QA/QC Under Development	Request annual data	Check	Paul Duffy, Bernard Hyde	See 1-CheckDataReq	Acceptance that all foreseen data sources are included
Check source data	**August**	Not Started	Receipt of annual data update	Check	Paul Duffy-Energy, Bernard Hyde-Agriculture	see 2-CheckSourceData	Checking cells & Checking summary in spreadsheets
Uniquely label and archive source data	**July/August**	Annual activity Started for 2005 Inventory	Receipt of source data	Documentation	All, Paul Duffy, Michael McGettigan, Bernard Hyde	See 1-CheckDataReq	List of source data in this file
Document calculations, assumptions, data used and checks made	**September/October**	Annual activity Started for 2007 Inventory	Make Calculations: (Update or compile new estimates)	Documentation	All, Paul Duffy, Michael McGettigan, Bernard Hyde	See 3-MakeCalculations	Spreadsheet annotations and documentation
Check Calculations	**November**	Annual activity Complete for 2007 Inventory	Finished Sector Calculations	Check	P.Duffy check M. McGettigan, Bernard Hyde check P. Duffy, M. McGettigan check Bernard Hyde	see 4-CheckCalculations	Checking cells & Checking summary in spreadsheets
Check & Document Final Inventory	**November**	Annual activity Complete for 2007 Inventory	Finished all Sector Calculations	Check	Michael McGettigan	see 5-CheckFinalInv	Checking cells & Checking summary in spreadsheets
Independent Review of the Final Inventory	**November**	Annual activity Complete for 2007 Inventory	Finished all Sector Calculations	Review	Michael McGettigan	See 6-ReviewFinalInv	
Document Changes: Compile a concise list of changes and the impacts on National totals	**December**	Annual activity Complete for 2007 Inventory	Annual inventory finalised	Documentation	Michael McGettigan	Sector by Sector report for significant inventory changes + description in NIR	
Check Reporting tables	**January +1**	Annual activity Complete for 2007 Inventory	Compiled reporting tables	Check	All, Paul Duffy, Michael McGettigan, Bernard Hyde	Include annotated checking cells in reported sheets or in checking sheets linked to reporting sheets	
QA/QC Coordinator annually compiles and updates an overview of QA/QC procedures	**March +1**	Annual activity Complete for 2007 Inventory	Annual inventory finalised	Documentation	Paul Duffy	see QA-QCOverview	Year-specific overview document
Archiving inventory material	**March +1**	Annual activity Started for 2007 Inventory	Inventory Reported	Documentation/ Archiving	Paul Duffy, Bernard Hyde	see Archiving	

Activities that should be ongoing throughout the Inventory Process

Periodic and special QA/QC Activities

QA/QC Activity	Deadline	Status	Trigger	Activity Type	Responsibility	Guidance, records and templates	Output & Link to output
Peer review the new method (e.g. with industry or other sector experts)	Periodically for Key Categories in rotation	Under Development	New /Un-peer reviewed Key Category methodology or new source estimate	Review	Michael McGettigan	see PeriodicPeerReview	
Inform data users, issue revision, make note to prevent error next year	Special	Under Development	Errors found in published data	Procedure to follow	Michael McGettigan	Keep records of errors, and inform users	
Institutional QA/QC audits (e.g. ISO 9001 2000)	Periodically	Under Development	Organisation audit	Review	Michael McGettigan	Keep records of audits, dates, personnel and findings	
Government Audits	Periodically	Under Development	National Audits	Review	Michael McGettigan	Keep records of audits, dates, personnel and findings	

Annex 3 Ireland's National Emissions Trading Registry

Under the Kyoto Protocol and the EU Emissions Trading Scheme, Ireland must establish and implement a National Registry to track the movement and surrender of EU emission allowances and Kyoto units. Ireland's Environmental Protection Agency is responsible for establishing and managing the National Registry in Ireland including security and governance.

Statutory Basis

The operation of the EU Emissions Trading Scheme and national registries is governed by Directive 2003/87/EC establishing a scheme for greenhouse gas emission allowance trading, as amended by Directive 2004/101/EC in respect of the Kyoto Protocol's project mechanisms. In Ireland, these Directives were transposed into national law through the European Communities (Greenhouse Gas Emission Trading) Regulations 2004 to 2005 (S.I. 437 of 2004 and S.I. 706 of 2005), and the Kyoto Protocol Flexible Mechanisms Regulation (S.I. 244 of 2006). The European Commission has set out specific legislation[1] for a standardised and secured system of registries based on UN data exchange standards to track the issue, holding, transfer and cancellation of allowances.

System Architecture

Ireland's National Emissions Trading Registry established connectivity with the supplementary transaction log, CITL, in 2004 and with the International Transaction Log, ITL, in October 2008 following completion of the Initialisation process (i.e. Readiness, Connectivity and Interoperability) (See the Independent Assessment Report for Ireland's National Emissions Trading Registry[2]). Completion of the Initialisation process demonstrated that Ireland fulfilled all required registry functions to the appropriate standard. All transactions in national registries are checked by the ITL and the CITL before completion.

Software

Ireland uses the GRETA registry software which was developed by DEFRA (now DECC) in the UK and is licensed to 10 other Parties. This software has gone through a number of upgrades since 2005 to provide functionality to comply with legal obligations under the Registry Regulations and to improve message performance and reliability between the ITL and the Registry. The latest software upgrade will take place in March 2010.

Hosting Arrangement

Ireland's National Emissions Trading Registry's production, training and test environments were originally hosted at Ireland's Local Government and Computer Services Board. The hosting arrangements changed on March 17 2009 for the production environment, followed by the testing and training environments in April/May 2009. The migration did not require further UN interoperability testing. The connectivity testing for the production environment was completed successfully with the ITL Administrator in February 2009. The complete readiness documentation associated with this migration is included in Chapter 14 of the 2010 National Inventory Report.

Security and Governance

The Registry Administrator has commissioned six independent audits since 2005 to continually assess the security status of the online web application system and supporting infrastructure. In addition, each audit has assessed the supporting technical and administrative procedures. The latest audit was in September 2009. All recommendations and critical findings have been addressed and implemented.

Information on the technical aspects of the registry as initially submitted in Ireland's initial report under the Kyoto Protocol is set out at points 1 to 6 below. Further details on changes to the registry during 2009 will be included in Chapter 12 and Chapter 14 of the 2010 National Inventory Report.

NATIONAL REGISTRY - INITIALISATION FACT SHEET - [Ireland]

Initial information

[1] Commission Regulation (EC) No. 2216/2004 for a standardised and secured system of registries as amended by Commission Regulation (EC) No. 916/2007 and Commission Regulation (EC) No. 994/2008

[2] http://unfccc.int/kyoto_protocol/registry_systems/independent_assessment_reports/items/4061.php

Legal basis establishment	Yes	Completion date: 14/7/04
Build software	No	Completion date:
Purchase software	Yes	Decision date: 31/8/04
License agreement	Yes	Signature date: 31/8/04
Translation	N/A	Completion date: N/A
Other customisation	See Appendix 1	Developed by: LGCSB
Attach customisation details as Appendix 1		

Registry administrator	
Name	Environmental Protection Agency
	Ms Jacinta Ponzi
Address	Environmental Protection Agency
City	PO Box 3000, Johnstown Castle Estate,
Postcode	Co Wexford
Country	Ireland
Telephone number	353 53 9170783
Facsimile number	353 53 9160699
E-mail	ETRAdmin@epa.ie

Physical location of the registry test environment	
Name of host organisation	Local Government Computer Services Board
Address	27 Conyngham Road
City	Dublin
Postcode	Dublin 8
Country	Ireland

Physical location of the registry production environment	
Name of host organisation	Local Government Computer Services Board
Address	27 Conyngham Road
City	Dublin
Postcode	Dublin 8
Country	Ireland

Physical location of the registry backup environment	
Name of host organisation	Data Records Management
Address	Blanchardstown
City	Dublin
Postcode	Dublin 15
Country	Ireland

URL and port(s) for test and production environments		
	URL	**Port**
Testing area (test)	https://test.etr.ie	443
Secure area (production)	https://secure.etr.ie	443
Public area (production)	https://www.etr.ie	80

For Connectivity Testing:
https://test.etr.ie/WebServicesExternal/AccountMgmtRegistry.asmx

https://test.etr.ie/WebServicesExternal/TransactionLogRegistry.asmx

Hardware specification for test, production and backup environments			
	Test	**Production**	**Backup**
Web server	See appendix 2		
Application server			
Database server			

Firewalls			
Attach system architecture for each environment as Appendix 2			

System and procedures for safeguarding of data	
System and procedures created	See Appendix 3
Completion date	
Attach as Appendix 3	

Security plan	
Plan created	See Appendix 4
Completion date	
Attach as Appendix 4	

Procedures for change management	
Procedures created	Yes Per collaborators (GRETA) arrangements, practices and procedures in relation to new version/releases
Completion date	27/7/04
Attach as Appendix 5	

Administrative procedures for creating accounts	
Procedures created	Yes
Completion date	Per DEFRA bulk upload procedure for operators. Developing Guidance Note for individual account holders.
Attach as Appendix 6	

Publicly Accessible Information	

1. Scope of customisation

The Local Government Computer Services Board, as Host and service provider to the National Registry, will undertake the small level of customisation required.

The customisation of the Irish National Registry will take place in two phases. The first phase will only include minor 'branding' of the DEFRA application. It is our intent to add the EPA logo to a few of the screens and possibly change the colour scheme. No translation is required. It is not our intent to change the functionality or layout of the DEFRA application in any significant manner. We will not interface the registry application with any other application or database. The brief specification of the exact requirements for the branding exercise will be completed at the end of November and the development is due to take place in the first few weeks of December. This should in no way effect the connectivity or process testing with the CITL as we are not changing the application as provided by DEFRA in any substantial manner.

In January we intend to review the application and specify functional changes (if any) that may be required beyond the above-mentioned branding exercise. If any substantial customisation is deemed to be required we will inform the Commission well in advance of the Phase 10 testing.

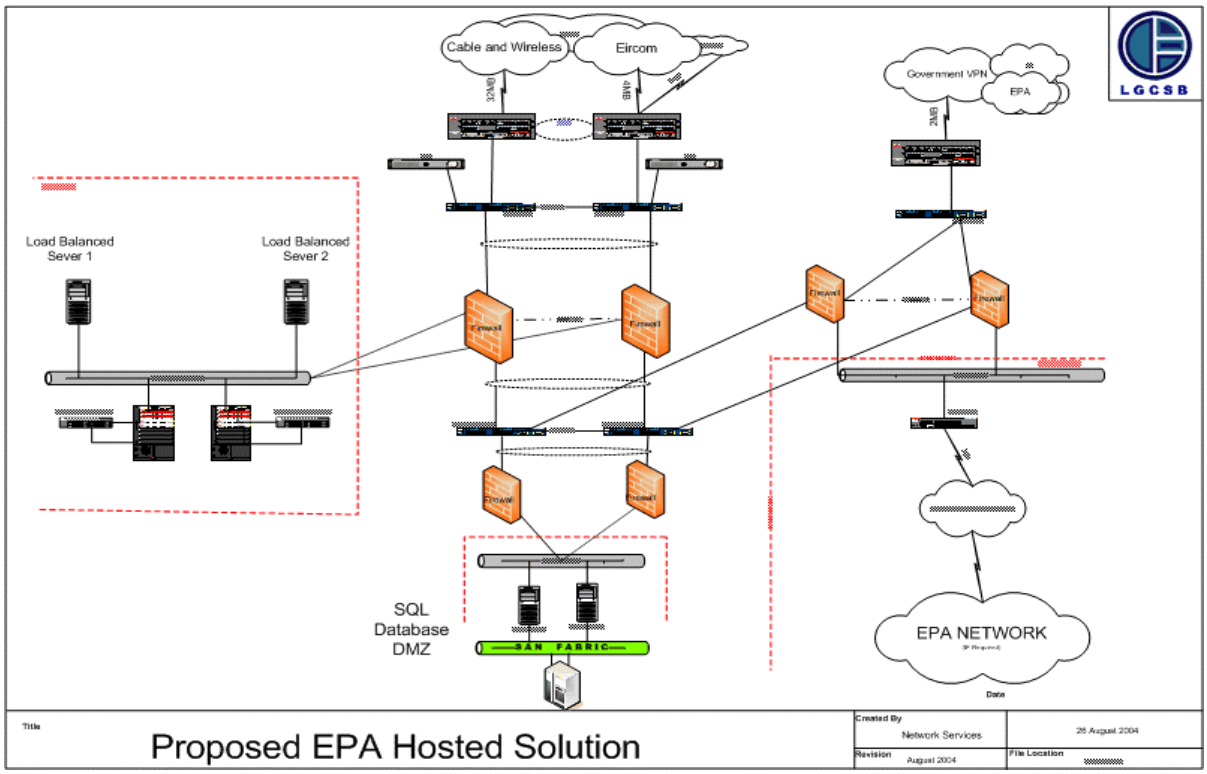
2. Hardware Specification

Qty	Description
	DL360 G3 Server with 36 GB HDD's for Database Servers
2	1x HP DL360G4 X3.0GHz 1P SCSI EU Rck Server 2x Intel X3.0GHz/800Mhz FSB 1MB DL360G4 Processor 2x 72.8GB Pluggable Ultra320 SCSI 15,000 rpm Universal Hard Drive (1in) 2x 1024MB of Advanced ECC PC2700 DDR SDRAM DIMM Memory Kit HP DL360G4 Redundant Power Supply
	Dell 1850z with 36GB HDD's for Web Servers
2	Dell 1850 1U Server Dual Xeon 2.8ghz 1GB Ram Redundant Power Supplies Dual NIC
	Dell 1655MC (Blade) with 36GB HDs for Test Web Server *
1	Dell 1655MC (Blade) with 36GB HDs for Test Web Server

Description
SAN Connection Hardware
2GB HBA (host bus adapters)
GBIC connector kit
5m Fibre Kit
Securepath Software

**For security reasons, our outsourcing partners, the Local Government Computer Services Board, will not provide exact specifications of the firewalls to be used in the Irish Registry solution.*

3. System Architecture



4. Fault Tolerance & Back-up

The LGCSB has an integrated high-end backup solution provided by CommVault Systems. All critical servers are backed up to both disk and tape on a daily basis, and all backups are stored off site in a 3rd party storage facility. The LGCSB, has also an offsite Disaster Recovery solution, which is located in the Cable & Wireless HQ in Airton Road in Tallaght. As previously mentioned, the LGCSB is protected against short power outages by our UPS, and for longer outages by our on-site generator. The LGCSB, also has two separate links to the internet, provided by two distinct providers, Cable & Wireless and Eircom. Internally the LGCSB provides a fully redundant and resilient network architecture, to ensure link failures do not compromise network connectivity.

5. Security & Protection

The Server room is located in a secure area of the LGCSB building. It is located in the centre of the building with no external access. The room is protected by biometric fingerprint scanner, to be used in conjunction with a proximity swipe card. Only members of the Web Hosting department have access to this room, and all other access is controlled by this team. All access granted must be accompanied by a member of the Web Hosting team, and all access is closely monitored. The Server room is monitored 24/7 by Closed Circuit television cameras and added security is provided by a motion detector. All unauthorised access of this room is signalled immediately via SMS message to the Web Hosting team.

6. Change Control Procedures

The EPA, as a party to the GRETA collaboration, has entered an agreement with DEFRA which includes procedures for change management. The EPA is cognisant of the details of article 27 of the Registry Regulations and Annex XIII of the Regulations, which deal with change management requirements.

Annex 4: Information on Models Used for Projections

Energy Model Linked to HERMES Macroeconomic Model – Economic & Social Research Institute	
Gas / Sector	Energy – All subsectors - CO_2 CH_4 N_2O Residential sector - CO_2 CH_4 N_2O Agriculture – Fuel Combustion sub-sector - CO_2 CH_4 N_2O Industry – Commercial, Institutional & Services sub-sector - CO_2 CH_4 N_2O Transport – All subsectors - CO_2 CH_4 N_2O
Model Type	Iterative model with feedback mechanisms linked to HERMES econometric model of the Irish economy
Purpose	Economic forecasting and policy analysis
Strengths	Forecasts linked to future economic growth and energy prices
Weakness	'Top down' model with limited technology representation
Synergies	
References	www.esri.ie

Waste Emissions Model – Department of Heritage, Heritage & Local Government	
Gas / Sector	Waste sector - CH_4 N_2O
Model Type	Excel based forecasting model
Purpose	Waste and waste emission projections
Strengths	Can be used for scenario analysis
Weakness	
Synergies	Incorporates effects of Biowaste Strategy April 2006
References	Brendan_oneill@environ.ie

CARBWARE – National Council of Forestry Research & Development (COFORD)	
Gas / Sector	Land Use Change & Forestry - CO_2
Model Type	Biological system model
Purpose	Calculate carbon sequestration from forestry in accordance with IPCC guidelines
Strengths	Sequestration calculated using Ireland specific research data and in accordance with IPCC best practice guidelines
Weakness	
Synergies	
References	www.coford.ie

FAPRI – Ireland Partnership	
Gas / Sector	Agriculture – Enteric Fermentation, Manure Management & Agricultural Soils sub-sectors - CH_4 N_2O
Model Type	Econometric model of agricultural outputs and inputs
Purpose	Economic forecasting and policy analysis
Strengths	Can model the effect of changes to the Common Agricultural Policy on the level of agricultural outputs and inputs at both the macro and farm level
Weakness	The calculation of agricultural emissions is complex and outputs from the model in some cases need to be manipulated before input into the Environmental Protection Agency models for calculating agricultural emissions
Synergies	Takes account of the agricultural policy framework under the Common Agricultural Policy as well as, the effect of wider environmental policies such as the EU Nitrates Directive, and macroeconomic projections from the Economic & Social Research Institute
References	www.tnet.teagasc.ie