



**Roinn Cumarsáide, Gníomhaithe
ar son na hAeráide & Comhshaoil**
Department of Communications,
Climate Action & Environment

Seventh National Communication Ireland

*A report under the United Nations Framework
Convention on Climate Change*

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Forward by Ireland's Minister for Communications, Climate Action and Environment



Climate change is the most urgent and pressing global challenge of our generation. Climate change is real and it is happening now. It presents huge challenges for Ireland and for the international community, challenges which must be met and opportunities which must be grasped if we are to achieve the collective transformation that will enable a global transition to a low carbon and climate resilient future.

Ireland's Seventh National Communication and Third Biennial Report are prepared in accordance with the Decisions and Guidance of the UNFCCC. These reports set out Ireland's progress in addressing the climate change challenge over the period 2013 to 2017, and provide the additional information relating to our progress in achieving emission reductions and on the provision of financial, technical and capacity-building support to other countries.

The international community has demonstrated the need for ambition, with the negotiation and swift entry into force of the Paris Agreement. This leadership needs to be translated into ambitious action at domestic level in order to drive the transformative changes needed in order to achieve the goals of the Paris Agreement. Ireland is committed to concerted multilateral action to tackle climate change and sees the Paris Agreement as the best hope of the global community for collectively ensuring the very survival of the planet.

Ireland is also committed to doing its part domestically, and set out in its National Policy Position of 2014 a vision of a low-carbon, climate resilient and environmentally sustainable economy by 2050. This vision is based on an aggregate reduction in carbon dioxide emissions of at least 80% (compared with 1990 levels) by 2050 across the electricity generation, built environment and transport sectors, and in parallel, an approach to carbon neutrality in the agriculture and land-use sector, including forestry, which does not compromise capacity for sustainable food production. This vision was given a legislative underpinning through the Climate Action and Low Carbon Development Act 2015.

Ireland's first National Mitigation Plan, published under this legislation in July 2017, sets out Ireland's approach to reducing our greenhouse gas emissions, building on policies and measures in place and providing a framework to develop and implement additional measures. It marks the beginning of a long-term transition towards the 2050 National Policy Position.

In parallel, Ireland's first National Adaptation Framework, published in January 2018, sets out the national adaptation strategy which aims to reduce Ireland's vulnerability to the impacts of climate change. It sets out the role of the key sectors of Irish society in the development of climate resilience and the coordination of adaptation actions across sectors.

(Minister Naughten's Signature to go here)

Denis Naughten, T.D. Minister for Communications, Climate Action and Environment

1. Executive Summary

Parties to the United Nations Framework Convention on Climate Change (UNFCCC) are requested under Article 12 of the Convention to communicate information relating to their national climate mitigation and adaptation policies. These National Communications enable Parties to advise the Conference of Parties about progress in implementing climate change measures. Ireland's seventh National Communication (NC7) is prepared in accordance with Decisions 9/CP.16 and 2/CP.17 and provides a comprehensive overview of Ireland's climate change activities. The data on which Ireland's NC7 is based relates to the period 2014-2017, depending on availability.

The UNFCCC also requires under Decision 2/CP.17 that Annex 1 (developed country) Parties, including Ireland, provide Biennial Reports every two years, the first of which was due by 1 January 2014. This Report includes Ireland's third Biennial Report (BR3) which gives additional information on the provision by Ireland of financial, technology and capacity-building support to non-Annex 1 Parties. In order to avoid unnecessary duplication, Ireland has limited the overlapping of content between NC7 and BR3 as much as possible, and sections of BR3 make references to further information found in NC7.

1.1 National circumstances relevant to Greenhouse Gas emissions and removals

Ireland is situated off the north-west coast of the continent of Europe between longitude 5.5° and 10.5° West and latitude 51.5° and 55.5° North. 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.

Ireland's national parliamentary democracy consists of the President and two houses –Dáil Éireann (the lower house) and Seanad Éireann (the upper house). The Irish Government retains responsibility for ensuring the delivery of Ireland's responsibilities under the United Nations Framework Convention on Climate Change (UNFCCC), the Kyoto Protocol and the Paris Agreement. A Cabinet Committee assists the Government in carrying out its responsibilities to implement a whole of Government approach given the cross sectoral nature of climate. This Committee is supported by a Senior Officials Group which provides whole of Government coordination, an essential function in the context of this cross-sectoral nature.

The Minister for Communications, Climate Action and Environment is responsible for Ireland's policy on climate change and has a lead role within Government in the delivery of this policy.

According to Ireland's 2016 Census, its population of 4,761,865 represented a 3.8% increase over 2011 levels, continuing the steady growth since the 1990s. The average age of 37.4 years, while an increase over 2011 levels, continues to represent a young profile. While the population density of 70 persons per square kilometre increased since 2011, it remains low by European standards. Population density remains heavily concentrated in the Dublin and the Eastern region. A highly dispersed and low-density population can be found outside this region.

Ireland is a small, globalised economy which experienced an extended strong period of growth from 1995 to 2007, with GDP rising by an average of 6% per annum. However, this was followed by a sharp drop in economic activity during the global financial crisis and the subsequent collapse of Ireland's domestic property market and construction sector. While GDP fell by 10% between 2007 and 2011 and Ireland's financial deficit necessitated an EU-IMF bailout program, strict adherence to deficit-reduction targets and refinancing of a large amount of banking debt enabled Ireland to exit the bailout program in 2013. The economy has shown rapid growth since 2014.

1.2 Greenhouse Gas Inventory Information

The Environmental Protection Agency (EPA) has overall responsibility for Ireland's national greenhouse gas inventory, performing the role of inventory agency in Ireland and undertaking all aspects of inventory preparation and management as well as the reporting of Ireland's emissions annually.

Ireland's has a Quantified Emission Limitation or Reduction Commitment (2013–2020) (percentage of base year or period), QELRC, of 80% as set out in the Doha amendment of Annex B to the Kyoto Protocol.¹ The QELRCs for the European Union and its Member States for the second commitment period are based on the understanding that these will be fulfilled jointly with the European Union and its Member States, in accordance with Article 4 of the Kyoto Protocol.

¹ Doha amendment to the Kyoto Protocol ([FCCC/KP/CMP/2012/13/Add.1](https://unfccc.int/kyoto_protocol/items/2830.php))

The joint assigned amount for the European Union, its member States and Iceland is calculated pursuant to the QELRC listed in the third column of the table contained in Annex B to the Kyoto Protocol, while the assigned amount of each Member State is determined in accordance with the terms of the joint fulfilment agreement. The assigned amount for Ireland is fixed based on Annex II to European Commission Decision 2013/162/EU and as adjusted by Commission Implementing Decision 2013/634/EU.

Ireland's total greenhouse gas emissions in 2015, including indirect emissions from solvent use (without LULUCF) were 59,878.21 kt CO₂ equivalent, an increase of 6.7% on 1990 levels but 15.8% lower than the 2001 peak of 71,124.17 kt CO₂ equivalent.

The *Energy* sector accounted for 61% of total emissions in 2015, *Agriculture* contributed 32.1% while a further 5.2% emanated from *Industrial Processes and Product Use* and 1.6% was due to *Waste*. Emissions of CO₂ accounted for 64.1% of the national total in 2015, with CH₄ and N₂O contributing 22.2% and 11.8% respectively. The combined emissions of HFC, PFC, SF₆ and NF₃ accounted for 1.9% of total emissions in 2015.

1.3 Policies and Measures

Ireland's **National Policy Position on Climate Action and Low Carbon Development (2014)** sets out the fundamental national objective of transitioning to a competitive, low carbon, climate-resilient and environmentally sustainable economy by 2050. It sets out the context for the objective, clarifies the level of greenhouse gas mitigation ambition envisaged and establishes the process to pursue and achieve the overall objective. The National Policy Position envisages that the evolution of Irish climate policy will be a dynamic, iterative process, with the ultimate objective of successive mitigation plans and adaptation frameworks incrementally achieving the required transition. It underlines the need to take a long-term view having regard to, inter alia, current and future obligations under EU or international agreements as well as the economic imperative for early and cost-effective action.

Ireland's **Climate Action and Low Carbon Development Act 2015**, provides the statutory basis for the national transition objective outlined in the National Policy Position. It provides the legislative framework for the development and submission to Government for approval of national mitigation plans and national adaptation frameworks.

Ireland's first **National Mitigation Plan** was published in July 2017, and represents an initial step to set the country on the pathway to achieve the level of decarbonisation required in order to achieve the national transition objective.² The Plan contains a series of mitigation measures covering greenhouse gas emissions in the Electricity Generation, Built Environment, Transport and Agriculture sectors. These measures and actions are outlined in greater detail in **Chapter 4.3.1**. The Plan sets out an extensive list of mitigation measures already in place across the four sectors concerned, including measures introduced at EU level and domestic measures. The Plan also presents a range of options for further measures to reduce emissions that are under development or consideration.

Ireland's emission reduction policies and measures are also informed by European Union measures. The EU **Emissions Trading Scheme (ETS)** is a cornerstone of the European Union's policy to combat climate change and is an essential tool for reducing greenhouse gas emissions in a cost-effective manner in the power generation and industrial sectors. In an Irish context, the emissions covered by the ETS relate mainly to dairies, refineries, mining, power generation, the production of cement, aluminium, lime and pharmaceutical goods, and to certain emissions from the aviation sector.

The ETS, together with the EU **Effort Sharing Decision No 406/2009/EC**³, forms the basis for the EU objective to reduce emissions by 20% over the 2013 to 2020 period, in line with the EU commitment under the Doha Amendment to the Kyoto Protocol.

1.4 Projections and the Total Effects of Policies and Measures

The reporting of Ireland's projected emissions is carried out in compliance with the European Union Monitoring Mechanism Regulation, Regulation No. 525/2013, and use two scenarios, *With Existing Measures* (based on measures already put in place at the end of 2015; this scenario assumes no additional policies or measures beyond these are implemented) and *With Additional Measures* (which assumes the implementation of the With Measures scenario along with the implementation of additional policy measures by 2020).

² Ireland's first National Mitigation Plan can be found here: <https://www.dccae.gov.ie/documents/National%20Mitigation%20Plan%202017.pdf>

³ Effort Sharing Decision No 406/2009/EC can be found here: http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2009.140.01.0136.01.ENG

The EPA produces greenhouse gas emission projections on an annual basis for all sectors of the economy in collaboration with relevant State and other bodies. Ireland's most recent projections, from April 2017, indicate that total emissions by 2020 will represent an increase of 10% or 5% on 1990 levels under the *With Existing Measures* and *With Additional Measures* scenarios respectively. By 2030 these increases will have risen to 19% and 12% respectively.

1.5 Vulnerability Assessment, Climate Change Impact and Adaptation Measures

Ireland's Climate Action and Low Carbon Development Act 2015 provides for the preparation of the National Adaptation Framework, which was published in January 2018. Relevant Government Ministers will develop sectoral adaptation plans under the Act, specifying the adaptation policy measures they propose to adopt. This process will begin in 2018, although a number of non-statutory sectoral plans have already been completed (Agriculture and Forestry; Transport; Energy; Flood Risk Management).

In an effort to promote enhanced cooperation and co-ordination, the National Adaptation Framework sets out the identification and grouping of sectors under four key thematic areas as follows; Natural Capital; Critical Infrastructure; River and coastal flood risk; and Public Health. This approach highlights the potential of cross-departmental work in identifying synergies and efficiencies that can be achieved through greater coherence between adaptation policies and measures.

Ireland's local government sector is already facing and responding to a range of weather and climate related impacts in respect of their key role in national emergency management structures. The sector will also have key responsibilities in terms of dealing with other medium to long term climate impacts that are likely to emerge over the coming decades. These will likely put significant pressure on the sector's ability to deliver services at local level and will require a strategic and planned response. All local authorities are required under the National Adaptation Framework to prepare and adopt a local area adaptation strategy or to collaborate in the preparation and adoption of a regional adaptation strategy.

1.6 Financial resources and transfer of technology

Ireland has a strong record of providing climate finance to developing countries, with significant progress achieved in the delivery of this climate finance in recent years.

Ireland's public funding for climate action includes on-going support for mitigation and adaptation action in developing countries, mainly through bilateral assistance to Ireland's key partner countries in sub-Saharan Africa. Ireland also provides contributions in respect of a number of multilateral funds established under the auspices of the UNFCCC, including the Least Developed Countries Fund and the Green Climate Fund. These funds, in line with their respective mandates, provide support for mitigation and adaptation action in developing countries. Funding through these mechanisms is provided through the Department of Communications, Climate Action and Environment and through the Official Development Assistance budget managed by the Department of Foreign Affairs and Trade. A consistent approach to programming climate support, based on policy prioritisation on addressing climate finance, has improved the predictability of Irish climate finance. Ireland also gave a commitment, at COP 21 in 2015, to provide at least €175 million in public funding for climate action in the period 2016 to 2020.

Ireland's support for technology transfer and capacity building is also represented through this range of support measures.

Further details of Ireland's contribution to climate finance and the transfer of technology can be found in **Chapter 7**.

1.7 Research and Systematic Observation

Understanding and responding to the impacts of climate change necessitates strong research and systematic observations. The EPA has the statutory role in coordinating environmental research in Ireland. Supporting a national climate change research programme to address key challenges for Ireland, the EPA develops essential research infrastructures both in the context of EU and international research activities, investment, and observation and assessment programmes.

In addition, the EPA coordinates climate-related research carried out by a number of other state bodies including Teagasc, Met Éireann, the Sustainable Energy Authority of Ireland (SEAI), the Department of Agriculture Food and the Marine, the Economic and Social Research Institute and Enterprise Ireland; some of this research is funded through the EU Horizon 2020 programme.

Details of the organisation of Irish climate change research since 2007 are outlined in **Chapter 8** of this report. The most significant developments in recent years have been the provision of €38.2 million in total for climate research in Ireland over the period 2010-2015 and the securing of significant funding under the EU Horizon 2020 programme for a number of research initiatives.

The EPA, in light of its statutory role, has established a National Climate Research Coordination Group bringing together the various actors to ensure ongoing coherence between different national and EU funding streams of climate research both to exploit synergies and to avoid duplication to ensure that publicly-funded research is accessible and broadly disseminated, and that it is relevant to inform the future development of policy, in particular through alignment with the objectives of National Mitigation Plan and National Adaptation Framework, both of which identify climate research as a key resource for informing policy development for both mitigation and adaptation pathways...

Met Éireann, Ireland's national meteorological service, carries out climate analysis and modelling and is responsible for systematic observations of meteorological parameters. In this regard, Met Éireann has engaged in a number of research consortia in 2017 (see **Chapter 8.4.1**), while the EPA is also supporting a number of international climate and weather research programmes over the 2017-2020 period.

Ireland's Department of Agriculture Food and the Marine is also supporting extensive research in the areas of greenhouse gas emissions and sinks focusing on emissions from a number of agricultural and landfill sources and on sinks. As outlined in **Chapter 8.5.2**, the EPA is also studying the impact of management on drained and restored wetlands.

The SEAI coordinates and funds a range of research, development, demonstration & innovation (RDDI) activities relating to the production, supply & use of energy. SEAI's RDDI funding is delivered through three primary mechanisms: the SEAI research, development & demonstration funding programme; the SEAI ocean energy prototype development fund; and supporting participation of Ireland-based researchers in Horizon 2020 activities. SEAI supports the successful participation of Irish industry, academia & public sector bodies in Horizon 2020 by fulfilling the role of National Delegate for Societal Challenge 3 (Secure, Clean and Efficient Energy). Ireland-based researchers in companies and academic institutions have secured in excess of €40M in energy-related Horizon 2020 funding to-date.

1.8 Education, Training and Public Awareness

Ireland has put in place a number of significant initiatives in the area of public awareness.

The National Dialogue on Climate Action was launched by the Minister for Communications, Climate Action and Environment in 2017 with a number of key objectives:

- to create awareness, engagement and motivation at a locally, regionally and national level in relation to the challenges presented by climate change;
- to create structures and information flows to facilitate people gathering to discuss, deliberate and maximise consensus on appropriate responses to these challenges, and to enable and empower appropriate action;
- to establish on a long term basis, appropriate networks for people to meet periodically to consider evidence-based inputs on the economic, social, behavioural, environmental and public aspects of climate and energy policy and to provide input into the prioritisation and implementation of climate policy.

In parallel, the Citizens Assembly, a participatory democracy process established by the Oireachtas and comprising 100 citizens examined issues relating to climate change during 2017.

The Climate Action and Low Carbon Development Act 2015 also established the Climate Change Advisory Council on a statutory basis, which provides independent advice and recommendations to the Irish Government on mitigation, adaptation and compliance with international climate change obligations. The Council's advice and recommendations are published for public consumption.

The EPA has a wide range of functions in relation to climate change awareness. Full details of these functions can be found in **Chapter 9.3**, but they, include providing of a wide range of public information on their website, funding climate-related television programmes, supporting a Climate Change Lecture series, producing a national State of the Environment report, sponsoring the Cool Planet Champions programme and funding communications training for nine Climate Ambassadors who have been tasked with improving climate change awareness in their local communities. This work is further supported by the Environmental Awareness Officers Network through Ireland's local authority system, and by the Tidy Towns competition.

The EPA also collaborated with key stakeholders in the agriculture sector with the Smart Farming initiative, and with the local authority sector with its National Waste Prevention Programme.

The SEAI raises awareness and guides behavioural change towards more sustainable energy use through a wide range of programmes. These are elaborated on in more detail in **Chapter 9.3** but include the Large Industry Energy Network, the Public Sector Partnership Programme, Sustainable Energy Communities, Energy in Education, a range of consumer information programmes and a National Smart Meter Project. The Department of Communications, Climate Action and Environment supports the Irish Environmental Network, an umbrella organisation of environmental NGOs in relation to their role in protecting the environment, raising awareness, promoting sustainability and participating in environmental policy development. The NGO sector also plays a role in climate change education, with ECO-UNESCO raising awareness, promoting environmental protection and encouraging active citizenship in children and young people. Further information on these activities can be found in **Chapter 9.3.2**

2. National Circumstances Relevant to Greenhouse Gas Emissions and Removals

2.1 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, the Kyoto Protocol, and the Paris Agreement. A Cabinet Committee assists the Government in carrying out its responsibilities to implement a whole of Government approach given the cross sectoral nature of climate. This Committee is supported by a Senior Officials Group which provides whole-of-Government coordination, an essential function in the cross-sectoral nature of climate change. The Minister for Communications, Climate Action and Environment is responsible for Ireland's policy on climate change and has an overarching role in the delivery of this policy.

2.2 Population

Ireland's most recent Census, in 2016, shows that Ireland's population stood at 4,761,865 in April 2016, an increase of 173,613 (3.8%) since April 2011. Ireland's population has been steadily growing since the 1990s, and has increased by 36% since 1990, although the increase from 2011 to 2016 has been the slowest over that period. The population growth recorded by the 2016 Census was brought about by natural population increases, offset by a small net migration. The average age of Ireland's population had increased from 36.1 years to 37.4 years over the same period.

Ireland's population density also increased to 70 persons per square kilometre by 2016, although this remains relatively low compared to other European countries. However, 40% of the population is concentrated in the Greater Dublin Area, outside of which the State has a highly-dispersed and low-density population.

Ireland has recently published a new National Development Plan and National Planning Framework which collectively will provide a strategic planning and development framework for Ireland and all its regions for the period between now and 2040, setting a high-level strategy for the co-ordination of a range of national, regional and local policies and activities, planning and investment, for delivery through both the public and private sectors. This framework will play a key role in directing climate change mitigation and adaptation actions at national, regional and local levels.

The National Planning Framework will seek to support national targets for emissions reduction and objectives for climate change mitigation and adaptation by ensuring that climate change considerations are further integrated into the planning system, and that they continue to be taken into account as a matter of course in planning-related decision making processes.

2.3 Geographic Profile

Ireland is situated off the north-west coast of the continent of Europe between longitude 5.5° and 10.5° West and latitude 51.5° and 55.5° North and 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 consists of a large central lowland of limestone with a relief of hills and a number of coastal mountains, the highest of which, Carrantuohill, is 1,040m.

The Shannon, at 340km, is Ireland's longest river. Ireland's National Parks are home to some of the most unique and spectacular scenery in the country, while wild bog lands 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.

2.4 Climate Profile

Ireland has a mild temperate oceanic climate, due to the controlling influence of the Atlantic Ocean. Mean annual temperatures generally range between 9°C and 10°C with the higher values in coastal regions. Summer is the warmest season, followed by Autumn, Spring and Winter. The highest temperatures occur inland during the summer, with mean seasonal maxima between 18°C and 20°C while highest values occur in coastal regions during the Winter. July is the warmest month, followed by August and June; the coldest month is January followed closely by February and then December. A long-term average national temperature series for Ireland, derived using data from five centennial stations, shows that temperatures have varied considerably from year to year. Warming periods occurred in the 1930s and 1940s and from the late 1980s to the present time in line with global trends.

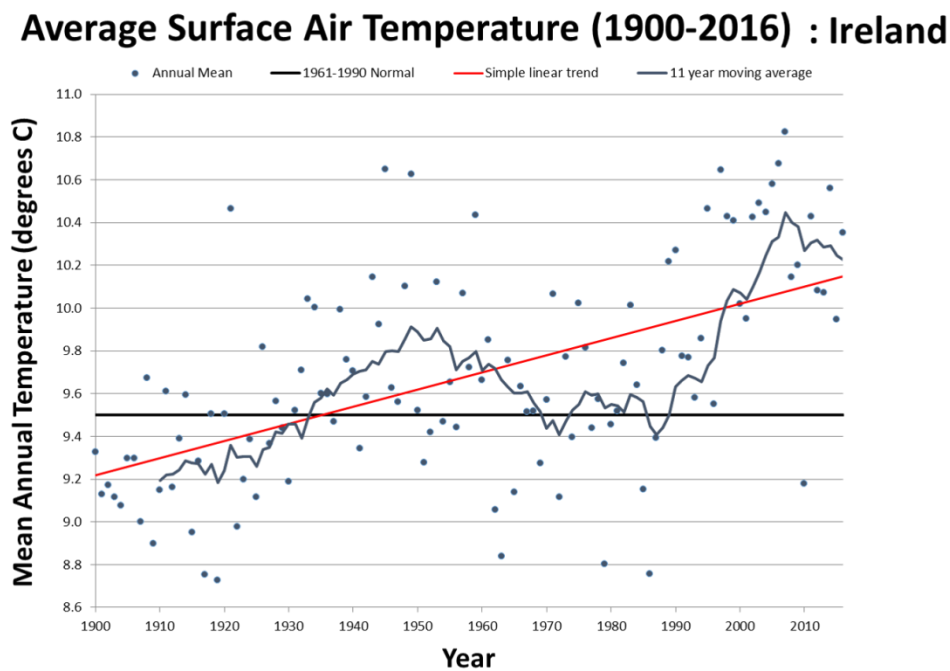


Figure 2.1: Average Surface Air Temperature (1900-1916)

The highest rainfall occurs in the Western half of the country and on high ground, while rainfall decreases to the Northeast. The average annual rainfall is approximately 1230 mm, but totals in excess of 3000 mm may occur on high ground. The driest seasons are Spring and Summer, with an average of approximately 260 mm, while Autumn and Winter have averages of approximately 350 mm. The driest months are April, May, June and July, with an average of approximately 80 mm each month. February, March, August and September have average rainfall totals of approximately 100 mm, while October, November, December and January have averages of approximately 130 mm.

Observations also show that Ireland's climate is changing in line with global trends in terms of sea level rise, increases in average temperature, changes in precipitation patterns and weather extremes (i.e. storms, flooding, sea surges and flash floods). The observed scale and rate of change is consistent with regional and global trends and these changes are projected to continue and increase over the coming decades.

2.5 Economic Profile

Ireland is a small, modern, trade-dependent economy. A strong period of economic growth over the period 1995-2007 saw GDP rise by an average of 6% per annum. However, this was followed by a sharp drop in economic activity during the world financial crisis and the subsequent collapse of Ireland's domestic property market and construction industry. GDP shrank by 10% between 2007 and 2011, with employment falling by 14%, with Ireland's deficit necessitating an EU-IMF bailout programme. Strict adherence to deficit-reduction targets and the refinancing of a large amount of banking debt enabled Ireland to exit the bailout program in 2013, with the economy recovering rapidly from 2014.

Ireland has since managed to lower some taxes and increase public spending while keeping to its deficit-reduction targets, resulting in GDP growth in 2015 and 2016.

The pace of expansion in recent years has led to a rapid recovery in the labour market. Annual employment has increased consistently since the upturn, with 2017 levels representing an increase of 231,100 jobs since the low-point in 2012. In parallel, the unemployment rate stood at 6.4% in July 2017, having fallen from a peak of 15.1% in early 2012. Since the collapse of Ireland's construction sector, exports have become a key component of the Irish economy, reaching a record level of almost €117 billion in 2016. Ireland now has the 27th largest export economy in the world. Ireland's key export partners are the UK (26% of exports), followed by Belgium (12.6%), Germany (6.7%) and Switzerland (5.4%)

While Ireland’s economy is rapidly approaching full employment, considerable vulnerabilities remain. Principal among these are the risks associated with the UK’s impending exit from the EU.

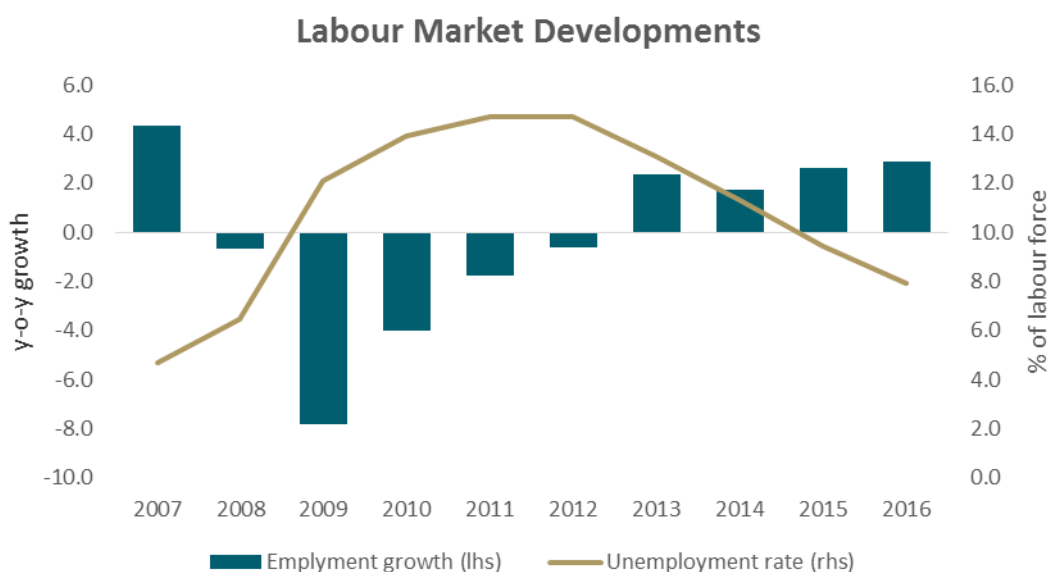


Figure 2.2: Labour Market Developments⁴

2.6 Energy

Ireland is not endowed with significant indigenous fossil fuel resources and has only in recent years begun to harness significant quantities of renewable resources and more recently natural gas from the Corrib gas field off the west coast of Ireland. Since around the year 2000 Ireland had been importing approximately 90% of its energy needs – this cost an estimated €4.6 billion in 2015. During 2016 this fell to around €3.4 billion due mainly to reduced gas imports as a result of the commencement of gas production from the Corrib gas field with a corresponding reduction in import dependency. Indigenous production of energy from renewable sources has been increasing steadily also, to the point where it has grown by a factor of 3 since 2005 driven mainly by increased generation of electricity from wind.

⁴ Ireland’s Department of Finance produces a Monthly Economic Bulletin which provides regular updates on some of the key developments within the Irish economy. This can be found at <http://www.finance.gov.ie/what-we-do/economic/monthly-economic-bulletin/>

Data relating to national and sectoral statistics for energy production, transformation and end-use are collected by the SEAI in the year following the activity. Following collection these data are rigorously analysed with the data and analysis typically becoming available for public use in December of that year.

2.6.1 Key Trends in 2016

- In 2016, overall energy use increased by 3.7%, while the economy grew by 5.1%.
- Energy-related CO₂ emissions increased by 3.6% in 2016 and were 16% below 2005 levels.
- Energy-related CO₂ emissions from the household, transport, services, industry and agricultural sectors account for approximately 60% of Ireland's total greenhouse gas (GHG) emissions.
- In 2016, the indigenous energy production in Ireland reached the highest level ever recorded at 4,246 ktoe. Natural gas production also reached the highest level ever, as a result of the Corrib gas field coming on stream.
- This reduced Ireland's energy import dependency from 88% in 2015 to 69% in 2016. As a result the energy import bill for Ireland fell from €4.6 billion in 2015 to €3.4 billion in 2016.

2.6.2 Energy Production 2005-2016⁵

Domestic production accounted for 32% of Ireland's energy requirements in 1990. However, since the mid- 1990s import dependency had grown significantly, due to the increase in energy use together with the decline in indigenous natural gas production at Kinsale since 1995 and decreasing peat production. This changed in 2016 when the Corrib gas field started production reducing overall import dependency to 69.6%. Production of indigenous gas decreased by 94% over the period between 1990 and 2015 to 106 ktoe but then increased dramatically in 2016 to 2,473 ktoe.

⁵ See Ireland's energy balance 2016 <https://www.seai.ie/resources/publications/Energy%20Balance%202016>

This is the highest natural gas production level ever recorded in Ireland. This high level of production from the Corrib field is expected to taper off significantly in the next couple of years.

Indigenous production of all energy reached a new peak in 2016 at 4,246 ktoe, up from the previous peak in 1995 at 4,105 ktoe.

Indigenous renewable energy production increased by 176% between 2005 and 2015 to 1,030 ktoe, but fell slightly to 1,028 ktoe in 2016. This was due to reduced wind and hydro levels but balanced by an increase in biomass and geothermal.

Peat production was down since 2013 following a high level production during that summer which provided very good harvesting conditions for peat. In 2016 peat production was down 11.7% to 679 ktoe compared with the previous year.

2.6.3 Energy Consumption – Trends 2005-2016⁶

In 2008 the Irish economy experienced a downturn that deepened into 2009. Initially in 2008, industry and transport also experienced reductions in energy use while there was continuing energy growth in the residential and services sectors, partly due to weather conditions. In 2009, however, all sectors of the economy experienced reductions in energy use and related CO₂ emissions, tracking the decline in the economy. 2011 to 2013 were mild years compared with 2010 and, notwithstanding the flat growth in GDP and return to growth in GNI* in 2013, there was a drop in energy demand across all sectors of the economy during these years.

In 2015 GDP grew by 26.3%, much of this was attributed to the transfer into Ireland of assets by multinationals, which had little or no effect on energy use. GNI* grew more modestly, but still significantly, by 11.9% in 2015. GDP growth in 2016 was 5.1% and GNI* grew by 9.4%.⁷

Figure 2.3 shows the relative decoupling of TPER (total primary energy requirement, also known as gross inland consumption) from economic growth up to 2007 and again from 2011 onwards. This is a result of changes in the structure of the economy and improvements in energy efficiency.

⁶ See full report *Energy in Ireland 1990-2016* here: <https://www.seai.ie/resources/publications/Energy-in-Ireland-1990-2016-Full-report.pdf>

⁷ Modified Gross National Income (or GNI*) was introduced by the CSO in 2017 to assess the level of activity in the Irish economy excluding the effects of globalization that disproportionately affect the Irish economic results. GNI* is defined as GNI less the effects of the profits of re-domiciled companies and the depreciation of intellectual property products and aircraft leasing companies.

CO₂ emissions grew a little slower than energy use in the period 2005 to 2011 due predominantly to decarbonisation of the electricity sector, however the trends remain relatively coupled since.

Between 2010 and 2014, the economy grew by 13% as measured by GDP (16.5% if measured by GNI*) while energy use continued to fall, with a cumulative drop of 10% between 2010 and 2014. Some of the reduction in energy use can be accounted for by weather, for example 2010 was an exceptionally cold year. Other reasons for the reduction can also be attributed to a large increase (83%) in wind generation, which reduced the primary energy requirements for electricity generation. There also continued to be reductions in the energy intensity of households, due to a combination of improved energy efficiency and economic factors.

2015 saw the first significant increase in overall energy use since before the economic downturn in 2008, with TPER growing by 5.5%. This was linked to increased domestic economic activity as evidenced by the fact that final energy consumption in the industry and transport sectors, which are closely aligned with the economy, increased by 4.8% and 5.9% respectively. Overall energy use continued to grow in 2016 but at a more modest rate of 3.7%.

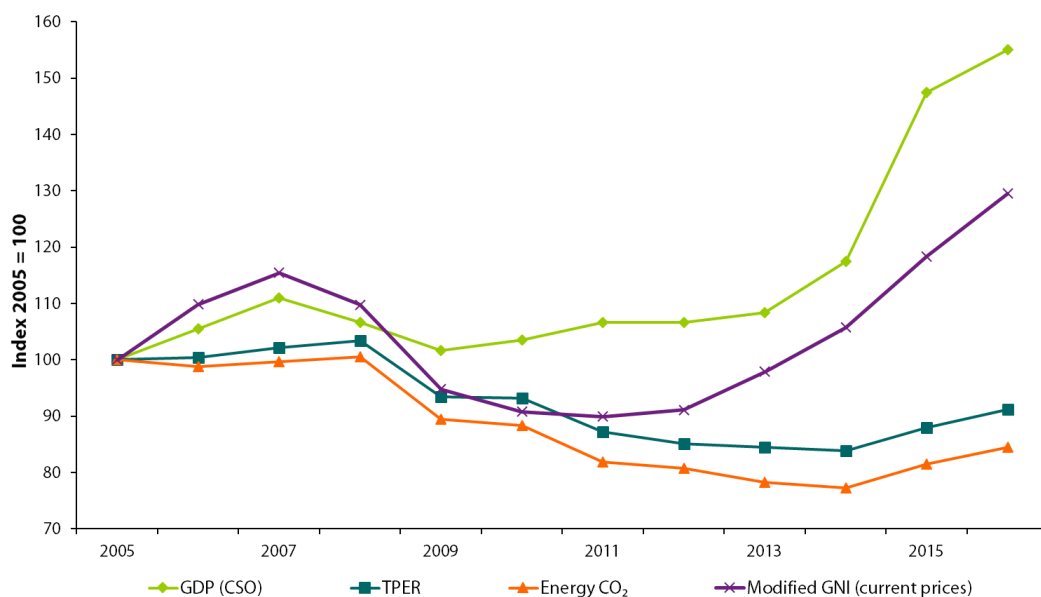


Figure 2.3: Total primary energy requirement (TPER) and economic growth (constant prices) since 2005

Table 2.1 displays the growth rates for the economy (GDP and GNI*), primary energy (TPER) and energy-related CO₂ emissions for the period 1990 – 2016. It is interesting to compare the trend over the eleven year period 2005 – 2016 with that for the whole period, given the significance of 2005 with respect to Ireland’s 2020 greenhouse gas emissions target. Ireland’s Greenhouse Gas emissions in non-Emissions Trading Scheme (non-ETS) sectors (i.e. in transport, agriculture, heating in buildings, waste and small industry) are required to be 20% below 2005 levels by 2020.

Table 2.1 Economy, primary energy & CO₂ emission growth rates

	Growth %	Growth %	Average annual growth rates %		
	1990 – 2016	2005 – 2016	'05 – '16	'10 – '16	2016
GDP	297.5	55.1	4.1	7.0	5.1
Modified GNI (current prices)	-	29.5	2.4	6.1	9.4
TPER	51.8	-8.8	-0.8	-0.4	3.7
Energy CO₂	28.1	-15.5	-1.5	-0.7	3.6
Energy CO₂ (excl. international aviation)	24.1	-16.6	-1.6	-0.9	3.7

Energy use is primarily driven by economic activity, but this relationship in Ireland is less straightforward than for other countries as significant portions of GDP or value added in Ireland are generated with very little consumption of energy. This was very well illustrated in 2015 when GDP grew by 26.3% as a result of the transfer into Ireland of intellectual property. Therefore, care must be taken when comparing macro-economic indicators such as energy intensity across countries.

Transport and industry have been more responsive to changes in economic activity while, in the short-term, residential and services energy use is heavily influenced by annual variations in weather and to some extent, energy price.

Figure 2.4 illustrates the trend in energy supply over the period 1990 – 2016, emphasising changes in the fuel mix. Primary energy consumption in Ireland in 2016 was 14,413 ktoe, a 3.7% increase on the previous year. Over the period 1990 – 2016 Ireland’s annual TPER grew in absolute terms by 52% (1.6% per annum on average). Between 2005 and 2016 primary energy requirement fell by 8.8%.

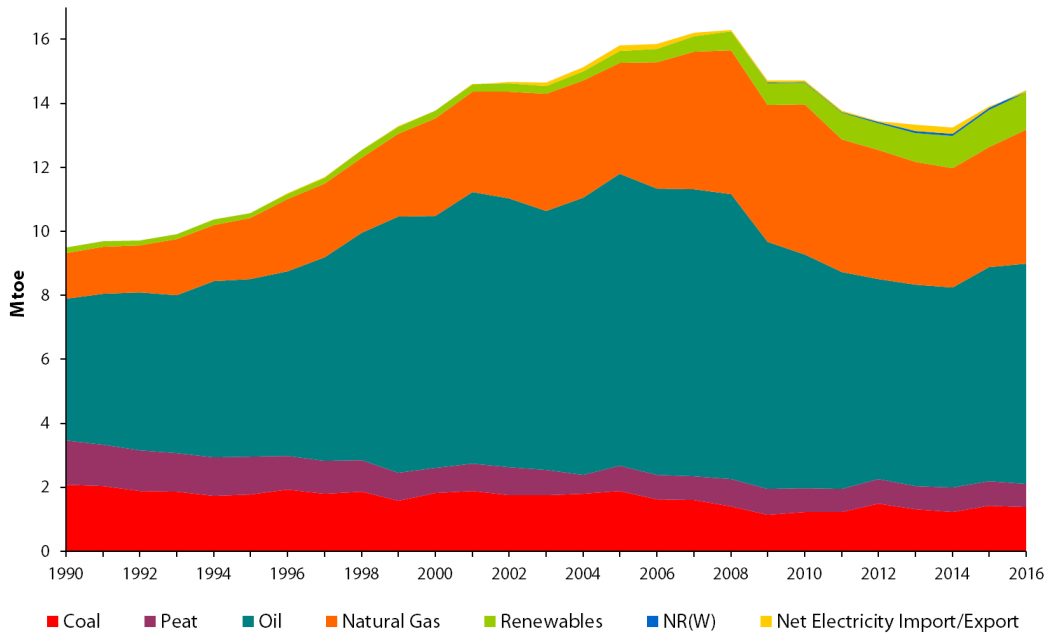


Figure 2.4: Final Energy Consumption in Ireland

The individual fuel growth rates, quantities and shares are shown in **Table 2.2**. Primary energy requirement peaked in 2008 and has fallen by 12% since then.

Table 2.2 Fuel growth rates, quantities & shares

	Overall Growth %		Average annual growth rates %			Quantity (ktoe)		Shares %	
	1990 – 2016	2005 – 2016	'05 – '16	'10 – '16	2016	2005	2016	2005	2016
Fossil Fuels (Total)	42.0	-13.1	-1.3	-0.9	5.0	15,254	13,250	96.5	91.9
Coal	-34.1	-27.0	-2.8	1.8	-3.7	1,882	1,373	11.9	9.5
Peat	-46.7	-4.0	-0.4	-0.5	-4.3	765	734	4.8	5.1
Oil	56.3	-24.3	-2.5	-0.9	3.8	9,130	6,911	57.8	48.0
Natural Gas	192.6	21.7	1.8	-1.7	12.4	3,477	4,231	22.0	29.4
Renewables (Total)	590.5	210.2	10.8	9.1	0.3	373	1,158	2.4	8.0
Hydro	-2.3	7.9	0.7	2.2	-15.6	54	59	0.3	0.4
Wind	-	453.0	16.8	13.9	-6.5	96	529	0.6	3.7
Biomass	217.6	85.7	5.8	8.0	17.6	180	335	1.1	2.3
Other Renewables	9883.6	448.3	16.7	4.2	0.3	43	236	0.3	1.6
Non-Renewable (Wastes)	-	-	-	40.6	-3.8	-	66	-	0.5
Electricity Imports (net)	-	-	-	-	-	176	-61	1.1	-0.4
Total	51.8	-8.8	-0.8	-0.4	3.7	15,803	14,413		

2.6.4 Annual Fuel Consumption Trends

Ireland's overall primary energy use grew by 4.9% in 2015. The consumption of all fuels increased in 2015 with the exception of peat, biomass and non-renewable wastes. Comparatively, overall primary energy use in Ireland experienced a growth of 3.7% during 2016.

2.6.5 Annual Fossil Fuel Trends

Details of fossil fuel growth rates, quantities and shares are outlined in **Table 2.2**. Key fossil fuels trends for Ireland are as follows:

- Fossil fuels accounted for 92% of all energy used in Ireland in 2016. Demand for fossil fuels increased by 5% in 2016 to 13,250 ktoe but was 13% lower than in 2005. The 2016 increase on 2015 figures saw fossil fuels account for a slightly lower proportion, at 91% of all energy used, excluding the embodied fossil fuel content of imported electricity.
- Coal use decreased by 3.7% and its share of TPER fell to 9.5% in 2016 down from 10.3% in 2015. Since 2005, coal demand has fallen by 27% (2.8% per annum).
- Peat had an annual average growth rate of -4.3% and its share of overall energy use was 5.1% in 2016.
- Oil continues to be the dominant energy source and maintained a 48% share of TPER in both 2015 and 2016. The share of oil in overall energy use peaked in 1999 at 60%. Consumption of oil, in absolute terms, increased by 3.8% in 2016 to 6,911 ktoe but compared with 2005, oil demand in 2016 was 24% lower.
- Natural gas use increased in 2016 by 12.4% to 4,231 ktoe and its share of TPER increased to 29%. Natural gas use was 22% higher than in 2005.
- Energy from non-renewable wastes decreased by an average rate of 3.8% in 2016 to 66 ktoe and accounted for just 0.5% of primary energy.

2.6.6 Annual Renewable Energy Trends

Details of renewable growth rates, quantities and shares are outlined in **Table 2.2**, the key trends of which are highlighted below:

- Total renewable energy produced increased slightly by 0.3% during 2016 to 1,158 ktoe.
- Hydro and wind decreased by 15.6% and 6.5% respectively as there was lower rainfall and less wind blowing in 2016 compared to 2015.
- Biomass use increased by 17.6% in 2016 to 335 ktoe and other renewables increased by 0.3% to 236 ktoe.
- The overall share of renewables in total primary energy supply stood at 8% in 2016, down from 8.3% in 2015. Furthermore, approximately three quarters of the additional wind capacity deployed in 2016 was commissioned in the latter half of that year.

2.6.7 Electricity Imports

Ireland was a net exporter of electricity in 2016, switching from net imports of 58 ktoe in 2015 to net exports of 61 ktoe in 2016 – a difference of 119 ktoe.

Figure 2.5 allocates Ireland's primary energy supply to each sector of the economy, according to its energy demand. The allocation is straightforward where fuels are used directly by a particular sector. Regarding electricity, the primary energy associated with each sector's electricity consumption is included to yield the total primary energy supply for each sector.

Primary energy supply gives a more complete measure than final energy demand (accounted for in the gas, oil, electricity and coal bills) of the impact of the individual sectors on national energy use and on energy-related CO₂ emissions. Energy use grew across all sectors in 2016, which can be directly attributed to the growth in the economy. Energy use in the residential and services sectors relates mainly to space heating and 2016 was a little warmer than 2015 but energy use increased nonetheless.

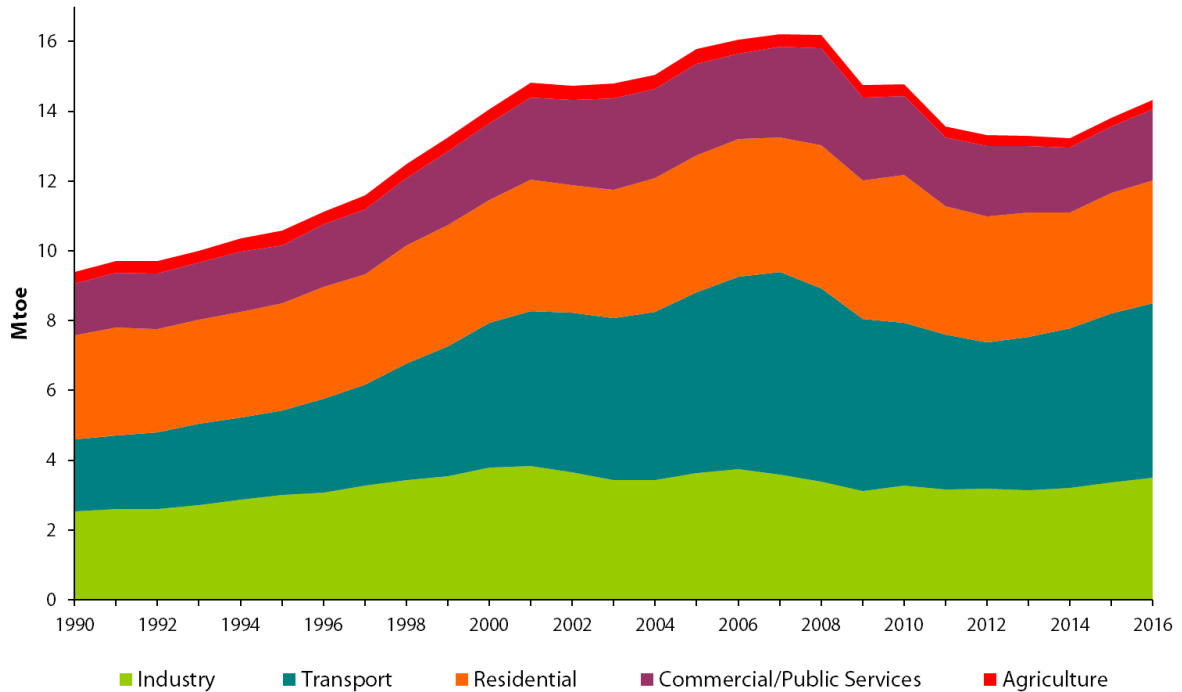


Figure 2.5: Total Primary Energy Requirement by Sector

Figure 2.5 illustrates total primary energy sectoral requirements and includes the following highlights:

- Transport experienced an increase in primary energy use in 2016 of 3% to 5,005 ktoe. Transport primary energy use fell by 28% between 2007 and 2012 but has increased by 19% since then. Transport remains the largest energy consuming sector with a 35% share of primary energy in 2016.
- In 2016, primary energy use in households increased by 2.1% to 3,514 ktoe. 2016 was warmer than 2015 with 6.5% fewer heating degree days. Residential share of primary energy was 24% in 2016.
- Industry primary energy increased by 4.6% in 2016 to 3,480 ktoe. Industry's share of primary energy was 24% in 2016.
- Use of primary energy in the commercial and public services sector increased by 6.3% in 2016 to 2,062 ktoe. Services' share of primary energy was 14% in 2016.

- Primary energy use in the residential sector and services sector can be considered collectively as energy in buildings as most of the energy use is associated with heating/cooling and lighting of buildings. In 2016, primary energy in buildings accounted for 39% of primary energy supply. Overall, primary energy use in buildings has fallen by 16% since 2005 (1.5% per annum), although in 2016 it grew by 3.6% to 5,577 ktoe.
- Agriculture/fisheries' primary energy use increased by 3.2% in 2016 to 284 ktoe and accounted for 2% of primary energy.

Table 2.3 shows the growth rates of the different sectors in terms of TPER and also provides the percentage shares of TPER for 1990 and 2016.

Table 2.3 Growth rates and shares of TPER by sector

	Overall Growth %		Average annual growth rates %			Quantity (ktoe)		Shares %	
	1990 – 2016	2005 – 2016	'05 – '16	'10 – '16	2016	2005	2016	2005	2016
Industry	37.3	-4.0	-0.4	1.0	4.6	3,626	3,480	22.9	24.3
Transport	143.7	-3.4	-0.3	1.2	3.0	5,179	5,005	32.7	34.9
Residential	17.3	-10.4	-1.0	-3.1	2.1	3,920	3,514	24.8	24.5
Services	39.8	-21.9	-2.2	-1.6	6.3	2,641	2,062	16.7	14.4
Agriculture / Fisheries	-21.0	-39.4	-4.4	-3.8	3.2	468	284	3.0	2.0

2.7 Transportation

Economic factors are the main drivers of transport demand and activity; **Figure 2.6** shows the strong correlation between transport indicators and general economic activity. The growth of the economy between 1990 and 2007 was associated with significant growth in total employment and increased immigration. This led to an increase in transport demand as people and goods required greater movement around the country and as a result generated additional CO₂ emissions.

Decreased emissions between 2008 and 2012 reflected the impact of the economic downturn, and improvements to energy efficiency in the car fleet underpinned by changes to vehicle registration tax and motor tax introduced in 2008. In addition, the Biofuels Obligation Scheme came into operation in mid-2010, with biofuels displacing up to 6% of the petrol and diesel used thus contributing further to reduced greenhouse gas emissions.

It is worth noting that transport emissions continued to fall right up to 2012 despite the fact that positive economic growth had returned from 2009 onwards.⁸

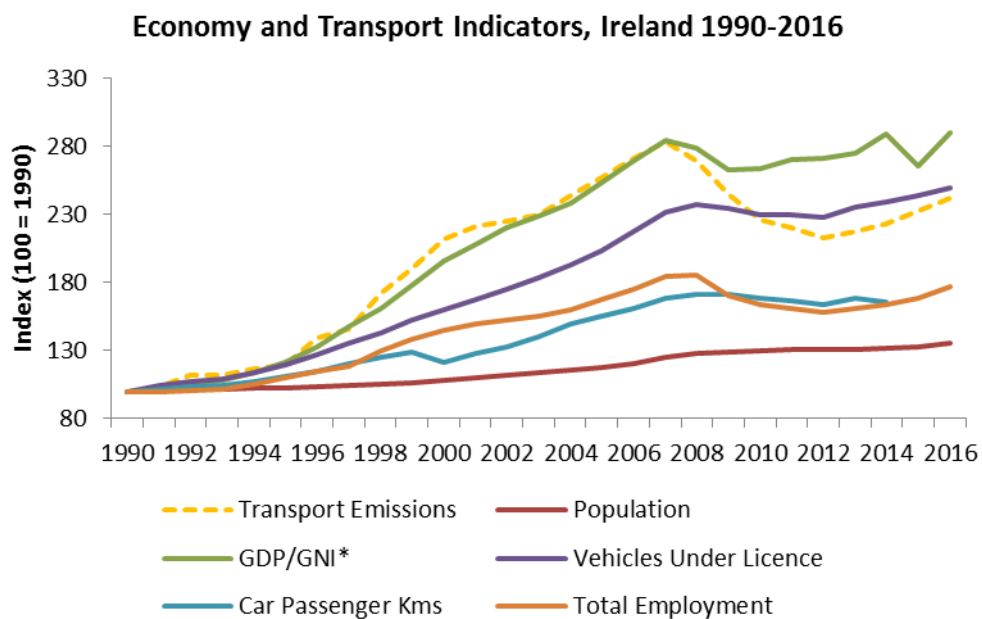


Figure 2.6: Economy and Transport Indicators, Ireland 1990-2016. Source Data: Central Statistics Office (CSO), SEAI, EU Commission and EPA

⁸ See rate of change for GDP/GNP as reported by OECD and CSO showing upward trend post 2009 here: <https://data.oecd.org/gdp/gross-domestic-product-gdp.htm>

With a return to economic growth, more people are making more journeys and these trips are generally becoming longer in terms of both duration and distance (National Travel Survey data, 2016). As a consequence, Ireland's transport emissions have been on the rise for three consecutive years. In 2016 the transport sector was the third largest contributor to national greenhouse gas emissions accounting for 20.0% of total emissions. In 2016 the sector emitted 12.3 million tonnes of CO₂ equivalent, a 3.8% increase on 2015 levels. The majority of transport CO₂ emissions arise from road transport; of this in 2016, private car use accounted for 54% with goods vehicles accounting for a further 27% (HGVs: 18.9%; LGVs: 8.2% of these emissions). The other main contributor was fuel tourism (the practice of purchasing fuel in Ireland for use outside the jurisdiction) at 10%.

Figure 2.7 shows the changes in transport emissions between 1990 and 2016; over this period, emissions have increased by 141% from c. 5 million tonnes of CO₂ in 1990 to 12.02 million tonnes in 2016 with emissions peaking in 2007 at 14.2 million tonnes. During this period there was a significant increase in both economic output and car ownership levels. Total annual vehicle kilometres for private cars rose by 15.9% between 2011 and 2016, with car ownership increasing 154% between 1990 and 2016, from c. 800,000 vehicles on the road in 1990 to over 2 million cars.

It is noteworthy that transport CO₂ emissions declined markedly from 2007 to 2012, resulting in a reduction of c. 3.5 Mt. The largest fall in emissions was within the HGV sector, specifically in the construction HGV sector, which accounted for 1.6 Mt or 46% of the overall reduction. A drop in fuel tourism accounted for a further 26% of the total reduction. There was a small reduction in CO₂ emissions from the private car sector over this period (0.27 Mt or 7.7% of the total reduction). Since 2013 CO₂ emissions have been on the rise again and have increased by just under 1 Mt.

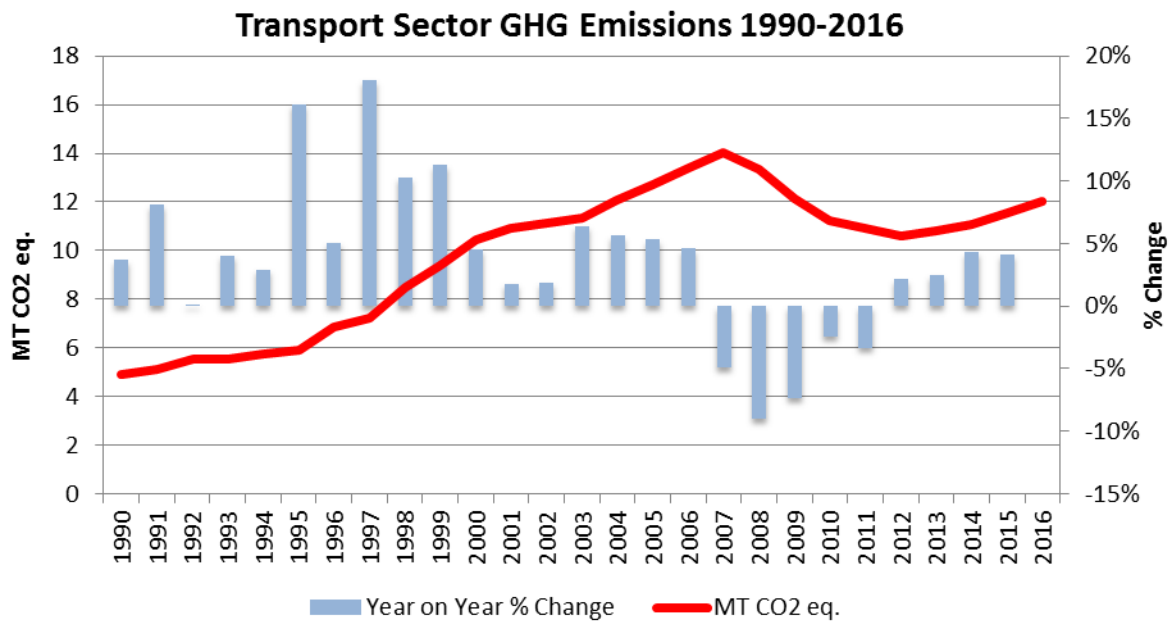


Figure 2.7: Transport Sector Greenhouse Gas Emissions 1990 – 2016

The Irish road network consists of approximately 98,898 km of road and remains the dominant mode of internal transport. Ireland has a higher road density compared to other EU Member States, with 20.9 km per 1000 inhabitants, compared to the mean of 9.5km in the EU28 (European Commission, 2013). This is accounted for by Ireland’s low level population density and highly dispersed spatial settlement patterns.

The total number of licenced private and commercial vehicles in Ireland has grown substantially, by approximately 186%, since 1985; in 2017 approximately 2.67 million vehicles were registered in Ireland with 1.9% annual growth. In terms of fleet composition, 77.2% of licenced vehicles in 2016 were private cars and 13% were goods vehicles, with the remainder including Small Public Service Vehicles , tractors, buses, motorcycles and vintage vehicles. The private car remains the dominant form of transport in Ireland, although modal shares for both car drivers and passengers have decreased slightly – car driver mode share fell from 70.4% in 2012 to 69.4% in 2016. Analysis of the latest Eurostat data (2014) suggests that the level of private car ownership in Ireland is lower than in many other European states. The estimated level of 438 private cars per 1000 inhabitants in Ireland ranks below the average of 22 other EU member states for which data is available, at 466.

Nonetheless, the total number of kilometres driven on the Irish road network continues to show renewed growth following a period of stagnation/small decline, in line with other elements of transport activity. In 2016 total km driven grew to 48.5 billion, of which private car made up 75.6%

with goods vehicles accounting for a further 15.9%. According to National Car Test data the total car kilometres travelled in Ireland increased from 23.1 billion kilometres in 2000 to 36.7 billion in 2016, with an average annual km/private car in 2016 of 18,000km – a 3.6% increase from 2015 and 10.6% increase from 2008 levels.

Goods vehicle kilometre trends show growth from 4.7 billion kilometres in 2000 to a peak of 8 billion kilometres in 2008, followed by a decline to 7.8 billion kilometres in 2016. Goods vehicle demand was impacted strongly by Ireland's economic downturn. Similarly, the level of road freight activity in Ireland decreased sharply after 2007 but is increasing again. In 2016, there were 98,656 goods vehicles (over 2 tonnes unladen weight) on the roads; this represented an increase of 13.3% on 2015. The number of larger vehicles over 10 tonnes unladen weight grew by 18.1% in 2016. Vehicles over 10 tonnes unladen weight accounted for one fifth of the overall fleet in 2016, but carried the majority of road freight activity, accounting for 54.3% of all laden journeys, 86.7% of tonnes carried and 88.4% of tonne-kilometres. Road freight activity (measured by total road freight tonne-kilometres) increased from 12.3 billion tonne-km in 2000 to 18.7 billion in 2007 and then decreased to 9.7 billion in 2015. In recent years road freight activity is gradually growing but at a slower rate than overall economic growth; activity levels reached 11.5 billion tonne-km in 2016, close to the 2009 level of 12.0 billion tonne-kilometres but considerably below the 2007 peak. Rail freight quantities are comparatively small and have declined starkly over recent decades from 3.4 million tonnes in 1985 to 581,000 tonnes in 2016.

The total number of passengers travelling on public transport services has grown each year since 2013. In 2017, the number of passengers using public transport increased to 251 million, a 7% increase since 2016. According to the 2016 census figures public transport accounts for 5.5% of all journeys taken nationwide. Bus services make up the largest part of Ireland's public transport system, accounting for 4.2% of total journeys in 2016 or 31.9 million passengers – an increase of 1.7 million passengers, or 5.5% on 2015 figures. Similarly, the total number of heavy rail passengers has experienced renewed growth in recent years from 36.7 million in 2013 to 45.5 million in 2017. The light rail network has displayed relatively consistent annual growth in passengers since its introduction in 2004, accounting for 37.6 million passengers in 2017 – a 10.26% increase on 2016 levels.

The level of bus service provision has increased after declines in both vehicle kilometres and vehicle seat kilometres from 2010 to 2013 and likewise heavy rail vehicle seat kilometres also increased

from 2014 to 2015 after several years of decline; thus, while the level of road and rail infrastructure in place in Ireland has remained constant, the quantity of land transport services available to the public has increased. Emissions from public transport follow the familiar trend, peaking in 2008 at over 770 kilotonnes of CO₂ followed by a steady but slowing decrease to 2015. Public transport emissions only accounted for an estimated 4.4% of total land transport emissions in 2016. The majority of these emissions (3.3%) arise from bus, coach and taxi journeys. The rail sector accounts for the remaining 1.1%.

2.8 Industrial Profile

The industry sector in Ireland is a significant energy user, accounting for 24% or 3,480 ktoe of Ireland's primary energy demand in 2016. However, Ireland's industry sector is not energy intensive and indeed its energy intensity has reduced by 82% since 1990, with the economic value of industrial output increasing by 707% between 1990 and 2016 while energy consumption increased by just 42%.

The 2017 report Energy in Ireland 1990-2016 outlines recent developments in energy use in the industrial and commercial sectors.⁹

2.8.1 Key Trends

In 2016, final energy use in industry grew 3.0% to 2.4 Mtoe while the economic activity of industry increased by 2.7%. In 2016 consumption of all fuel experienced growth except for renewables, which fell by 2.9% to 173 ktoe, and non-renewable wastes which fell by 5.2% to 42 ktoe. Natural gas had the largest share of direct fuel use at 31% or 762 ktoe, and its use in industry increased by 3.9% in 2016. Oil use increased by 4.3% and accounted for just under one fifth of industry's energy use at 484 ktoe. Coal use grew by 3.7% and accounted for just 4.4% of the energy share of industry. Non-renewable wastes accounted for 1.6% of industrial energy use and fell by 3.4% in 2015.

Electricity consumption in industry increased by 3% to 872 ktoe and accounted for 36% of industry's final energy use.

⁹ Energy in Ireland 1990-2016: <https://www.seai.ie/resources/publications/Energy-in-Ireland-1990-2016-Full-report.pdf>

2.8.2 Trends 2005 - 2016

Final energy use in industry grew by 42% to 2,445 ktoe over the period 2005 – 2016. Between 2006 and 2009 there was an 18% fall in industrial final energy use. Following a small increase in 2010 of 2.8%, consumption in industry fell until 2012. Energy use in industry increased by 11.7% since 2013. In 2016 it increased by 1.6%.

Figure 2.9: Industry Final Energy Use by Fuel shows that over the period 1990 – 2016 only electricity, natural gas and renewables have increased their share. Since 2009 non-renewable wastes have been used in industry, but in 2016 accounted for just 1.7% of industry’s energy use. The share of electricity has risen from 22% to 36%, natural gas from 21% to 31% and renewables from 3.7% to 7.1%. The increase in renewables is mainly due to the use of biomass in the wood processing industry, the use of tallow in the rendering industry and the use of the renewable portion of wastes in cement manufacturing.

Direct use of fossil fuels accounted for 56% of energy use in industry in 2016 and grew by 4.0% in 2016 or 6.9% over the period 1990 – 2016. So, while coal and oil consumption in industry have fallen over the period by 49% and 30% respectively, overall fossil fuel use has grown due to the 113% increase in natural gas use. This change in fuel mix resulted in lower emissions from fuel use in industry.

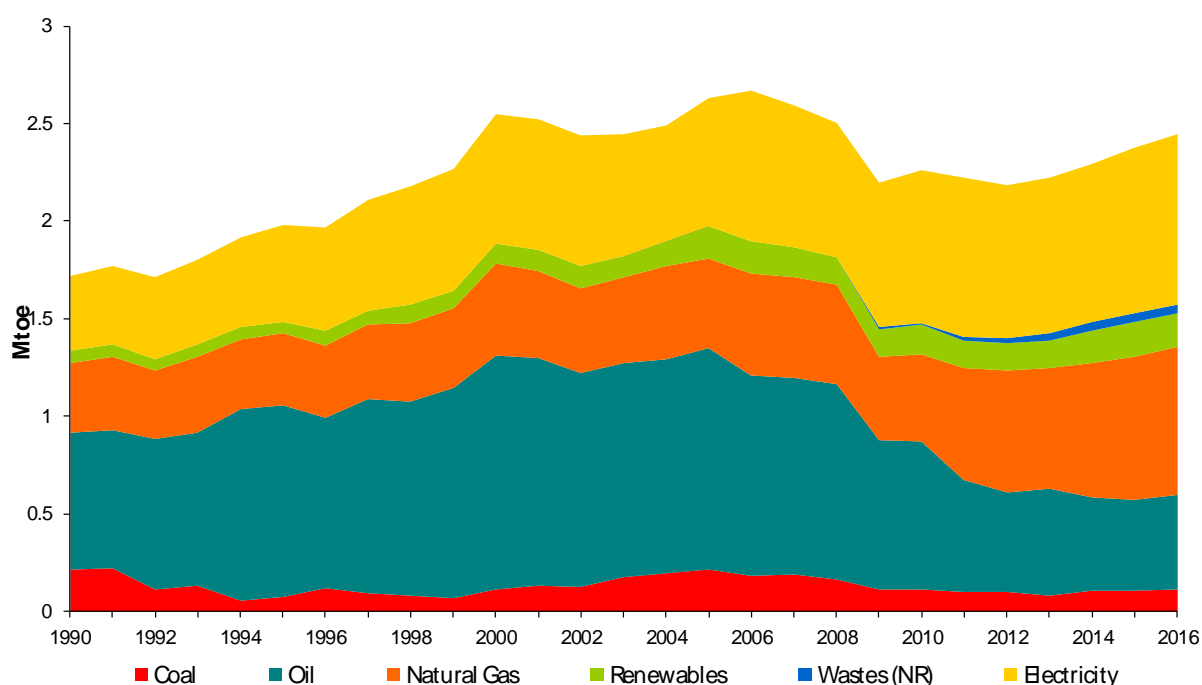


Figure 2.9: Industry Final Energy Use by Fuel

2.9 Waste

2.9.1 National waste management and Greenhouse Gas

In terms of waste management, the largest contributor to methane emissions in Ireland is the landfilling of Municipal Solid Waste (MSW). Municipal Solid Waste consists of three main elements - household, commercial (including non-process industrial waste), and street cleansing waste (e.g. street sweepings, street bins and municipal parks and cemeteries maintenance waste). The biodegradable element of Municipal Solid Waste (Biodegradable Municipal Waste - BMW) primarily responsible for methane emissions consists of organic materials such as food and kitchen waste from households, caterers, restaurants and retail premises, as well as bio-degradable garden and park waste.

Methane may, if not properly managed, be emitted from landfill sites as fugitive emissions, a process affected by the local weather conditions (humidity and climate). A simple model may divide the landfill process into three steps:

1. During the initial active phase, the degradable portion of the landfilled waste undergoes both aerobic and anaerobic degradation; as the landfill is not sealed during this phase both methane and biogenic carbon dioxide are emitted;
2. Once the landfill has been sealed, the 'methanogenic' phase takes place and the landfill gas contains greater quantities of methane than in the first phase;
3. Finally, as different types of carbon degrade at different rates (sugars and fat degrade relatively quickly, while cellulose degrades more slowly) and there is very little degradation of lignin products (contained in wood) in landfill, these materials may not degrade appreciably even over much longer time periods.

The decrease of methane emissions from Waste reduced as a percentage share of total methane emissions over the period 1990 to 2011 as a result of improved management of landfill facilities, including increased recovery of landfill gas utilised for electricity generation and flaring. According to the EPA report- '*Ireland's Environment- An Assessment 2016*' the waste sector in 2014 accounted for 2.1% of total national Greenhouse Gas Emissions.¹⁰

¹⁰ See Pg. 44 of '*Ireland's Environment - An Assessment 2016*' here: <http://www.epa.ie/ebooks/soe2016/index.html#48>

Notwithstanding the above, national and regional waste policy are all predicated on the management of waste in line with the waste hierarchy, whereby the prevention, preparation for re-use, recycling and other recovery of waste are preferred (in that order) to the disposal of waste (in Ireland disposal means the landfilling of waste). In effect, national waste policy seeks to (i) limit the overall amount of Municipal Solid Waste going to landfill (which in turn reduces Biodegradable Municipal Waste to landfill); and (ii) reduce the share of biodegradable material which is present in the Municipal Solid Waste which does go to landfill (and divert Biodegradable Municipal Waste to more sustainable treatment such as anaerobic digestion and composting).

There are a number of reasons for seeking to reduce landfill as much as possible including:

- Its impact on the environment from emissions of leachate (polluting water tables) and methane gas (greenhouse gas); and
- The lost economic opportunity of burying material in the ground as opposed to reusing / recycling or recovering energy from it.

2.9.2 Trends in Municipal Solid Waste to Landfill

The implementation of national and regional waste management policy has meant that the landfill of Municipal Solid Waste (MSW) has decreased from 92% in 1995 to 21% in 2014. This also reflects the increase in recycling and recovery of MSW from 8% in 1995 to 79% in 2014.¹¹

Diversion of municipal waste from landfill has been increasing for the following reasons:

- Increases in the landfill levy for disposal of waste to landfill;
- Requirements to divert biodegradable municipal waste from disposal to landfill under the landfill Directive targets;
- Capacity for incineration of municipal waste at Ireland's first municipal waste incinerator;
- Increasing mechanical treatment of residual waste at waste facilities, leading to the production of refuse derived fuel/solid recovered fuel which is used as a fuel both in Ireland and abroad. Organic fines arising from the mechanical treatment of residual waste can be bio-stabilised, and are generally recovered via backfill at landfill.

¹¹ EPA National Waste Report 1995 can be found here:
http://www.epa.ie/pubs/reports/waste/stats/EPA_National_Waste_Report_19952.pdf
EPA National Waste Statistics can be found here:
<http://www.epa.ie/nationalwastestatistics/municipal/>

In addition, Ireland's first MSW waste to energy facility came into operation in 2011 and now treats 211,000 tonnes of Municipal Solid Waste per annum. A second waste to energy facility treated waste for the first time on 1 June, 2017 as part of its commissioning phase. It is now fully operational and will treat up to 600,000 tonnes of Municipal Solid Waste per annum.

Ireland's cement industry continues to steadily increase the amount of Solid Recovered Fuel (SRF) co-incinerated in the production of cement, estimated to be in the region of 226,000 tonnes for 2017. This process not only recovers energy from Municipal Solid Waste, but also decreases our reliance on importing fossil fuels. Waste Management Plans published in 2015 indicate a need for up to 300,000 tonnes of additional thermal treatment capacity for residual Municipal Solid Waste within the State.

However, a confluence of events in 2015 and 2016 (principally a delay in certain infrastructure coming on stream and access to suitable export markets being difficult) saw an increase in the overall amount of Municipal Solid Waste landfilled, bucking the trend of previous years.

Notwithstanding the above, disposal to landfill of Municipal Solid Waste is estimated to decrease significantly over the period 2018 to 2021. The number of landfills accepting Municipal Solid Waste has decreased from twenty-five in 2010 to five in 2017 and this is likely to decrease to four during 2018.

2.9.3 Trends in Biodegradable Municipal Waste to Landfill

The Landfill Directive, (1999/31/EC), sets limits on the quantity of Biodegradable Municipal Waste (BMW) that can be disposed to landfill. The limits (tied to 1995 statistical base year) are phased, with each phase having a stricter diversion obligation.

The EPA produces national statistics on waste generation and management to meet legislative reporting obligations and to inform policy. The latest data on Biodegradable Municipal Waste to landfill reports that Ireland met the 2010 and 2013 targets under the Landfill Directive (1999/31/EC).

¹² In July 2016 Ireland notified the Commission of its intention to avail of a four-year derogation (for the 2016 target deadline) which moved the deadline out to 2020. The third and final target (maximum quantity of 427,000 tonnes of Biodegradable Municipal Waste landfilled) was actually

¹² EPA publication on Biodegradable Municipal Waste Statistics can be found here: http://www.epa.ie/pubs/reports/waste/stats/bmwwaste/EPA_BMW_2013-16_data_release_web.pdf

met in 2016 (390,000 tonnes disposed) although, with the derogation in place, this target is not in force until 2020.

2.10 Building Stock and Urban Structure

The 2016 Census results show a total of 2,003,645 houses and apartments in Ireland. Of these, 1,697,665 were occupied by persons usually resident in the State. The census showed considerable slowdown in housing stock growth since 2011. The total housing stock grew by just 8,800 (0.4%) between 2011 and 2016, in sharp contrast to the growth of 225,232 dwellings recorded between 2006 and 2011.

The SEAI completed a survey of non-residential buildings in 2015.¹³ The total number of commercial buildings is estimated to be around 109,000, of which 82,000 are categorised as either Retail or Office. Central Statistics Office Data for planning permissions show planning permissions for new non-residential buildings increasing from 276 in Q1 2011 to 524 in Q1 2017.

The cumulative number of Building Energy Rating audits carried out since Jan 2009 is 768,788. Overall, Heating Oil and Mains Gas were the two most prevalent main space heating systems accounting for 78% of all dwellings audited (39% each), followed by Electricity at 15%. Due to the implementation of improved Building Regulations 96% of dwellings built since 2010 are "A" or "B" rated.

2.10.1 Energy in the Residential Sector¹⁴

Accounting for weather variations, residential energy demand decreased annually between 2007 and 2012 but grew in both 2015 and 2016. Residential final energy use in 2016 was 2,704 ktoe, 8.0% below that in 2005. Correcting for weather variations 2016 residential final energy use was 10.8% below 2005.

The main driver for increased residential energy consumption is the increase in total floor area of Ireland's housing stock, given that space heating is the dominant end use within the sector. Total floor area of all occupied dwellings increased by 103% between 1990 and 2016. This was as a result

¹³SEAI Insight Paper Extensive survey of the commercial buildings stock in the Republic of Ireland: <https://www.seai.ie/resources/publications/Extensive-Survey-of-Commercial-Buildings-Stock-in-the-Republic-of-Ireland.pdf>

¹⁴ SEAI 2016 Report - 'Energy in Ireland 1990-2015' can be found here: <http://www.seai.ie/resources/publications/Energy-in-Ireland-1990-2015.pdf>

of the total number of dwellings increasing by 74% and the average floor area per dwelling increasing by 17%. The increased number of dwellings is in turn driven by population growth, which increased by 35% between 1990 and 2016, and a reduction in the average number of people per dwelling. The number of people per dwelling fell from 3.3 in 1991 to 2.7 in 2011 but actually increased marginally between 2011 and 2016 due to Ireland's housing crisis. By international standards the average household size in Ireland remains very high, second only in the EU28 to Croatia. The EU countries with the lowest persons per household were Sweden on 1.9 and Germany and Denmark both on 2.0.

Revisions in Ireland's building regulations have also had an impact on residential energy use by significantly improving, over time, the insulation, heating system and overall energy requirements of the new housing stock.¹⁵

2.10.2 Energy Efficiency and Intensity¹⁶

Ireland has an unusual residential fuel mix compared to many EU Member States. The single largest fuel source is oil, accounting for 34% of total residential fuel consumption in 2014. This is due to the fact that a large share of dwellings are in rural areas, have no access to the gas grid and use oil fired boilers for space and water heating. Energy intensity of residential buildings remained relatively constant between 2000 and 2006. From 2007 the average unit consumption declined year on year to an 'average' consumption of 17.9 MWh of energy per dwelling.

This comprised 75% in the form of direct fuels and the remaining 25% as electricity. The decline in fuel consumption to 73% of the 2000 value is the main driver behind the overall reduction in household energy intensity since 2006. Electricity use per dwelling has declined steadily since 2010 to 11% below the 2000 value. Over the period 2000 to 2012 the strongest factor driving growth in residential sector energy use was the increase in the number of dwellings followed by the increase in the average floor area.

Countering these influences was an improvement in energy efficiency and behavioural impacts, which capture the effect of reductions by occupants of comfort levels and fuel expenditure due to economic or other reasons. Energy efficiency in the residential sector improved by 34.7% between

¹⁵ A full list of Irish building regulations and revisions can be found here:

<http://www.housing.gov.ie/housing/building-standards/building-regulations/building-regulations>

¹⁶ SEAI 2016 Report *Energy Efficiency in Ireland* can be found here:

<http://www.seai.ie/resources/publications/Energy-Efficiency-in-Ireland-2016-Report.pdf>

2000 and 2014. The gains in efficiency have mainly been brought about by the improvement in space heating which saw a 39.3% gain with the transition from open fire heating to boilers and central heating and increased insulation levels. This is also linked to the increase in new buildings built to higher standards since 2000 and also to the uptake of retrofit schemes since 2005.

2.10.3 Key Trends in 2016

Residential energy use increased by 1.2% in 2016 relative to 2015. 2016 was milder than 2015 in terms of degree days (6.5% fewer degree days). When corrections for weather effects are taken into account the increase in energy use was 4.8% in 2016 relative to 2015 (see **Table 2.4: Growth Rates, Quantities and Shares of Final Consumption in Residential Sector**). Between 2014 and 2016 residential final energy demand, adjusted for weather variation, increased by 6.5% (annual average growth of 3.2%).

The salient trends in energy use in the residential sector are as follows:

- Overall direct fossil fuel use in households increased by 1.4% to 1,944 ktoe in 2016 and accounted for 72% of household energy use.
- Oil consumption in households increased by 5.1% in 2016, to 1,005 ktoe. The price of oil fell internationally by 47% in 2015 and the price to Irish households fell in the region of 20% at the same time and remained below 2015 levels throughout 2016. Oil's share of household energy stood at 37% in 2016.
- Electricity consumption fell by 0.1% in 2016 to 677 ktoe (7,873 GWh) and its share of residential final consumption was 25%.
- Natural gas usage increased by 1.4% in 2016 to 563 ktoe and accounted for 21% of residential energy use.
- Direct renewables usage in households increased in 2016, growing by 8.8% to 83 ktoe, and its share increased to 3.1%.
- Coal use in households fell in 2016 by 13.3% to 179 ktoe and a 6.6% share of the residential sector energy use.

- Peat usage decreased by 1.9% in 2016 and peat briquette usage fell by 5.1%. Total peat consumption was 197 ktoe in 2016. The peat and briquette share in household energy was 7.3% in 2016.

2.10.4 Trends 1990 – 2016

Residential final energy use grew by 19.7% (0.7% per annum) over the period 1990 – 2016 to a figure of 2,704 ktoe in absolute terms. Corrected for weather the growth was 12.5%. During this time the number of households in the State increased by 75% from approximately 1.0 million to 1.76 million.

Oil remains the dominant fuel in the residential sector, though its share reduced slightly from 39% in 2005 to 37% in 2016. Electricity was the second most dominant energy form in the sector in 2016 at 25%, with natural gas having the next largest share at 21%. The renewables share of final energy used directly in households in 2016 was 3.1%. The growth rates, quantities and shares are shown in **Table 2.4**.

Figure 2.10: Residential Final Energy Use by Fuel shows significant changes in the mix of fuels consumed in the residential sector over the period. Looking at the period 2007 to 2014, overall weather corrected residential energy use declined by 18% or 556 ktoe. The majority of the reduction was from oil which fell by 28% or 334 ktoe, followed by gas which fell by 17% or 106 ktoe. A number of factors contribute to this reduction: the higher oil price and the significant increase in oil price, relative to gas, in the period 2010 to 2015; potentially there are greater opportunity for fuel switching to peat and non-traded wood in rural areas, where the majority of oil fired dwellings are located.

It is also notable that total electricity consumption peaked in 2008 and has reduced slightly to 2016, having more than doubled between 1990 and 2016 and in spite of the continued growth in population and number of dwellings.

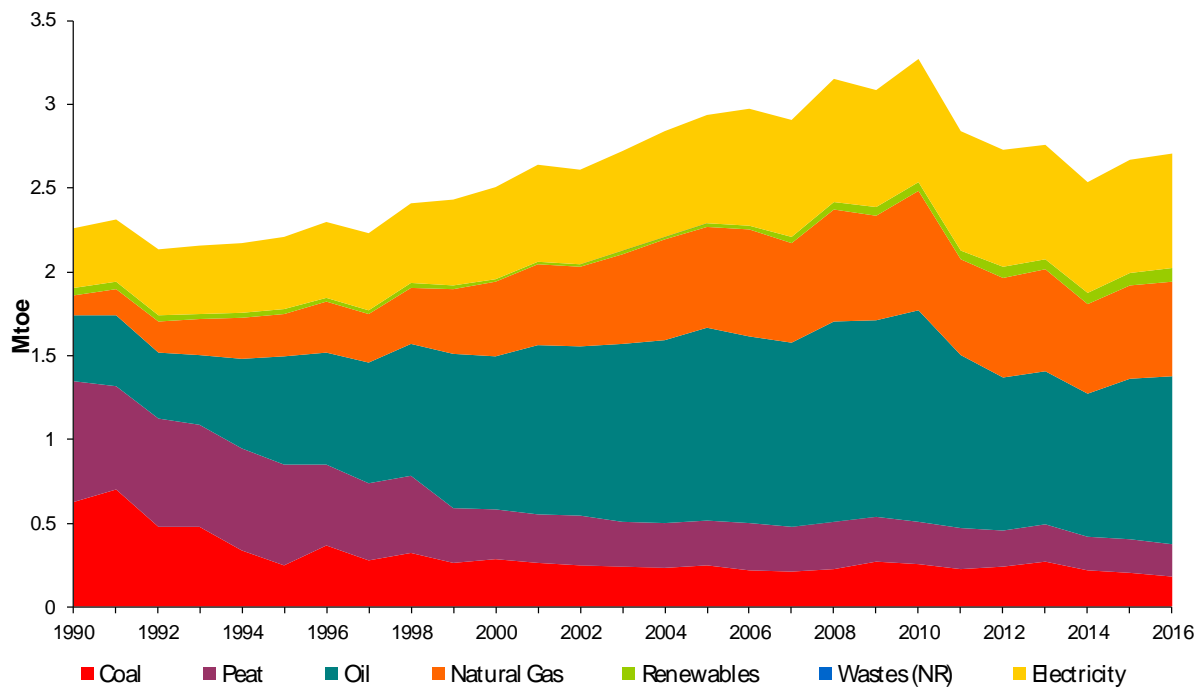


Figure 2.10: Residential Final Energy Use by Fuel

Central heating systems are generally more energy efficient than individual room heating appliances, so for a given level of space heating, less energy use would be expected. On the other hand, a considerable increase in the level of comfort, in the form of higher temperatures and a move towards whole house heating, is often associated with the introduction of central heating.

The increase in electricity usage in households may in part be explained by an increase in the use of domestic appliances: washing machines, driers, dishwashers, microwave ovens, computers, televisions, games consoles.

Table 2.4: Growth Rates, Quantities and Shares of Final Consumption in Residential Sector

	Overall Growth %		Average annual growth %			Quantity (ktoe)		Shares %	
	1990 – 2016	2005 – 2016	'05 – '16	'10 – '16	2016	2005	2016	2005	2016
Fossil Fuels (Total)	4.6	-14.4	-1.4	-4.0	1.4	2,271	1,944	77.3	71.9
- Coal	-71.4	-27.3	-2.9	-5.7	-13.3	246	179	8.4	6.6
- Peat	-72.8	-27.9	-2.9	-4.1	-1.9	273	197	9.3	7.3
* Briquettes	-55.4	-23.4	-2.4	-3.9	-5.1	90	69	3.1	2.6
- Oil	158.1	-12.2	-1.2	-3.7	5.1	1,145	1,005	39.0	37.2
- Gas	380.1	-7.2	-0.7	-3.8	1.4	607	563	20.6	20.8
Renewables	86.1	266.0	12.5	7.4	8.8	23	83	0.8	3.1
Combustible Fuels (Total)	3.9	-13.6	-1.3	-3.9	1.3	2,287	1,976	77.8	73.1
Electricity	90.1	4.8	0.4	-1.4	-0.1	646	677	22.0	25.0
Total	19.7	-8.0	-0.8	-3.1	1.2	2,940	2,704		
Total Weather Corrected	12.5	-10.8	-1.0	-1.2	4.8	2,998	2,675		

2.10.5 Energy-related CO₂ Emissions – including emissions associated with electricity

In order to determine total energy-related CO₂ emissions from the residential sector, it is necessary to view electricity on a primary energy basis, i.e. the fuels required to generate the electricity consumed by households. There was a reduction in energy related CO₂ emissions between 2010 and 2014, but there was a return to growth in CO₂ emissions in 2015 and again in 2016. Over the period 1990 – 2016 energy-related CO₂ emissions from the residential sector fell by 10% while those in transport, industry and services rose, respectively, by 142%, 11%, and 9.7%. In 2016 residential sector energy-related CO₂ emissions (including upstream electricity emissions) were 9,690 kt CO₂, representing 24% of the total energy-related CO₂ emissions. The residential sector total was the second largest source of CO₂ emissions after transport, which accounts for 37%.

2.10.6 Energy-related CO₂ Emissions – excluding emissions associated with electricity

If upstream emissions associated with electricity use are excluded, the CO₂ emissions from direct fossil fuel use in the residential sector in 2016 were 16.5% lower than in 1990 and 16.7% lower than in 2005. This was achieved through a combination of less carbon intensive fuel mix and a reduction in overall energy usage post 2010. Excluding upstream electricity emissions, direct CO₂ emissions from the household sector were 5,889 kt and were 0.3% higher in 2016 compared with 2015.

The residential sector is examined in more detail with respect to energy-related CO₂ emissions in **Figure 2.11** where a relatively constant or flat overall trend can be seen until 2010, which becomes a reducing trend after that year.

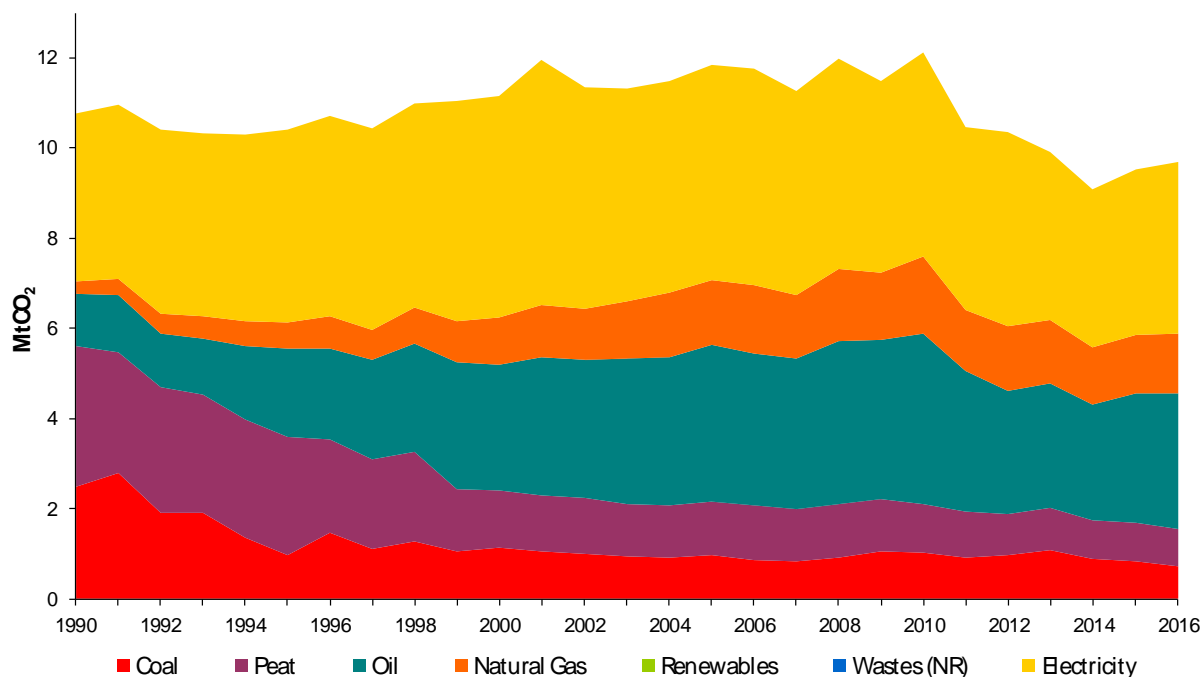


Figure 2.11: Residential Energy-Related CO₂ by Fuel

Table 2.5: Growth Rates, Quantities and Shares of Energy-Related CO₂ Emissions in Residential Sector

	Overall Growth %		Average annual growth %			Quantity (kt CO ₂)		Shares %	
	1990 – 2016	2005 – 2016	'05 – '16	'10 – '16	2016	2005	2016	2005	2016
- Coal	-71.0	-27.1	-2.8	-5.6	-13.2	989	721	8.4	7.4
- Peat	-73.0	-28.0	-2.9	-4.1	-1.8	1,170	842	9.9	8.7
* Briquettes	-55.4	-23.4	-2.4	-3.9	-5.1	374	286	3.2	3.0
- Oil	156.0	-13.2	-1.3	-3.8	5.1	3,467	3,008	29.3	31.0
- Gas	388.2	-8.8	-0.8	-4.1	-0.5	1,443	1,317	12.2	13.6
Renewables	-	-	-	-	-	-	-	0.0	0.0
Combustible Fuels (Total)	-16.5	-16.7	-1.6	-4.2	0.3	7,069	5,889	59.7	60.8
Electricity	2.4	-20.4	-2.0	-2.9	3.7	4,773	3,801	40.3	39.2
Total	-10.0	-18.2	-1.8	-3.7	1.6	11,843	9,690		

2.10.7 Energy-related CO₂ Emissions per Dwelling

The emissions of energy-related CO₂ per dwelling fell by 34% over the period 2005 – 2016 while the reduction for unit energy use was 26% – see Table 2.6 and **Figure 2.11**. In 2016 the average dwelling was responsible for emitting 5.5 tonnes of energy-related CO₂. A total of 3.3 tonnes CO₂ (61%) came from direct fuel use in the home and the remainder indirectly from electricity use.

Energy related CO₂ emissions per dwelling for direct non-electric fuel use fell by 33% between 2005 and 2016, primarily as a result of reduced energy consumption per dwelling. CO₂ emissions from electricity use reduced by 36% in the same time period due to a combination of reduced electricity use and reduced carbon intensity of the electricity grid. The carbon intensity of grid electricity has improved since 2002 when high-efficiency CCGT (Combined Cycle Gas Turbine) plants were brought online and because of the growing contribution of renewables in electricity generation.

Emissions from energy use in households increased by 1% in 2016, mainly as a result of increased CO₂ intensity of electricity supplied and also increased oil consumption.

Table 2.6: Growth Rates and Quantities of Residential Unit Energy Consumption and Unit CO₂ Emissions

	Overall Growth %		Average annual growth %			Quantity (kWh/dwelling)	
	1990 – 2016	2005 – 2016	'05 – '16	'10 – '16	2016	2005	2016
Unit Energy Consumption							
Total Energy	-31.4	-25.9	-2.7	-4.1	0.6	24,129	17,883
Fuel Energy	-38.9	-28.8	-3.0	-4.6	1.0	18,827	13,405
Electrical Energy	8.9	-15.6	-1.5	-2.3	-0.7	5,302	4,478
Unit Energy Consumption Weather Corrected						Quantity (kWh/dwelling)	
Total Energy Weather Corrected	-35.5	-28.1	-3.0	-2.6	4.2	24,608	17,691
Fuel Energy Weather Corrected	-43.2	-31.4	-3.4	-2.7	5.6	19,286	13,223
Electrical Energy Weather Corrected	7.7	-16.0	-1.6	-2.4	0.0	5,322	4,468
Unit Energy-Related CO₂ Emissions						Quantity (tCO₂/dwelling)	
Total Energy CO ₂	-48.4	-34.1	-3.7	-4.6	1.0	8.4	5.5
Fuel CO ₂	-52.2	-32.9	-3.6	-5.1	-0.3	5.0	3.3
Electricity CO ₂	-41.3	-35.8	-4.0	-3.8	3.1	3.4	2.2

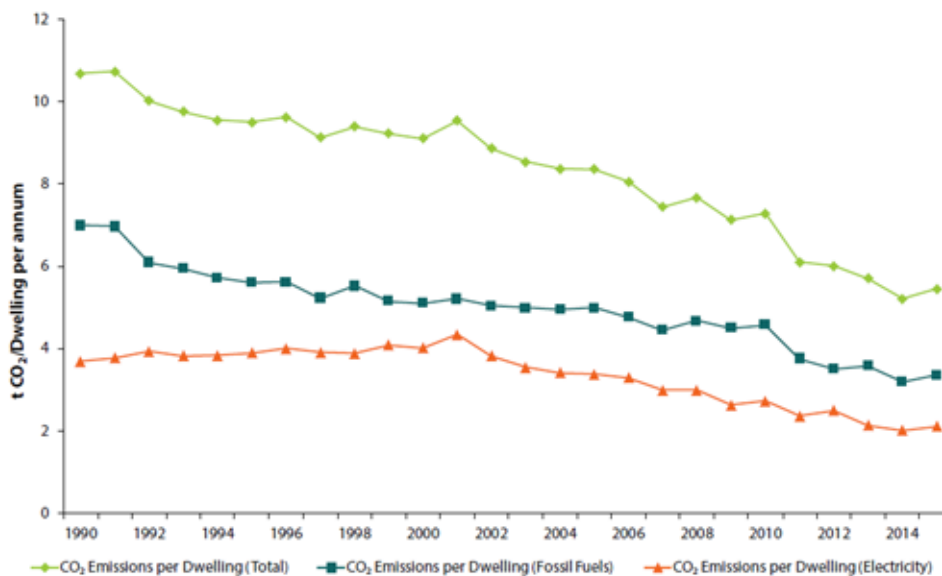


Figure 2.12: Unit Energy-Related CO₂ Emissions per Dwelling

2.11 Land-use

2.11.1 Agriculture

Agricultural Profile

Ireland has a land area of 6.9 million hectares, of which 4.5 million hectares, or about 65%, is used for agriculture. Ireland’s national forest estate covers 750,000 hectares (end of 2015), or close to 11% of the land.¹⁷ Some 81% of agricultural land is devoted to grass (silage, hay and pasture), 11% to rough grazing (0.47 million hectares) and 8% to crops, fruit and horticulture production (0.38 million hectares).¹⁸ Beef and milk production currently account for 68% of agricultural output at producer prices. The average farm size is now around 32.5 hectares.

¹⁷ See National Mitigation Plan (2017) from the Department of Communications, Climate Action & Environment here: <https://www.dccae.gov.ie/documents/National%20Mitigation%20Plan%202017.pdf>

¹⁸ See Department of Agriculture Food and Marine (2017) Fact Sheet on Irish Agriculture here: <https://www.agriculture.gov.ie/media/migration/publications/2016/FactsheetIrishAgriculture180117290517.pdf>

The agri-food sector is Ireland’s largest indigenous manufacturing industry, with total agri-food employment, including on-farm employment in primary agriculture, forestry and fishing, as well as the food processing industry, accounting for over 165,700 jobs.

The most recent data available shows the agri-food sector accounting for 7.6% of Gross Value Added (2014), 23% of all manufacturing turnover (2014), 8.4% of employment (2015) and 10.7% of merchandise exports (2015). Ireland’s livestock numbers in June 2015 included 6.9 million cattle, 5.1 million sheep and 1.5 million pigs which represents peak annual numbers as the December census is generally lower due to a predominantly grassland based production.

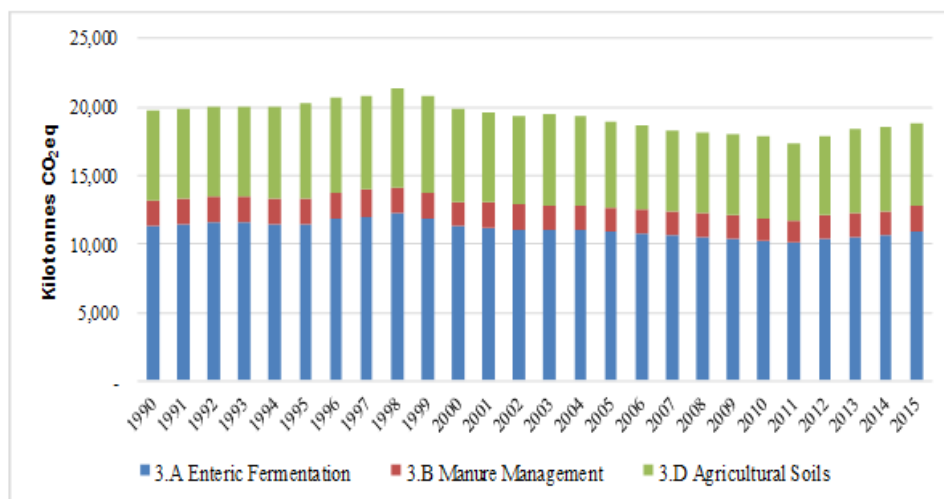


Figure 2.13: Agricultural Emissions

Methane (CH₄)

Methane emissions from Enteric Fermentation and Manure Management are due to the type and number of livestock present on farms and in Ireland’s case, the amounts are largely determined by a large cattle population. The combined total of emissions of CH₄ from enteric fermentation and manure management expressed in CO₂ equivalents was 12,699.26 kt in 1990. This increased by 7.1 % to reach 13,604.77 kt CO₂ equivalents in 1998 and subsequently decreased by 17.5% to 11,221.80 kt CO₂ equivalents in 2011, gradually increasing again to 12,221.04 kt CO₂ equivalent in 2015. Cattle accounted for 90.9 % of CH₄ emissions in Irish agriculture in 2015.

Nitrous Oxide N₂O

The emissions of N₂O from the Agriculture sector follow similar trends to those of CH₄ because cattle also largely determine the amount of nitrogen inputs to agricultural soils from synthetic fertiliser and

animal manures, which produce the bulk of N₂O emissions (87.3 % of the sector N₂O emissions in 2015). Nitrous oxide emissions in the sector increased from 7,046.06 kt CO₂ equivalent in 1990 by 10.0 % in the period 1990-1998 with emissions in 1998 totalling 7,752.32 kt CO₂ equivalent.

Nitrous oxide emissions totalling 6,585.50 kt CO₂ equivalent in 2015 represented a reduction of 15.1% on the 1998 level and 6.5% on the 1990 level. Emissions from crop residues, mineralisation/immobilization associated with loss/gain of soil organic matter and the cultivation of organic soils account for the remainder of agricultural N₂O emissions in Ireland.

2.11.2 Forestry

Since the 1920s, when forest cover in Ireland had fallen to 1%, a series of national afforestation programmes resulted in an increase in forests to 10.5% of the land area of the country (or 731,652 ha) by 2012, according to the latest available national forest inventory data. In particular, the period from 1990 to present has seen a significant expansion of forest cover through the introduction of annual payments to landowners, for a limited period, to compensate for lost agricultural income. Between 2012 and 2016, an average of 6,400 ha has been planted per annum.¹⁹ Despite these efforts, forest cover is still quite low when compared with the rest of Europe, where the average is 42%. Most of the current forest comprises commercial plantations, while it is estimated that there are 85,000 ha of native woodland remaining, a considerable portion of which is now in national parks. The afforestation programme has also resulted in a significant change to the ownership structure of Irish forests; approximately 50% of the national estate is now privately owned.

The acceleration of the afforestation programme over the last quarter of a century, coupled with high levels of reforestation, has resulted in three quarters of the national estate being less than 30 years old. Roundwood harvest has been steadily increasing over the past decade as the private estate has matured. In 2016 it reached 3.4 million cubic metres and was primarily used as feedstock for sawn wood and panel products, and fuelwood. The majority of the sawn wood and panel-board output is exported; Ireland is now a net exporter of both product categories. Usage of wood fuels is also increasing due to renewable energy policies and an increase in the supply of forest based biomass, particularly from timber processing and forest harvesting residues. Over a third of the forest harvest is used for energy purposes, with a significant portion stemming from processing residues and used within the forest products industry itself. In 2016, the use of wood fuel, primarily

for heat purposes, is estimated to have resulted in over 700,000 million tonnes of CO₂ emissions being abated.²⁰

Roundwood production is forecast to more than double, to 8 million cubic metres, by 2035 as the estate matures. Use of this expanded harvest in long-lived wood products and as a renewable fuel will extend the contribution of the forest sector to climate change mitigation. Sustaining harvest levels and climate change mitigation will require the continued expansion of forest cover to mid-century and possibly beyond.

There is a close liaison between the Forest Service and environmental and planning agencies in the regulation of afforestation and other forestry practices. Ireland operates a licencing system for wood harvesting. Afforestation must be approved by the Forest Service of the Department of Agriculture, Food and the Marine. A forest policy review “Forests, products and people- Ireland's forest policy- a renewed vision” was published in 2014, which continues to emphasise the climate change mitigation benefits of the forest sector, through both afforestation and the sustainable use of harvested wood products.²¹

Climate change mitigation and the forest sector

The afforestation programme plays an important role in mitigating climate change by creating new land based sinks for carbon dioxide, and providing a source of renewable raw materials for use as fuel and wood products. Given the high levels of afforestation since 1990 the average rate of sequestration in those forests over the first commitment period of the Kyoto Protocol was 3.22 Mt CO₂ per annum, net of deforestation. Current afforestation will have little effect on levels of sequestration during the second commitment period 2013-2020, because forests grow relatively slowly as they establish themselves over the first five years or so.

However, the long term (2021-2030) projected average sequestration rates for afforested, reforested and deforested lands (ARD activities as used in the Kyoto Protocol) will increase to 4.45

²¹ Forest policy review “Forests, products and people- Ireland's forest policy- a renewed vision” can be found here: <https://www.agriculture.gov.ie/media/migration/forestry/forestpolicyreviewforestsproductsandpeople/00487%20Forestry%20Review%20-%20web%202022.7.14.pdf>

Mt CO₂ equivalent per annum due to the increased productivity in older age class forests and storage of carbon in harvested wood products.²²

In contrast to afforested areas, forests established before 1990 are estimated to sequester a lower average rate of 0.142 Mt CO₂eq per annum for the second commitment period. It is expected that management of areas established before 1990 will result in an average net emission of 2.25 Mt CO₂eq per annum for the period 2021-2030. This is due to a shift in the age class structure towards younger, less productive forests, as a result of harvesting activities.²³

The total carbon stock in forest biomass and deadwood pools (excluding soil carbon) is estimated to be circa 58 Mt of CO₂ in 2012. Forest soils represent a very significant carbon pool; current estimates are that the total carbon stock in forest soils is in the region of 323 million tonnes of CO₂.²⁴ The carbon stored in HWP is estimated to be 6.9Mt C by 2015.²⁵

2.11.3 Peatlands

Peat soils cover around 21%, or 1.47 million hectares, of Ireland's land area and are either privately or publicly owned.²⁶ Peatlands include bogs and fens and all peat soils currently in use for agriculture and forestry purposes. It is estimated that Irish peatlands store some 1,566 million tonnes of carbon, which represents approximately 64% of the total carbon stock present in Ireland.

Greenhouse gas emissions and sinks associated with human intervention of peatlands are reported under the UNFCCC under three IPCC land use categories: Wetlands, Forest land and Grassland, and identified through analysis of land cover and the specific land declared by land managers. Peatland

²² EC decision 529 2013 submission by Ireland can be found here: <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:32013D0529>

²³ Black, K., Hendrick, E., Gallagher, G., Farrington, P. (2012). Establishment of Ireland's projected reference level for Forest Management for the period 2013-2020 under Article 3.4 of the Kyoto Protocol. Irish Forestry 69: 7-32

²⁴ EC decision 529 2013 submission by Ireland can be found here: <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:32013D0529>

²⁵ National Forest Inventory - Results Covering the National Forest Inventory, 2009-2012 can be found here: <https://www.agriculture.gov.ie/media/migration/forestry/nationalforestinventory/2012/Forest%20Inventory%20Main%20Findings.pdf>

²⁶ *Managing Ireland's Peatlands, A National Peatlands Strategy (2015)* can be found here: <https://www.npws.ie/sites/default/files/publications/pdf/NationalPeatlandsStrategy2015EnglishVers.pdf>

under forest and grass are assumed to be subject to artificial drainage and carbon losses are estimated using IPCC default methodologies.

Peatlands within the Wetlands category are dominated by the area of degraded and pristine peatland ecosystems. It is estimated that at least 74% of these lands exist in a degraded condition, with some estimates of greater than 90%, which is a legacy of traditional methods of peat extraction which peaked during the 1920s and 1940s. These degraded peatlands have largely reverted to ecosystem classes which resemble pristine peatlands but with disturbed patterns of biodiversity, a much reduced resilience and carbon sequestration potential. In recent years traditional practices have been replaced by mechanised methods of extraction, nevertheless use of peat for residential heating has declined steadily since 1990.

Commercial industrial peat extraction occurs on approximately 80kha of Irish land. The semi-state company, Bord na Móna dominates activity in this sector. Bord na Móna completed its acquisition of lands in the early 1980s, at which time it began its operational drainage of lands intended for peat extraction. Bord na Móna will cease commercial extraction on its lands over the next two decades and is currently developing a long term strategy for environmentally sensitive management of its resources.

Ireland will consider the recently accepted 2013 Supplement to the IPCC 2006 guidance for inventories in the context of on-going research into greenhouse gas emissions and sinks, country specific conditions, the development of inventory methodologies and potential reporting under Article 3.4 activity Wetlands Drainage and Rewetting.

3. Greenhouse Gas Inventory Information

3.1 Introduction

This Chapter outlines the process by which Ireland's emissions are measured and reported. It explains the rationale behind the methodologies used and gives detailed information on emissions and trends over the period 1990 to 2015.

The Environmental Protection Agency has overall responsibility for the national greenhouse gas inventory in Ireland's national system of recording emissions. This was established in 2007 under Article 5 of the Kyoto Protocol. The Office of Environmental Sustainability (OES) in the EPA performs the role of inventory agency in Ireland and undertakes all aspects of inventory preparation and management as well as the reporting of Ireland's submissions annually in accordance with the requirements Regulation (EU) [No. 525/2013](#)²⁷ of the European Parliament and of the Council and the UNFCCC.

The national greenhouse gas inventory is compiled following the reporting guidelines²⁸ on annual inventories adopted by the United Nations Framework Convention on Climate Change (UNFCCC) which describes the scope and reporting of greenhouse gas emission inventories by Parties included in Annex I to the Convention. The inventory is compiled on an annual basis and submitted each January to the European Commission in accordance with Regulation No.525/2013 and to the UNFCCC Secretariat by the 15th April deadline. The National Inventory Report 2017²⁹ (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 2015.

The complete inventory currently comprises a time series from 1990 to 2015 for carbon dioxide (CO₂), methane (CH₄) nitrous oxide (N₂O) and for the fluorinated or F-gases (HFCs, PFCs, SF₆ and NF₃) – the year 1995 has been chosen as the base year for the fluorinated gases for obligations under the

²⁷ REGULATION (EU) No 525/2013 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 21 May 2013 on a mechanism for monitoring and reporting greenhouse gas emissions and for reporting other information at national and Union level relevant to climate change and repealing Decision No 280/2004/EC

²⁸ Decision 24/CP.19 Revision of UNFCCC reporting guidelines on annual inventories for Parties included in Annex I of the Convention ([FCCC/CP/2013/10/Add.3](#))

²⁹ [Ireland National Inventory Report 2017](#)

Kyoto Protocol. Summary tables showing emissions by gases and sector for the full time series are presented in **Annex 1** at the end of this Chapter. The greenhouse gas inventory data outlined in this report was submitted to the UNFCCC on the 12th of April 2017.

3.1.1 Overview of National emissions

In 2015, total emissions of greenhouse gases including indirect emissions from solvent use (without LULUCF) in Ireland were 59,878.21 kt CO₂ equivalent, which is 6.7% higher than emissions in 1990. Total greenhouse gas emissions excluding indirect emissions from solvent use, reported in the Industrial Processes and Product Use (IPPU) sector, in Ireland were 59,797.96 kt CO₂ equivalent. The total for 2015 is 15.8% lower than the peak of 71,124.17 kt CO₂ equivalent in 2001 when emissions reached a maximum following a period of unprecedented economic growth.

The Energy sector accounted for 61.0% of total emissions in 2015, Agriculture contributed 32.1% while a further 5.2% emanated from Industrial Processes and Product Use and 1.6% was due to Waste. Emissions of CO₂ accounted for 64.1% of the national total in 2015, with CH₄ and N₂O contributing 22.2% and 11.8%, respectively. The combined emissions of HFC, PFC, SF₆ and NF₃ accounted for 1.9% of total emissions in 2015. Trends of greenhouse gas emissions by sector and gas are presented in Figures 3.1 and 3.2.

Fuel combustion in the Energy sector is the principal source of emissions in Ireland and major increases in fuel use have driven the increase in emissions in the 1990-2015 time-series. The largest increase took place in transport with an increase of 130.3% on 1990 levels, while there were decreases of 4.2 and 4.6% from the Industrial Processes and Product Use and Agriculture sectors respectively. As the emissions from Energy increased, the contribution of Agriculture to total national emissions decreased from 35.9% in 1990 to 32.1% in 2015. This is primarily because of falling livestock numbers since 1998 due to reform of the Common Agricultural Policy (CAP).

Ireland's has a Quantified Emission Limitation or Reduction Commitment (2013–2020) (percentage of base year or period), or QELRC, of 80 as set out in the Doha amendment of Annex B to the Kyoto Protocol.³⁰ The QELRCs for the European Union and its Member States for a second commitment period are based on the understanding that these will be fulfilled jointly with the European Union

³⁰ Doha amendment to the Kyoto Protocol ([FCCC/KP/CMP/2012/13/Add.1](https://unfccc.int/kyoto_protocol/items/2830.php))

and its Member States, in accordance with Article 4 of the Kyoto Protocol. The joint assigned amount for the European Union, its Member States and Iceland is calculated pursuant to the QELRC listed in the third column of the table contained in Annex B to the Kyoto Protocol, while the assigned amount of each Member State is determined in accordance with the terms of the joint fulfilment agreement. The assigned amount for Ireland is fixed based on Annex II to European Commission decision 2013/162/EU and as adjusted by Commission implementing decision 2013/634/EU.

The assigned amount for Ireland for the 8 year second commitment period before including deforestation in the base year is 343,467,221 t CO₂ in accordance with the joint fulfilment agreement by the European Union, its Member States and Iceland. When the provisions of Article 3, paragraph 7 bis, are included, Ireland’s assigned amount is 343,519,892 t CO₂; (Annual Emission Allocations 2013–2020, 343,467,221 kt CO₂ (as set under the EU agreement) + (8,229.962 kt CO₂ × 0.8 × 8)). These numbers were determined following the expert review of Ireland’s report to facilitate the calculation of the assigned amount for the second commitment period of the Kyoto Protocol³¹ based on Ireland’s greenhouse gas inventory submission in 2016.

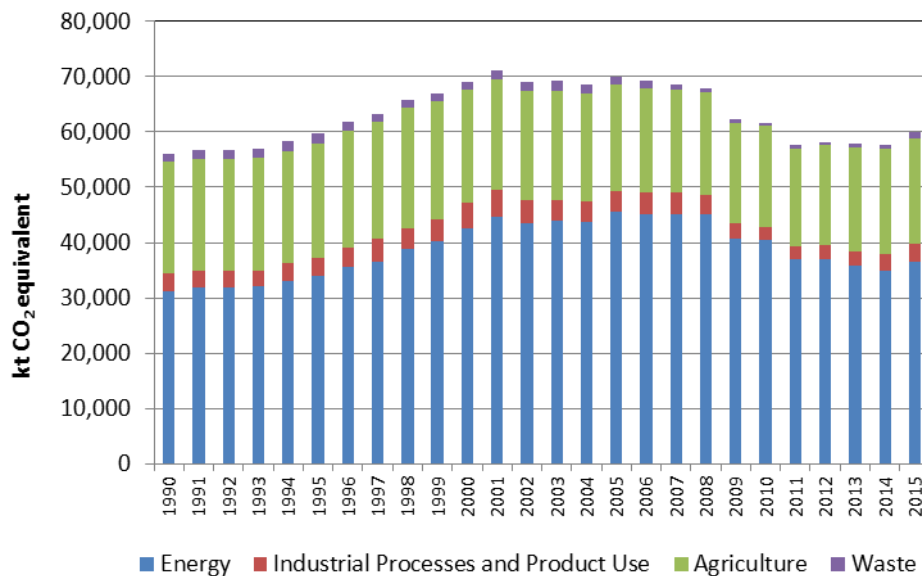


Figure 3.1 Trend in Greenhouse Gas emissions by Sector (excluding LULUCF) 1990-2015

³¹ Report on the review of the report to facilitate the calculation of the assigned amount for the second commitment period of the Kyoto Protocol of Ireland ([FCCC/IRR/2016/IRL](https://www.ec.europa.eu/clima/policies/kyoto/irland_en))

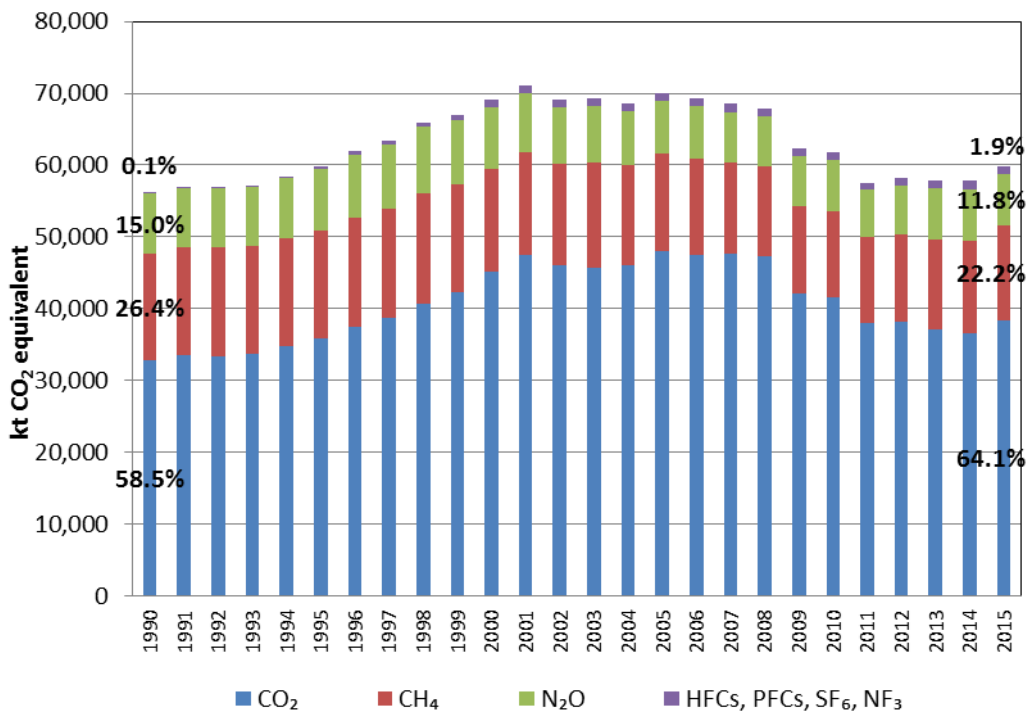


Figure 3.2 Trend in Greenhouse Gas emissions by Gas (excluding LULUCF) 1990-2015

3.2 National Inventory system

The Environmental Protection Agency is required to establish and maintain databases of information on the environment and to disseminate such information to interested parties by the [Environmental Protection Agency Act 1992](#). 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 then Department of the Environment (now Department of Communications, Climate Action and Environment DCCAE) 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).

3.2.1 Inventory System – Institutional and Procedural arrangements

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. The EPA's Office of Environmental Sustainability (OES) is the designated inventory agency and the EPA is also designated as the single national entity with overall responsibility for the annual greenhouse gas inventory. Within the OES, the Sustainable Production and Consumption Programme (SPCP), compiles the national greenhouse gas emission inventories for submission on behalf of the DCCAE under the Framework Convention on Climate Change and Regulation (EU) 525/2013, the latter being the basis for EU Member States' reporting under the Convention and the Kyoto Protocol. All formal mechanisms together with the QA/QC procedures are fully operational since they were established in the 2007 reporting cycle.

Following establishment of the national system, institutional arrangements directed towards national inventory reporting that involve the EPA, DECLG and other stakeholders were reorganised, extended and legally consolidated across all participating institutions to strengthen inventory capacity within the EPA. This ensured that more formal and comprehensive mechanisms of data collection and processing were 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. These MOUs stipulate 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 3.1 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 and this plan is set out in **Annex A.2**

Annex A.3 of this report provides 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 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 (IPPC), Industrial Emissions Directive 2010/75/EU (IED) and submissions prepared under the European Pollutant Release and Transfer Register (E-PRTR) and also obtains information from other diverse sources to prepare the inventories for fluorinated gases and solvent use. 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 Emissions Trading Unit (ETU), also within the Sustainable Production and Consumption Programme, is a key component of the national system. The ETU are responsible for administering the European Union Emissions Trading System (ETS), under Directive 2003/87/EC, in Ireland and, as such, provide annual verified emissions data to the inventory team.

The estimates of emissions and removals for forest lands under the Convention, as well as those in respect of Article 3, paragraph 3, activities under the Kyoto Protocol, are prepared by consultants contracted to the Department of Agriculture, Food and the Marine (DAFM). These are delivered to the inventory agency under a Memorandum of Understanding between DAFM and OES. A research fellow contracted directly to another office (Office of Evidence and Assessment) within the EPA is responsible for completion of the annual inventory for all other land categories in LULUCF for the annual inventory under the Convention and elected activities under Article 3, paragraph 4, of the Kyoto Protocol (Cropland management and Grazing land management). The deliverables received by OES from DAFM and the research fellow include the completed CRF tables and draft NIR sections for their respective areas of responsibility.

3.2.2 Inventory Planning

The inventory agency plans for preparation of the annual inventory as soon as possible after completion of the annual reporting cycle in April following submission to the UNFCCC secretariat. Planning largely involves the identification of improvements to be undertaken by way of revised methodologies and updated activity data or emission factors as well as 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 Kyoto Protocol activities under Article 3, paragraphs 3 and 4, as new data becomes available through national research and development of the national 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 Regulation (EU) 525/2013, are considered in inventory planning.

3.2.3 Overview of Inventory preparation and management

The first version of the latest annual inventory, produced in autumn of the following year, and a short National Inventory Report are used to comply with the subsequent 15th January deadline prescribed by Regulation (EU) 525/2013, 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 subsequent to the receipt of updated or outstanding information nationally. In addition, any observations or amendments following initial assessment at EU level of the 15th January submission by Member States to the European Commission are incorporated into the inventory between 15th January and 15th March.

The complete and final inventory submission, including the National Inventory Report, is submitted to the European Commission by 15th March as required under Regulation (EU) 525/2013. This version of the latest inventory is fixed and retained for submission to the UNFCCC secretariat by 15th 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.

3.2.4 Inventory Preparation

An emissions inventory database normally contains information on measured emission quantities, activity statistics (populations, fuel consumption, vehicle/kilometres of travel, industrial production and 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 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 enteric fermentation, manure management, municipal solid waste disposed at solid waste disposal site and CO₂ sequestration by forest biomass, it may be necessary to apply sophisticated models to generate the activity data, the emission factors and or the emissions.

The methods recommended by 2006 IPCC Guidelines for national greenhouse gas inventories 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 sectors and Parties.

Table 3.1: Key Data Providers and Information covered by MOU

Key Data Provider	Data Supplied	Deadline	Sector in which data are used
Sustainable Energy Authority of Ireland	National Energy Balance; Detailed national energy consumption disaggregated by economic sector and fuel	30 September	Energy, Waste
Department of Agriculture, Food and Marine	Table 1.1-1.4 Statistical data for cattle compiled under the Animal Identification and Movement (AIM) scheme	30 September	Agriculture
	Fertiliser and lime statistics Poultry statistics Sheep statistics	30 September	LULUCF and Article 3.3 of the Kyoto Protocol

Department of Agriculture, Food and Marine (Forest Sector Development Division)	<p>Table 2.1</p> <p>Greenhouse gas emission/removal estimates from all pools for forest lands under the Convention</p> <p>Statistical data on Afforestation, Reforestation, Deforestation and harvesting for forest land lands under Article 3.3 of KP</p> <p>Greenhouse gas emission/removal estimates from all biomass pools for KP Article 3.3</p>		
Central Statistics Office	Annual population, livestock populations, crop statistics, housing survey data	30 September	Agriculture, Industrial Processes, Waste
Gas Networks Ireland	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
Environmental Protection Agency Emissions Trading Unit	Verified CO ₂ estimates and related fuel and production data for installations covered by the EU ETS ³²	30 April	Energy, Industrial Processes
*Department of Communications, Climate Action and	National Oil Balance (as a component of the energy balance)	30 September	Energy

³² ETS – Emissions Trading Scheme

Environment			
*Road Safety Authority	Road transport statistics from the National Car Test (NCT)	30 April	Energy
Department of Agriculture, Food and the Marine (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
Department of Agriculture, Food and the Marine (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

*These bodies have MOUs with SEAI rather than with OES

3.2.5 Data collection and storage

Preparation for the annual greenhouse gas inventory takes place in an Excel spread sheet 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. These are combined and allocated according to IPCC requirements for direct transmission into the CRF Reporter online application for the generation of the CRF tables and Party submissions. 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 greenhouse gas 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 EPA servers.

Table 3.1 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 greenhouse gas 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. In collating and compiling the activity data, the inventory team collects data from the various data streams e.g. Annual Emissions Reports (AERs) under the European Pollutant Release and Transfer Register.

A national model called CARBWARE 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. 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), Co-ordinated Information on the Environment (CORINE) Land Cover Maps and the General Soil Map of Ireland. These are supported by statistical information from Bord na Móna, CSO and the National Roads Authority.

The static national model, CARBWARE has been extensively developed to a dynamic version to provide the necessary estimates for Article 3, paragraph 3 and paragraph 4, selected activities under the Kyoto Protocol. This work was undertaken by FERs Ltd, the consultants working to DAFM, who supply the estimates from these activities to OES under an agreed MOU (Table 3.1).

Secondary MOUs between DAFM 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 CH₄ and N₂O. The model processes detailed spatially explicit data on forest species and soil type obtained from the NFI, FIPS, soils maps, supported by the Grants and Premiums Administration System (GPAS) of DAFM, and felling license records. The model uses complex pre-processing functions, growth models, allometric equations and pool allocation and transfers to produce the results required for Article 3, paragraph 3 and paragraph 4, selected activities.

The annual ETS compilation serves as an important source of activity-specific and company-specific data on CO₂ emissions, fuel use and emission factors for major combustion sources and industrial processes. The emissions trading scheme covers approximately 100 installations in Ireland with combined CO₂ emissions of 16,829.71 kt in 2015, accounting for 28.1% of total greenhouse gas emissions (59,878.21 kt CO₂ equivalent). 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 CO₂ emissions for the purposes of reporting national greenhouse gas inventories under the Convention and the Protocol.

All the data used in the compilation of the national greenhouse gas inventory submission is stored on an EPA data server located in the Monaghan Regional Inspectorate of the EPA where key staff involved in the compilation of the national inventory are located. All background data for recent years are available in electronic format, with a transparent file structure. All data (emission estimates, activity data, inventory submissions, references, QA/QC) on the data server are backed up daily.

3.2.6 Methodologies and emission factors

Table 3.2 and Table 3.3 present summaries of the methodologies and emission factors used by Ireland to estimate greenhouse gas emissions reported for the years 1990-2015. More than 80% of the total emissions (excluding LULUCF) are covered by Tier 2 methods or higher in Ireland's greenhouse gas inventory under the Convention and a Tier 3 model is applied for carbon stock changes for Article 3, paragraph 3 and paragraph 4, activities under the Kyoto Protocol.

Table Table 3.2 Summary of Methods (DO NOT EDIT)

IPCC SOURCE AND SINK CATEGORIES	CO ₂	CH ₄	N ₂ O	HFC	PFC	SF ₆	NF ₃
1. Energy	T1,T2,T3	T1,T2,T3	T1,T2,T3				
A. Fuel Combustion (Sectoral Approach)	T1,T2,T3	T1,T2,T3	T1,T2,T3				
1. Energy Industries	T1, T3	T1, T2	T1, T2				
2. Manufacturing Industries and Construction	T1, T2, T3	T1	T1				
3. Transport	T2, T3	T1, T2, T3	T1, T2, T3				
4. Other Sectors	T1, T2	T1	T1				
5. Other							

B. Fugitive Emissions from Fuels	NA	T1, T2	NA				
1. Solid Fuels	NA	T1	NA				
2. Oil and Natural Gas	NA	T1, T2	NA				
C. Carbon Dioxide Transport and Storage	NA						
2. Industrial Processes and Product Use	T1,T3	NA	D	T1, T2, T3	T2	T2	T2
A. Mineral Industry	T3	NA	NA	NA	NA	NA	NA
B. Chemical Industry	NA	NA	NA				
C. Metal Production	NA	NA	NA				
D. Non-Energy Products from Fuels and Solvent Use	T1	NA	NA				
E. Electronic Industry	NA	NA	NA	T2	T2	T2	T2
F. Product Uses as Substitutes for ODS	NA	NA	NA	T1, T2, T3	NA	NA	NA
G. Other Product Manufacture and Use			T1			T1	
H. Other							
3. Agriculture	T1	T1,T2	T1,T2				
A. Enteric Fermentation		T1, T2	NA				
B. Manure Management		T1, T2	T2				
C. Rice Cultivation		NA	NA				
D. Agricultural Soils		NA	T1				
E. Prescribed Burning of Savannas		NA	NA				
F. Field Burning of Agricultural Residues		NA	NA				
G. Liming	T1						

H. Urea Application	T1						
I. Other	NA						
4. Land-Use Land-Use Change Change and Forestry	T1,T2,T3	T1	T1				
A. Forest Land	T1,T2,T3	T1	T1				
B. Cropland							
C. Grassland	T1, T3		T1				
D. Wetlands	T1	T1	T1				
E. Settlements	T1, T3		T1				
F. Other Land	T1, T3						
G. Harvested wood products	T2						
H. Other							
5. Waste	T1	T1,T2	T1				
A. Solid Waste Disposal	NA	T2	NA				
B. Biological treatment of solid waste	NA	T1	T1				
C. Incineration and open burning of waste	T1	T1	T1				
D. Wastewater treatment and discharge	NA	T1,T2	T1				
E. Other							
6. Other							
Article 3.3 Afforestation and Deforestation	T3	T1	T1				
International Bunkers							
Aviation	T1	T1	T1				

Navigation	T1	T1	T1				
Multilateral Operations	NA	NA	NA				
CO₂ Emissions from Biomass	T1	T1	T1				
CO₂ captured	NA	NA	NA				
Long-term storage of C in waste disposal sites	NA	NA	NA				
Indirect N₂O	NA	NA	NA				
Indirect CO₂	T1	NA	NA				

T1: IPCC Tier 1 or equivalent

T2: IPCC Tier 2 or equivalent

T3: IPCC Tier 3 or equivalent

Table 3.3 Summary of Emission Factors

IPCC SOURCE AND SINK CATEGORIES	CO ₂	CH ₄	N ₂ O	HFC	PFC	SF ₆	NF ₃
1. Energy	CS,D,M,PS	CS,D,M	D,M				
A. Fuel Combustion (Sectoral Approach)	CS,D,M,PS	D,M	D,M				
1. Energy Industries	CS,D,PS	D	D				
2. Manufacturing Industries and Construction	CS,D,PS	D	D				
3. Transport	CS,M	D,M	D,M				
4. Other Sectors	CS,D	D	D				
5. Other							
B. Fugitive Emissions from Fuels	NA	CS,D	NA				

1. Solid Fuels	NA	D	NA				
2. Oil and Natural Gas	NA	CS,D	NA				
C. Carbon Dioxide Transport and Storage	NA	NA	NA				
2. Industrial Processes and Product Use	D,PS	NA	D	CS	NA	NA	NA
A. Mineral Industry	PS						
B. Chemical Industry	NA	NA	NA				
C. Metal Production	NA	NA					
D. Non-Energy Products from Fuels and Solvent Use	D	NA	NA	NA	NA	NA	NA
E. Electronic Industry							
F. Product Uses as Substitutes for ODS				CS	NA	NA	NA
G. Other Product Manufacture and Use			D	NA		NA	
H. Other							
3. Agriculture	D	CS,D	CS,D				
A. Enteric Fermentation		CS,D	NA				
B. Manure Management		CS,D	CS,D				
C. Rice Cultivation		NA	NA				
D. Agricultural Soils		NA	CS,D				
E. Prescribed Burning of Savannas							
F. Field Burning of Agricultural Residues		NA	NA				
G. Liming	D						
H. Urea Application	D						
I. Other	NA						
4. Land-Use Land-Use Change and	CS,D,OTH	D	D				

Forestry							
A. Forest Land	CS	D	D				
B. Cropland							
C. Grassland	CS,D		D				
D. Wetlands	CS,D	D	D				
E. Settlements	CS,D, OTH		D				
F. Other Land	CS						
G. Harvested wood products	D						
H. Other							
5. Waste	D	CS,D	D				
A. Solid Waste Disposal	NA	CS,D	NA				
B. Biological treatment of solid waste	NA	D	D				
C. Incineration and open burning of waste	D	D	D				
D. Wastewater treatment and discharge	NA	CS,D	D				
E. Other							
6. Other							
Article 3.3 Afforestation and Deforestation	CS	D	D				
International Bunkers							
Aviation	CS	CR	CR				
Marine	CS	D	D				
Multilateral Operations	NA	NA	NA				
CO₂ Emissions from Biomass	CS, D	D, M, CR	D, M, CR				

CO₂ captured	NA	NA	NA				
Long-term storage of C in waste disposal sites	NA	NA	NA				
Indirect N₂O	NA	NA	NA				
Indirect CO₂	CS, CR, D	NA	NA				

3.2.6.1 Carbon Dioxide CO₂

Tier 2 or Tier 3 methods are used for most CO₂ 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 Manufacturing Industries and Construction and 1.A.4 Other Sectors, the CO₂ 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 CO₂ emissions, such as cement and lime production, where country and plant specific circumstances are again taken fully into account.

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, paragraph 3 and paragraph 4, activities under the Kyoto Protocol is a Tier 3 methodology. The methods for CO₂ in other LULUCF categories and for relevant CH₄ and N₂O emissions in this sector are invariably Tier 1.

3.2.6.2 Methane CH₄

Ireland's national circumstances are well captured in the Tier 2 methods applied for the major sources of CH₄ in the inventory, which are enteric fermentation and manure management associated with cattle and the CH₄ emissions from solid waste disposal sites.

Tier 2 and Tier 3 methods are used for CH₄ 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 CH₄ emissions.

3.2.6.3 Nitrous Oxide N₂O

Ireland relies on the simplified IPCC Tier 1 methodologies and default emission factors to estimate all N₂O emissions in agriculture, which is the main source of N₂O in the inventory.

Tier 2 and Tier 3 methods are used for N₂O 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 N₂O emissions.

3.2.7 Overview of key categories

The 2006 IPCC guidelines defines a key category as one that is prioritised within the national inventory system because its estimate has a significant influence on the Party's total inventory of greenhouse gases in terms of the absolute level of emissions and removals, the trend in emissions and removals or uncertainty in emissions or removals. Information about key categories is 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 2006 IPCC guidelines provide two approaches 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 approach, approach 1, is again used for 2015 data to further highlight which sources of emissions are the most important in Ireland. This approach identifies key categories using a pre-determined cumulative emissions threshold. Key categories are those that, when summed together in descending order of magnitude, add up to 95 percent of the total level.

The 2006 IPCC guidelines encourage inventory agencies to use approach 2 for its key category analysis, and this has also been suggested in previous annual inventory review reports. In response to this, initial work on using approach 2 was carried out, which highlighted differences between the level of disaggregation found in the approach 1 key category analysis compared to the approach 1 uncertainty assessment. Some sub-categories are reported at a more detailed level in the key category analysis compared to the Uncertainty Analysis (such as transport). Due to resource constraints, it was not possible to complete this work for this year's greenhouse gas inventory submission so the finalisation of the approach 2 key category analysis and the further disaggregation of the approach 1 uncertainty assessment are planned improvements for the 2018 greenhouse gas inventory submission.

3.2.7.1 Key categories at IPCC Level 2

As inventories of CO₂, CH₄ and N₂O were developed in Ireland during the 1990s, it was quickly established that CO₂ emissions from fuel combustion was by far the largest contributor to the

combined national total for these three primary greenhouse gases. It was also evident that CH₄ emissions produced by Ireland’s large cattle herd and the N₂O emissions from agricultural soils, associated with farming practices and large inputs of nitrogen to agricultural soils, were also major sources, even if the estimates were more uncertain than those for CO₂. A preliminary 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 CO₂ emissions from fuel combustion and CH₄ and N₂O emissions from agriculture.

The results at the IPCC Level 2 source category classification may be readily drawn from the CRF table Summary 2. Those for 1990 and 2015 are shown in Table 3.4 and Table 3.5, respectively. There are seven highly significant key categories of emissions in Ireland in the 1990-2015 trend including; CO₂ combustion sources in 1.A.1 Energy Industries, 1.A.2 Manufacturing Industries and Construction, 1.A.3 Transport and 1.A.4 Other Sectors, along with the CH₄ emissions from categories 3.A Enteric Fermentation and 3.B Manure Management and N₂O emissions from 3.D Agricultural Soils. These seven categories accounted for 88.1% and 90.7% of total emissions in 1990 and 2015, respectively.

In the case of 2015 emissions, three additional Level 2 source categories are needed to reach the cumulative 95% threshold that defines key categories: 2.F.1 Refrigeration and air-conditioning with HFC emissions, 2.A.1 Cement Production with CO₂ emissions and 5.A Solid Waste Disposal with CH₄ emissions. Category 2.F.1 is key in 2015 level analysis and not in 1990, whereas categories 2.B.1 and 2.B.2 are key in 1990 level analysis and not in 2015. The increase in the contribution of CO₂ emissions from category 1.A.3 Transport from 9.0% in 1990 to 19.5% in 2015 is notable, along with the corresponding reductions in the contributions from the three categories: two (3.A and 3.D) in Agriculture and (1.A.4) in Energy. This simple analysis of key categories continues to prove useful to the formulation of mitigation strategies and for prioritising work on inventories in Ireland.

When LULUCF is accounted for in the Level 2 analysis, CO₂ emissions in four LULUCF categories (4.A Forest land, 4.C. Grassland, 4.D Wetlands) become key categories in 1990, and the same three categories and associated gas, plus CO₂ emissions in LULUCF category 4.G Harvested wood products, become key categories in 2015.

Table 3.4: Key Categories at IPCC Level 2 in 1990

IPCC Level 2 Source Category	GHG	Emissions in 1990 (kt CO ₂ eq)	1990 Level Assessment (%)	Cumulative Total of Level (%)
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3.A	Enteric Fermentation	CH ₄	11,356.97	20.24	20.24
1.A.1	Energy Industries	CO ₂	11,145.01	19.87	40.11
1.A.4	Other Sectors(Comm/Resid/Agric)	CO ₂	10,030.94	17.88	57.99
3.D.	Agricultural Soils	N ₂ O	6,566.36	11.70	69.69
1.A.3	Transport	CO ₂	5,021.69	8.95	78.64
1.A.2	Manufacturing Industries and Construction	CO ₂	3,942.63	7.03	85.67
3.B	Manure Management	CH ₄	1,342.29	2.39	88.06
5.A	Solid Waste Disposal	CH ₄	1,318.08	2.35	90.41
2.B.2	Nitric Acid Production	N ₂ O	995.32	1.77	92.19
2.B.1	Ammonia Production	CO ₂	990.23	1.77	93.95
2.A.1	Cement Production	CO ₂	884.00	1.58	95.53

* Nitric acid and Ammonia plants ceased operation in 2002 and 2001, respectively

Table 3.5 Key Categories at IPCC Level 2 in 2015

IPCC Level 2 Source Category		GHG	Emissions in 1990 (kt CO ₂ eq)	1990 Level Assessment (%)	Cumulative Total of Level (%)
1.A.3	Transport	CO ₂	11,692.86	19.53	19.53
1.A.1	Energy Industries	CO ₂	11,631.37	19.43	38.95
3.A	Enteric Fermentation	CH ₄	10,936.46	18.26	57.22
1.A.4	Other Sectors(Comm/Resid/Agric)	CO ₂	8,131.64	13.58	70.80
3.D.	Agricultural Soils	N ₂ O	6,079.52	10.15	80.95
1.A.2	Manufacturing Industries and Construction	CO ₂	4,524.99	7.56	88.51
2.A.1	Cement Production	CO ₂	1,652.01	2.76	91.27
3.B	Manure Management	CH ₄	1,284.58	2.15	93.41
2.F.1	Product Uses as Substitutes for ODS -Refrigeration and air-con (incl. MAC)	HFC	909.62	1.52	94.93
5.A	Solid Waste Disposal	CH ₄	741.41	1.24	96.17

3.2.7.2 Disaggregated key Categories

Ireland uses the approach 1 from the 2006 IPCC guidelines to extend the analysis above to identify key categories that may be treated separately at a more disaggregated level, level 3. This 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 approach 1 level 3 assessment in relation to emissions excluding LULUCF in both 1990 and 2015 are presented in tables A.4.1 and A.4.2 of Annex A.4, respectively.

Tables A.4.3 and A.4.4 present the approach 1 level 3 assessment including LULUCF. 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. Results for approach 1 trend assessment for 1990-2015 excluding LULUCF are shown in Table A.4.5 and the trend assessment including LULUCF is presented in Table A.4.6.

The complete tables of ranked sources for 2015 key category analysis are provided in Tables 1.A-D in Annex 1 of Ireland's NIR 2017.

The results of the level and trend assessments for 2015 excluding LULUCF categories may be summarised as follows:

- (i) The level assessment identifies 27 key categories, 21 of which are also key categories by trend assessment. Methane emissions in 3.A.1 Enteric Fermentation – Dairy Cattle; CH₄ emissions in 3.B.1 Manure Management – Non-Dairy Cattle; CH₄ emissions in 3.B.1 Manure Management – Dairy Cattle; N₂O emissions in 3.D.2 Agricultural Soils – Indirect Soil Emissions; CO₂ emissions in 3.G.1 Liming and CO₂ emissions in 1.A.3.d National Navigation – Liquid Fuels are key categories by level assessment only.
- (ii) There are 18 key categories of CO₂ in level assessment, accounting for 62.7% of total emissions;
- (iii) There are six key categories of CH₄, two key categories of N₂O and one category of HFC in level assessment, which account for 20.9%, 10.2% and 1.5%, respectively, of total emissions;
- (iv) Energy accounts for 16 key categories, Agriculture for 8, while Industrial Processes and Product Use contributes two and Waste contributes one;

- (v) The trend assessment identifies 26 key categories, all of which but five (CH₄ emissions in; 1.A.4.b. Residential – peat fuel and solid fuels; CO₂ emissions in 1.A.2 Manufacturing Industries & Construction – Non-Renewable waste; CH₄ emissions in 1.B.2.b Fugitive emissions – Natural gas; HFC emissions in 2.F.4 Product Uses as Substitutes for ODS – Aerosols (incl.MDIs) , are key categories for 2015 level assessment;
- (vi) There are 17 key categories of CO₂ in trend assessment, accounting for 80.6% of the total trend;
- (vii) There are 6 key categories of CH₄, one key category of N₂O and two key categories of HFC in trend assessment, which account for 8.0%, 3.0% and 3.6%, respectively, of the total trend.

The results of the level and trend assessment for 2015 including LULUCF categories may be summarised as follows:

- (i) The level assessment identifies 35 key categories, 23 of these are sources of CO₂ emissions, accounting for 68.1% of total emissions;
- (ii) There are eight additional categories that are not present in the assessment excluding LULUCF, six of which are LULUCF. The remaining two categories are N₂O emissions in 3.B.2.5 Manure Management- Indirect N₂O and N₂O emissions in 3.B.2.1 Manure Management – Non-Dairy Cattle.
- (iii) The six additional LULUCF categories are: CO₂ emissions from 4.C.1 Grassland Remaining Grassland, 4.A.2 Land Converted to Forest Land, 4.D.1 Wetlands Remaining Wetlands, 4.G Harvested Wood Products and 4.C (II) Drained organic soils – Other grasslands; and CH₄ emissions in 4.C (II) Drained organic soils – rewetted organic soils.
- (iv) There are seven key categories from sources of CH₄, four key categories of N₂O and one category of HFC, which account for 17.3%, 8.9% and 1.2%, respectively, of total emissions;
- (v) Energy accounts for 16 key categories, Agriculture for ten, LULUCF for six, while Industrial Processes contributes 2 and Waste contributes 1;
- (vi) The trend assessment identifies 33 key categories, seven of which were not present in the assessment excluding LULUCF: CO₂ emissions from LULUCF categories: 4.A.2 Land converted

to Forest Land, 4.A.1 Forest land Remaining Forest Land, 4.C.1 Grassland Remaining Grassland, 4.D.1 Wetlands Remaining Wetlands, 4.C.2 Land Converted to Grassland and 4.G Harvested Wood Products; CH₄ emissions in 4.C (II) Drained organic soils – rewetted organic soils; and CO₂ emissions from 1.A.3.d Navigation – Liquid Fuels.

(vii) There are 23 key categories of CO₂ in the trend assessment, accounting for 83.8% of the total trend;

(viii) There are seven key categories of CH₄, one key category of N₂O and two key categories of HFC in the trend assessment, which account for 6.6%, 2.3% and 2.6%, respectively, of the total trend.

The list of key categories given by level assessment in 2015 is very similar to that for 1990. However, the higher ranking of the main CO₂ sources in Energy, at the expense of CH₄ and N₂O sources in Agriculture, is notable in 2015. Seven out of the top ten key categories in 1990 (excluding LULUCF) were in the top ten in 2015 but in a different order. The remaining three key sectors in 2015 are: CO₂ emissions from 1.A.4.b Residential – Liquid Fuels and 1.A.2. Manufacturing Industries & Construction - gaseous fuels and 2.A.1 Cement Production. These sectors replaced 3 key sectors in 1990: CO₂ emissions from 1.A.4.b. Residential - peat fuel, 1.A.4.b. Residential - solid fuels and 1.A.2. Manufacturing Industries & Construction – Liquid Fuels. Those seven key categories contributed 54.8 and 61.6%, of total emissions in 1990 and 2015, respectively. The emissions of CO₂ from the use of petrol and diesel by road traffic (1.A.3.b) and CH₄ emissions from 3.A.1. Enteric Fermentation - Non-Dairy Cattle were the largest source categories of greenhouse gas emissions in Ireland in 2015, accounting for 18.7 and 11.0% of the total, respectively.

The CO₂ removals in six categories (4.C.1 Grassland Remaining Grassland, 4.A.2 Land converted to Forest Land, 4.D.1 Wetlands Remaining Wetlands, 4.G Harvested Wood Products and 4.C (II) Drained organic soils – Other grasslands; and CH₄ emissions in 4.C (II) Drained organic soils – rewetted organic soils) are key categories in level assessment when the LULUCF sector is included in the detailed analysis. CO₂ removals in category KP A.1 Afforestation/Reforestation (which is determined largely by 4.A.1 Forest Land Remaining Forest Land as well as 4.A.2 Land converted to Forest Land under LULUCF); CO₂ emissions in KP B.1 Forest Management and KP B.3 Grazing Land Management; and CH₄ emissions in KP B.3 Grazing Land Management are also key categories in 2015 when Article 3, paragraph 3 and paragraph 4, activities are included in the analysis.

3.2.8 Process for the recalculation of previously submitted Inventory data

On-going 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 1 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 2017 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 10 of the NIR 2017 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 1990-2014, 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 2017 greenhouse gas inventory submission.

3.2.9 Uncertainty assessment

The approach 1, propagation of error, method provided by the 2006 IPCC guidelines has been used to make an assessment of uncertainty in the emissions inventory data for 2015 in the same way as for previous years. This method estimates uncertainties for the entire inventory in a year and the uncertainty in the trend over time by combining the uncertainties in activity data and emission factors for each source category. The analysis for 2015 data is presented in Table A.5.1 (excluding LULUCF) and Table A.5.2 (including LULUCF) in Annex A.5, using emissions on a GWP basis and a level of source category disaggregation that corresponds in general to the level used for emissions calculation and for key category analysis. This disaggregation level limits the likely dependency and correlation between source categories.

The input values of uncertainty for activity data and emission factors in the greenhouse gas inventory have been assigned largely on the basis of general information related to the methodological descriptions in the 2006 IPCC guidelines, supported by opinions elicited from the principal data suppliers, such as the CSO, SEAI, Government Departments and individual experts who contributed to certain parts of the inventory.

Where higher tier methods are used for combustion sources, such as those covered by ETS and road transport, the activity data uncertainty estimates are those indicated for the tier concerned.

Accordingly, low estimates of uncertainty apply to the activity data for categories such as 1.A.1 Energy Industries and 1.A.3 Transport, as shown on Table 1.12. Slightly higher uncertainty levels are used for energy activity data in sub-categories under 1.A.2 Manufacturing Industries and Construction and 1.A.4 Other Sectors, where the end use of fuels is not as well quantified in the top-down methods used. Low activity data uncertainties are justified in respect of CO₂ emissions sources in 2.A Industrial Processes, for which bottom-up data are applied in most cases and the major sources of emissions are covered by ETS. Country-specific CO₂ emission factors are used for all combustion sources, which gives a basis for assigning the uncertainties for emission factors while again considering the applicable tiers. Uncertainties in the emission factors for CH₄ and N₂O released from combustion sources are high and not well established quantitatively. For CH₄ and N₂O emission factors for combustion categories, the most up-to-date IPCC publications are used and an indicative uncertainty of 50% is used for both gases.

The Agriculture sector is the second most important sector in Ireland's greenhouse gas inventory and has a major influence on overall uncertainty due to its large contribution in terms of CH₄ and N₂O emissions. Ireland has long-established and robust statistical data collection procedures in place for agriculture in general, which guides the selection of 1% as the activity data uncertainty for all agriculture sub-categories. The 2006 IPCC guidelines indicate that the emission factor estimates for the Tier 2 method to determine CH₄ emissions from enteric fermentation in cattle are likely to have an uncertainty of 20%. Following the opinion of national agriculture experts, a value of 15% has been adopted for these emissions to take into account Ireland's detailed Tier 2 method and use of reliable data.

In some of the other important emissions sources in Agriculture (such as manure management and agricultural soils) the activity data or emission factors ultimately used are determined by several specific component inputs, which are individually subject to varying degrees of uncertainty. The uncertainty estimates used for emission factors for these sources have been derived by assigning uncertainties to the key component parameters and combining them at the level of activity data or emission factors, as appropriate, using equations 3.1 and 3.2 in chapter 3 of the 2006 IPCC guidelines Volume 1 for each activity to obtain the input to the Tier 1 uncertainty assessment. The footnotes to Table A.5.1 show how some of these uncertainty inputs are obtained.

Category 5.A Solid Waste is the principal source of CH₄ emissions outside Agriculture. Under the methodology used, the component uncertainties for both activity data and emission factor for CH₄ generation are derived using equations 3.1 and 3.2 in chapter 3 of the 2006 IPCC guidelines Volume 1 as shown in the footnotes to Table A.5.1. These are combined with uncertainties of 30% and 10% for flaring and utilisation respectively to obtain the overall uncertainty using equation 3.2.

Equations 3.1 and 3.2 are both applied as appropriate in a hierarchical approach to derive uncertainty for LULUCF under the Convention and for activities under Article 3, paragraph 3 and paragraph 4, of the Kyoto Protocol. This is achieved by developing uncertainties for carbon pools, which are combined to give the values for the individual land-use categories, which are then combined with uncertainties for other reported activities to give the totals for LULUCF and Article 3, paragraph 3 and paragraph 4, separately. Additional information on uncertainties for LULUCF is provided in chapters 6 and 11 of NIR 2017.

The F-gas inventory has been substantially revised following work by consultants in 2013, and new data sources were established. The uncertainties associated with the F-gas emission estimates were

reviewed, and are still considered to be appropriate for this GREENHOUSE GAS inventory submission.

The approach 1 uncertainty analysis (excluding LULUCF) for Ireland's 2015 inventory under the Convention gives an overall uncertainty of 10.01% in total emissions and a trend uncertainty of 2.76% for the period 1990 to 2015. This equates to a decrease on level and an increase in trend as compared to the values reported in the 2016 GREENHOUSE GAS inventory submission (for 1990 to 2014) of 10.16 and 2.72%, respectively.

The reason for the overall decrease from 2014 to 2015 is mainly due to the application of revised activity data and methodology for the estimation of CH₄ emissions from 5.A Solid Waste Disposal.

The reason for the trend increase from 2014 to 2015 is mainly due to revised (higher) N₂O uncertainty estimates for 3.D.1 Direct N₂O Emissions from Managed Soils.

Relatively low estimates are determined largely by the low uncertainties in the estimate of CO₂ emissions, which account for 64.1% of total national emissions in 2015 and which are estimated to have a level uncertainty of 1.27% (excluding LULUCF). When CH₄ is included, bringing the proportion of total emissions up to 86.3%, the total uncertainty estimate is 3.20% (excluding LULUCF), even though there are large uncertainties assigned to the CH₄ emission factors in some source categories. However, it is the influence of N₂O that leads to a higher uncertainty in total emissions bringing it to 10.01%. The impact of HFCs, PFCs, SF₆ and NF₃ on inventory uncertainty remains negligible because these gases account for only 1.9% of total emissions in Ireland.

The approach 1 uncertainty analysis (including LULUCF) for Ireland's 2015 inventory under the Convention (Table A.5.2) gives an overall level uncertainty of 9.63% in total emissions and a trend uncertainty of 10.47% for the period 1990 to 2015.

The overall level uncertainty (including LULUCF) of the 2015 inventory is a decrease on the last inventory submission. The corresponding value in 2016 inventory submission (2014 data) was 9.70%. The reason for the decrease from 2014 to 2015 is due to revised uncertainty estimates for CO₂ in LULUCF sector changes: (4.D.1 Wetlands Remaining Wetlands). The overall uncertainty increase for N₂O was due to the same reasons as described above in the uncertainty analysis excluding LULUCF.

3.2.10 Quality assurance and quality control

In 2005, the inventory agency in Ireland commissioned a project with UK consultants NETCEN to establish formal QA/QC procedures 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 of the QA/QC system. In addition, the manual provides guidance and templates for appropriate quality checking, documentation and traceability. The selection of source data, calculation methodologies, peer and expert review of inventory data and the annual requirements for continuous improvement for the inventory are also outlined in the manual.

The QA/QC plan (Annex A.2) 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.

The inventory agency initiated a new approach to QA/QC in the 2006 reporting cycle. Its application was completed and consolidated in delivering the submissions up to this present 2017 GREENHOUSE GAS inventory submission. This involved the allocation of responsibilities linked to the national system mentioned in Chapter 3.2.1 and the use of a template spread sheet 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.

Ireland's calculation spread sheets in all sectors are structured and organised to facilitate the QA/QC process and more efficient time-series analysis and 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 the agriculture sector was performed by a Technical Inspector in the Department of Agriculture, Food and the Marine. This review used the new calculation files to assess the consistency of the time series which had been subject to considerable improvement and recalculation in the 2006 reporting cycle. These improvements and recalculations were part of a move to higher tier methods for enteric fermentation in cattle as well as advice from the Department on various aspects of input data and calculation parameters. A detailed bilateral review with UK agricultural experts took place in the offices of the EPA in July 2014 to review, in particular, the changes to the agriculture inventory with respect to the use of the 2006 IPCC guidelines. The inventory agency also continues to work closely with the Department of Agriculture, Food and the Marine and seeks advice and guidance from experts in Teagasc, the Irish Agriculture and Food Development Authority on a regular basis.

The inventory team has contracted an external service provider, Aether, to assist in aspects of inventory compilation since 2013. The transparency, robustness and accessibility of the inventory data within the electronic filing structures were assessed by Aether, who concluded that the system is very well organised.

The ETS returns to the ETU provide for the complete coverage of CO₂ estimates in several 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 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 on-going with regard to the EU and its Member States. In 2014, experts from the inventory team attended 2 workshops, in March and June, organised by UBA Germany and the European Commission to facilitate the implementation of the 2006 IPCC guidelines for inventory reporting for the first submission for the second commitment period in 2015.

3.2.11 Procedures for consideration and approval of the Inventory

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 Sustainable Production and Consumption Programme in OES (Annex A.3). 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 autumn of the following year. This is in advance of their official submission to the European Commission in accordance with Regulation (EU) 525/2013 in January and March of the reporting year and subsequently to the UNFCCC secretariat in April. The national system is also exploited for the purpose of parallel inventory preparation and reporting of air pollutants 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.

3.3 Emissions by Greenhouse Gas

The trends in emissions of the seven greenhouse gases in Ireland over the period 1990-2015 are shown in Table 3.6 and in further detail in Annex A.1.1 to Annex A.1.6.

The trends in the principal emission components, shown as CO₂ equivalents, within the five IPCC sectors are shown in Figures 3.1 and 3.2. Total emissions of the seven greenhouse gases in Ireland (including indirect CO₂ emissions without land use, land use change and forestry) increased steadily from 56,102.8 kt CO₂ eq in 1990 to 71,124.2 kt CO₂ eq in 2001, which is the highest level of GREENHOUSE GAS emissions ever reported in Ireland. Emissions then plateaued until 2008 with estimates ranging from 67,882.8 kt CO₂ eq to 69,981.6 kt CO₂ eq. There was then a sharp decrease from 67,882.8 kt CO₂ eq in 2008 to 57,567.4 kt CO₂ eq in 2011. Emissions then plateaued again between 2011 and 2014. There was a rise in emissions between 2014 and 2015 of 3.7% to 59,878.2 kt CO₂ eq, which is the second largest annual growth rate ever reported in Ireland.

The largest annual change occurred from 2008 to 2009 when emissions decreased by 5,642.8 kt CO₂ eq from 67,882.8 kt CO₂ eq to 62,240.0 kt CO₂ eq a reduction of 8.3%. Total emissions in 2015 were 6.7% higher than in 1990 and 15.8% lower than the peak level in 2001. Inter annual changes to national total emission estimates are shown in Figure 3.3.

Emissions of CO₂ accounted for 64.1% of the total (excluding LULUCF) of 59,878.2 kt CO₂ equivalent in 2015, with CH₄ and N₂O contributing 22.2% and 11.8%, respectively. The combined emissions of HFC, PFC, SF₆ and NF₃ accounted for 1.9% of total emissions in 2015. In 1990 emissions of CO₂, CH₄, N₂O and the combined emissions of HFCs, PFCs, SF₆ and NF₃ accounted for 58.5, 26.4, 15.0 and less than 0.1%, respectively of total emissions of 56,102.8 kt CO₂ equivalent as presented in Figure 3.2.

Table 3.6 Greenhouse Gas Emissions 1990-2015 (kt CO₂ equivalent)

(a) Emissions by Gas

Greenhouse Gas Emissions	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Percentage change (1990-2015)
CO ₂ emissions without net CO ₂ from LULUCF	32,840.7	35,793.2	45,192.9	48,027.7	47,485.3	47,576.1	47,251.6	42,068.7	41,630.1	37,965.0	38,144.1	37,122.8	36,633.1	38,392.8	16.9%
CO ₂ emissions with net CO ₂ from LULUCF	38,282.7	42,028.7	50,653.4	52,682.3	52,991.3	51,786.7	50,307.2	44,578.7	45,007.9	41,444.8	42,116.2	40,795.2	40,618.6	42,060.0	9.9%
CH ₄ emissions without CH ₄ from LULUCF	14,803.4	14,996.8	14,292.2	13,511.2	13,461.8	12,801.9	12,604.1	12,232.2	11,980.6	11,936.4	12,235.7	12,564.4	12,881.4	13,263.4	-10.4%
CH ₄ emissions with CH ₄ from LULUCF	15,030.0	15,305.3	14,576.6	13,816.3	13,785.8	13,134.6	12,947.9	12,556.8	12,470.2	12,329.4	12,570.0	12,956.0	13,260.8	13,634.2	-9.3%

N ₂ O emissions without N ₂ O from LULUCF	8,423.4	8,698.3	8,635.2	7,422.8	7,185.9	6,993.1	6,990.5	6,901.2	7,069.6	6,649.6	6,747.9	7,112.5	7,049.0	7,079.2	-16.0%
N ₂ O emissions with N ₂ O from LULUCF	8,551.8	8,863.9	8,828.9	7,666.2	7,430.9	7,249.7	7,265.6	7,173.7	7,372.0	6,925.2	7,016.6	7,389.3	7,324.6	7,354.8	-14.0%
HFCs	1.2	103.2	456.7	678.4	898.8	905.9	845.8	915.1	932.0	955.2	948.6	1,070.0	1,152.6	1,076.8	87154.2%
PFCs	0.1	97.6	397.8	216.4	191.0	168.1	136.1	83.6	46.6	15.9	9.6	8.3	3.6	20.5	17013.9%
SF ₆	33.9	79.1	51.8	96.8	60.2	62.9	54.7	39.2	33.1	45.5	37.4	43.5	37.4	44.5	31.3%
NF ₃	NO	4.4	49.2	28.4	28.2	37.7	NO	NO	NO	NO	0.8	0.9	1.0	1.0	-
Total (without LULUCF)	56,102.8	59,772.6	69,075.7	69,981.6	69,311.2	68,545.6	67,882.8	62,240.0	61,691.9	57,567.4	58,124.0	57,922.5	57,757.9	59,878.2	6.7%
Total (with LULUCF)	61,899.7	66,482.2	75,014.2	75,184.8	75,386.2	73,345.5	71,557.3	65,347.1	65,861.9	61,715.8	62,699.1	62,263.3	62,398.5	64,191.8	3.7%
Total (without LULUCF,	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	-

with indirect ³³															
Total (with LULUCF, with indirect)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	-

³³ Ireland's national total during the second commitment period also includes indirect CO2 emissions from NMVOCs from solvent use (category 2.D.3 in the IPPU sector) to be consistent with reporting under the Kyoto Protocol for the first commitment period (previous CRF sector 3, solvent and other product use)

(b) Emissions by IPCC Source Category (kt CO₂ equivalent)

Greenhouse Gas Source and Sink Categories	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Percentage change (1990-2015)
1. Energy	31,118.5	33,893.1	42,526.1	45,648.8	45,151.8	45,115.2	45,209.9	40,742.4	40,359.6	36,871.7	36,953.6	35,725.0	34,994.7	36,541.6	17.4%
2. Industrial Processes	3,272.2	3,273.6	4,742.8	3,769.0	3,875.3	3,927.4	3,495.4	2,678.2	2,458.5	2,332.4	2,535.6	2,576.7	3,001.9	3,135.3	-4.2%
3. Agriculture	20,144.8	20,762.8	20,295.2	19,248.8	18,933.0	18,629.4	18,464.6	18,278.6	18,349.2	17,748.1	18,094.9	18,923.9	18,882.5	19,227.1	-4.6%
4. LULUCF	5,796.9	6,709.6	5,938.6	5,203.2	6,075.0	4,799.9	3,674.6	3,107.1	4,170.0	4,148.3	4,575.1	4,340.8	4,640.6	4,313.6	-25.6%
5. Waste	1,567.3	1,843.0	1,511.6	1,315.1	1,351.1	873.6	712.9	540.8	524.6	615.2	540.0	696.8	878.8	974.2	-37.8%
6. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	-
Total (including LULUCF)	61,899.7	66,482.2	75,014.2	75,184.8	75,386.2	73,345.5	71,557.3	65,347.1	65,861.9	61,715.8	62,699.1	62,263.3	62,398.5	64,191.8	3.7%

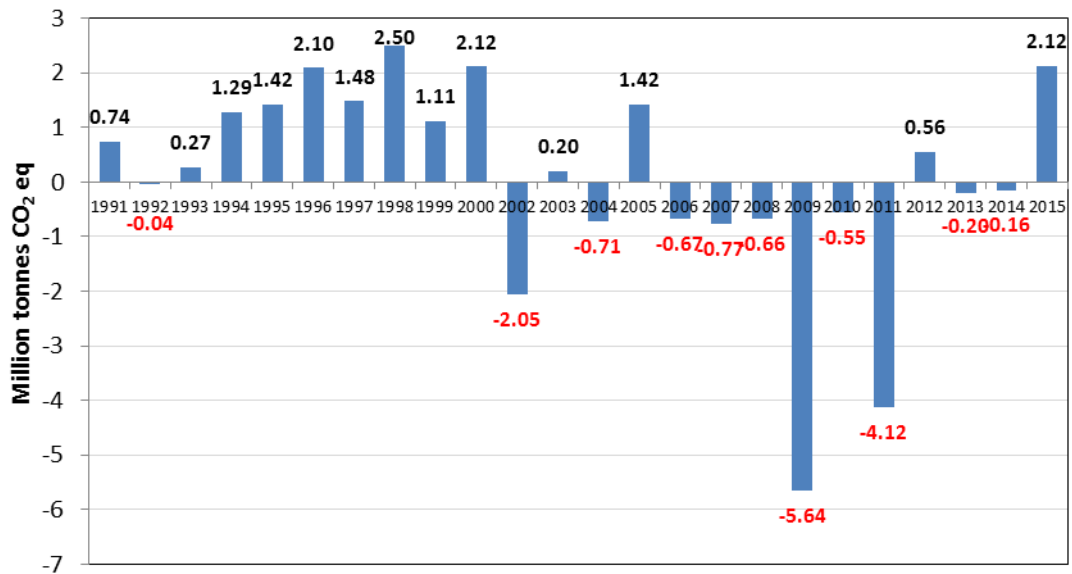


Figure 3.3 Inter annual changes to national total GREENHOUSE GAS emissions 1990-2015

3.3.1 Carbon Dioxide

Carbon dioxide is the most significant contributor to the greenhouse gas emissions with 1.A.1 Energy Industries and 1.A.3 Transport sectors responsible for 30.3% and 30.5% of total CO₂ emissions (excluding LULUCF) in 2015, respectively. 1.A.4 Other Sectors represents a share of 21.2%, 1.A.2 Manufacturing Industries and Construction has an 11.8% share and the remainder of CO₂ emissions (6.3% share) fall into other categories.

Emissions of CO₂ increased from 32,840.7 kt in 1990 to 38,392.8 kt in 2015, which equates to an increase of 16.9%. The main driver behind this increase in emissions is primarily fuel combustion in Transport followed by Energy Industries. Over the period 1990-2015, emissions of CO₂ from transport, predominantly road traffic in Ireland, increased by 132.8%. This trend is exaggerated somewhat in later years by so-called fuel-tourism. In 2015 it is estimated that 2.4% of petrol and 17.1% of diesel sold in Ireland was used in vehicles in the UK and other countries.

Over the time-series, emissions of CO₂ from 1.A.1 Energy Industries increased in the first decade by 54.7% until they peaked in 2001 and decreased by 32.5 to 2015, showing an overall increase of 4.4% CO₂ over the 1990-2015 period. In addition, even though Ireland has only a small number of energy intensive industries, CO₂ emissions from combustion in the industrial sector 1.A.2 Manufacturing Industries and Construction increased by 14.8% between 1990 and 2015.

3.3.2 Methane

Methane is the second most significant contributor to greenhouse gas emissions in Ireland which is due to the large population of cattle. In 2015 emissions of CH₄ were 13,263.4 CO₂ equivalent, indicating a decrease of 10.4% on the 1990 level of 14,803.4 kt CO₂ equivalent. Emissions of CH₄ increased progressively from 1990, reaching a peak in 1998 of 15,408.3 kt CO₂ equivalent, which reflects an increase in livestock numbers and therefore increased emissions from source categories 3.A Enteric Fermentation and 3.B Manure Management.

Between 1998 and 2011 CH₄ emissions decreased because of falling livestock numbers due to reform of the Common Agricultural Policy (CAP). However, total CH₄ emissions in the period 2001-2014 fluctuated to some extent on a yearly basis. This trend is a direct result of fluctuating CH₄ emissions from 1.A.4 Other Sectors and 1.B Fugitive Emissions from Fuels. The main contributor to the CH₄ trend has been Agriculture and in 2015 the sector accounted for 92.1% of the total methane emissions (compared to 85.8% share in 1990 when emissions from Waste had a larger share in the methane trend). Nevertheless, the sectoral methane emissions from Agriculture decreased by 3.8% between 1990 (12,699.3 kt CO₂ equivalent) and 2015 (12,221.0 kt CO₂ equivalent).

Another significant source of methane emissions is Waste sector, especially from landfill gas in category 5.A Solid Waste Disposal on Land. CH₄ emissions from Waste decreased from 9.3% share of total methane emissions (1,380.0 kt CO₂ equivalent) in 1990 to 6.1% share (806.2 kt CO₂ equivalent) in 2015. This decrease is a result of improved management of landfill facilities, including increased recovery of landfill gas utilised for electricity generation and flaring.

3.3.3 Nitrous Oxide

Nitrous oxide emissions decreased by 16.0% from their 1990 level of 8,423.4 kt CO₂ equivalent in 1990 to 7,079.2 kt CO₂ equivalent in 2015. Similar to CH₄, emissions of N₂O increased during the 1990s to reach peak level of 9,245.9 kt CO₂ equivalent in 1998 reflecting increased use of synthetic fertilisers and increased amounts of animal manures associated with increasing animal numbers over that period. Emissions of N₂O subsequently show a clear downward trend following reductions in synthetic fertiliser use and organic nitrogen applications on land because of the effect of the CAP reform on animal numbers as well the closure of Ireland's only nitric acid plant in 2002.

The largest contributor to the trend is the Agriculture sector with 93.0% share of the total N₂O emissions (6,585.3 kt CO₂ equivalent) in 2015. This reflects an increase from 83.6% share (7,046.1 kt CO₂ equivalent) in 1990 despite being a lower absolute number. Emissions from IPPU in chemical

industry used to be the second largest contributor to the trend contributing 11.8% to total N₂O emissions in 1990 and an average of 9.3% share to the trend between 1990 and 2000, before falling to 3.6% share in 2002 – the year of nitric acid plant closure.

Energy and Waste sectors contribute 4.6% and 1.8%, respectively to total N₂O emissions in 2015.

3.3.4 HFC_s, PFC_s and SF₆

Emissions of F-gases (HFCs, PFCs, SF₆ and NF₃) were 1,142.7 kt CO₂ equivalent in 2015 compared to 35.2 kt CO₂ equivalent in 1990, a 31 fold increase over the time series. However, F-gas emissions only account for 1.9% of the national total in 2015. F-gases include a wide range of substances that are used in a diverse range of products and manufacturing processes. Therefore it can be difficult to identify the factors contributing to actual trends in emissions over time. However, it is possible to establish the main contributory sub-categories underlying these trends.

The main causative factor of the increase in F-gas emissions has been the growth in HFC emissions from 2.F.1 Refrigeration and Air Conditioning through their use as replacement refrigerants across virtually all refrigeration sub-categories since 1996. Increased use of HFCs in 2.F.4 categories: Metered Dose Inhalers (MDIs) and Aerosols is also an important component of the trend. On the other hand, following a 2013 study on F-gases, emissions from 2.F.2 Foams were proven to be not occurring in manufacturing process and consequently were removed from the whole time series. Similar was the finding in 2.F.3 Fire extinguishers between 1990-1996 (incl.) and significant emission reductions for the following years in the trend have been applied. Sector 2.E.1 Semiconductor Manufacture was the only source in 1990 until 2.F.4 Aerosols entered the market in 1990, followed by 2.F.1 MAC in 1993, 2.F.1 Refrigeration and Air Conditioning in 1995 and both 2.F.3 Fire extinguishers and 2.F.4 MDIs in 1996. Emissions from HFCs increased steadily from 1.2 kt CO₂ equivalent in 1990 to 1,076.8 kt CO₂ in 2015.

Emissions of PFCs increased from 0.12 kt CO₂ equivalent in 1990 up to their peak of 397.8 kt CO₂ equivalent in 2000 through their use in the semiconductor manufacturing process in 2.E.1 Semiconductor Manufacture. Semiconductor manufacturers continue to investigate various reduction initiatives through gas substitution and new process technologies which is reflected in the downward trend in PFC emissions between 2000 and 2015 (20.5 kt CO₂ equivalent in 2015).

SF₆ is used in a diverse number of products and processes and is therefore included in several IPCC source sub-categories including 2.E.1 Semiconductor Manufacture, 2.G.1 Electrical Equipment and

four subcategories under 2.G.2 Other. Emissions of SF₆ were 33.9 kt CO₂ equivalent and 44.5 kt CO₂ equivalent in 1990 and 2015, respectively. However, total emissions of SF₆ across the time series vary considerably, primarily because the two largest sources (Semiconductor Manufacture and Electrical Equipment) vary considerably from year to year. Emissions of SF₆ grew steadily from 1990, peaking at 126.1 kt CO₂ equivalent in 1997.

The increase over the period 1990-1997 was largely due to increased use of SF₆ in Semiconductor Manufacture. Emissions from both Semiconductor Manufacture and Electrical Equipment then show a steady decline across the time series (although there are peaks in 2003 and 2005 due to elevated emissions from Semiconductor Manufacture). Similar to PFCs, semiconductor manufacturers have undertaken to reduce the use of SF₆ through gas substitution and new process technologies. In 2.E.1 Electrical Equipment, where SF₆ is used for electrical insulation, arc quenching and current interruption, a leak reduction programme has been in place since 1997, when peak emissions are observed.

NF₃ are solely released from 2.E.1 Semiconductor Manufacture. Emissions of NF₃ were reported since 1995 (4.37 kt CO₂ eq.) when use of this gas commenced in the industry and peaked in 2000 (49.2 kt CO₂ eq.), followed by fluctuations until 2008 when NF₃ was phased out from Semiconductor Manufacture for four consecutive years. Since 2012 small amounts of NF₃ were used again in Semiconductor Manufacture resulting in low emission levels averaging 0.90 kt CO₂ eq per year.

3.4 National Registry

Directive 2009/29/EC adopted in 2009, provides for the centralization of the EU ETS operations into a single European Union registry operated by the European Commission as well as for the inclusion of the aviation sector. At the same time, and with a view to increasing efficiency in the operations of their respective national registries, the EU Member States who are also Parties to the Kyoto Protocol (26) plus Iceland, Liechtenstein and Norway decided to operate their registries in a consolidated manner in accordance with all relevant decisions applicable to the establishment of Party registries - Decision 13/CMP.1 and Decision 24/CP.8.

The consolidated platform which implements the national registries in a consolidated manner (including the registry of the EU) is called the Union Registry and was developed together with the new EU Registry, on the basis the following modalities:

- Each Party retains its organization designated as its registry administrator to maintain the national registry of that Party and remains responsible for all the obligations of Parties that are to be fulfilled through registries;
- Each Kyoto unit issued by the Parties in such a consolidated system is issued by one of the constituent Parties and continues to carry the Party of origin identifier in its unique serial number;
- Each Party retains its own set of national accounts as required by paragraph 21 of the Annex to Decision 15/CMP.1. Each account within a national registry keeps a unique account number comprising the identifier of the Party and a unique number within the Party where the account is maintained;
- Kyoto transactions continue to be forwarded to and checked by the UNFCCC Independent Transaction Log (ITL), which remains responsible for verifying the accuracy and validity of those transactions;
- The transaction log and registries continue to reconcile their data with each other in order to ensure data consistency and facilitate the automated checks of the ITL;
- The requirements of paragraphs 44 to 48 of the Annex to Decision 13/CMP.1 concerning making non-confidential information accessible to the public is fulfilled by each Party through a publically available web page hosted by the Union Registry;
- All registries reside on a consolidated IT platform sharing the same infrastructure technologies. The chosen architecture implements modalities to ensure that the consolidated national registries are uniquely identifiable, protected and distinguishable from each other, notably:
 - With regards to the data exchange, each national registry connects to the ITL directly and establishes a secure communication link through a consolidated communication channel (VPN tunnel);
 - The ITL remains responsible for authenticating the national registries and takes the full and final record of all transactions involving Kyoto units and other administrative processes such that those actions cannot be disputed or repudiated;
 - With regards to the data storage, the consolidated platform continues to guarantee that data is kept confidential and protected against unauthorized manipulation;
 - The data storage architecture also ensures that the data pertaining to a national registry are distinguishable and uniquely identifiable from the data pertaining to other consolidated national registries;

- In addition, each consolidated national registry keeps a distinct user access entry point (URL) and a distinct set of authorisation and configuration rules.

Following the successful implementation of the Union Registry, the 28 national registries concerned were re-certified in June 2012 and switched over to their new national registry on 20 June 2012. Croatia was migrated and consolidated as of 1 March 2013. During the go-live process, all relevant transaction and holdings data were migrated to the Union Registry platform and the individual connections to and from the ITL were re-established for each Party.

The following changes to the national registry have occurred since the last National Communication Report:

a) The name and contact information of the registry administrator designated by the Party to maintain the national registry;

Ireland's EPA is responsible for establishing and maintaining the National Registry in Ireland.

Party	Entity	
IRELAND	Environmental Protection Agency	PO Box 3000 Johnstown Castle Estate Co Wexford Y35 W821 IRELAND T: +353 53 91 60600 F: +353 53 91 60699
National Administrator	Primary Contact	Dr Maria MARTIN EPA Regional Inspectorate McCumiskey House Richview Clonskeagh Dublin14 D14 YR62 IRELAND T: +353 1 2680100 F: +353 1 2680199

		E: etradmin@epa.ie E: m.martin@epa.ie
	Alternate Contact	Ms Jacinta PONZI Environmental Protection Agency PO Box 3000 Johnstown Castle Estate Co Wexford Y35 W821 IRELAND T: +353 53 91 60600 F: +353 53 91 60699 E: etradmin@epa.ie E: j.ponzi@epa.ie

b) The names of the other Parties with which the Party cooperates by maintaining their national registries in a consolidated system;

No change of cooperation arrangement occurred during the reporting period.

c) A description of the database structure and capacity of the national registry;

In 2016 new tables were added to the database for the implementation of the CP2 functionality. Versions of the Union Registry released after 6.1.6 (the production version at the time of the last National Communication submission) introduced other minor changes in the structure of the database. These changes were limited and only affected EU ETS functionality.

No change was required to the database and application backup plan or to the disaster recovery plan.

No change to the capacity of the national registry has occurred during the reporting period.

d) A description of how the national registry conforms to the DES between registry systems for the purpose of ensuring the accurate, transparent and efficient exchange of data between national registries, the clean development mechanism registry and the transaction log (decision 19/CP.7, para 1);

Each release of the registry is subject to both regression testing and tests related to new functionality. These tests also include thorough testing against the DES and were successfully

carried out prior to each release of a new version in Production. Annex H testing is carried out every year.

No other change in the registry's conformance to the technical standards occurred for the reporting period.

- e) A description of the procedures employed in the national registry to minimize discrepancies in the issuance, transfer, acquisition, cancellation and retirement of emission reduction units (ERUs), certified emission reductions (CERs), temporary certified emissions reductions (tCERs), long-term certified emission reductions (ICERs), assigned amount units (AAUs) and/or removal units (RMUs), and replacement of tCERS and ICERs, and of the steps taken to terminate transactions where a discrepancy is notified and to correct problems in the event of a failure to terminate the transactions;**

No change of discrepancies procedures occurred during the reporting period.

- f) An overview of security measures employed in the national registry to prevent unauthorized manipulations and to prevent operator error and of how these measures are kept up to date;**

The mandatory use of hardware tokens for authentication and signature was introduced for registry administrators.

- g) A list of the information publicly accessible by means of the user interface to the national registry;**

Publicly available information is provided via the Union Registry homepage for each registry – for Ireland, this is found at the following link:

<https://ets-registry.webgate.ec.europa.eu/euregistry/IE/public/reports/publicReports.xhtml>

See also the website of Ireland's Environmental Protection Agency:

<http://www.epa.ie/climate/emissionstradingoverview/union%20registry/publicreports/>

In accordance with the requirements of Annex E to Decision 13/CMP.1, all required information for a Party with an active Kyoto registry is provided with the exceptions as outlined below.

Account Information (Paragraph 45)

In line with the data protection requirements of Regulation (EC) No 45/2001 and Directive 95/46/EC and in accordance with Article 110 and Annex XIV of Commission Regulation (EU) No 389/2013, the information on account representatives, account holdings, account numbers, all transactions made and carbon unit identifiers, held in the EUTL, the Union Registry and any other KP registry (required by paragraph 45) is considered confidential.

The most up-to-date information may be accessed via the homepage of Ireland's domain on the Union Registry and on the website of Ireland's Environmental Protection Agency using the above referenced links.

JI projects in Ireland (Paragraph 46)

Note that no Article 6 (Joint Implementation) projects are reported as conversion to an ERU under an Article 6 project, as this did not occur in the reporting period.

Holding and transaction information of units (Paragraph 47)

Holding and transaction information is provided on a holding type level, due to more detailed information being declared confidential.

The detailed information on transactions is considered confidential according to Article 110 of Commission Regulation (EU) No 389/2013:

Information, including the holdings of all accounts, all transactions made, the unique unit identification code of the allowances and the unique numeric value of the unit serial number of the Kyoto units held or affected by a transaction, held in the EUTL, the Union Registry and any other KP registry shall be considered confidential except as otherwise required by Union law, or by provisions of national law that pursue a legitimate objective compatible with this Regulation and are proportionate.

The most up-to-date information may be accessed via the homepage of Ireland's domain on the Union Registry and on the website of Ireland's Environmental Protection Agency using the above referenced links.

Paragraph 47c

Ireland does not host JI projects.

Paragraph 47e

Ireland does not perform LULUCF activities and therefore does not issue RMUs.

For the first commitment period, Ireland did complete its LULUCF transactions for CP1 through the issuance of 17,901,299 RMUs for the activity Afforestation/Reforestation and the net source cancellation of 1,610,147 RMUs for the activity Deforestation.

Reference should be made to the final report on the individual review of the report upon expiration of the additional period for fulfilling commitments (true-up period) for the first commitment period of the Kyoto Protocol of Ireland.

The report is available on the UNFCCC webpage together with the true-up period assessment report (TUPAR) and the true-up period report submission by Ireland:

http://unfccc.int/kyoto_protocol/reporting/trueup_period_reports_under_the_kyoto_protocol/items/9049.php

Paragraph 47g

No ERUs, CERs, AAUs and RMUs have been cancelled on the basis of activities under Article 3, paragraphs 3 and 4 to date.

For the first commitment period, Ireland did complete the net source cancellation of 1,610,147 RMUs for the activity Deforestation.

Reference should be made to the final report on the individual review of the report upon expiration of the additional period for fulfilling commitments (true-up period) for the first commitment period of the Kyoto Protocol of Ireland.

The report is available on the UNFCCC webpage together with the true-up period assessment report (TUPAR) and the true-up period report submission by Ireland:

http://unfccc.int/kyoto_protocol/reporting/trueup_period_reports_under_the_kyoto_protocol/items/9049.php

Paragraph 47h

No ERUs, CERs, AAUs and RMUs have been cancelled following determination by the Compliance Committee that the Party is not in compliance with its commitment under Article 3, paragraph 1 to date.

Paragraph 47j

For the second commitment period CP2, no ERUs, CERs, AAUs and RMUs have been retired to date.

For the first commitment period, the total quantity of Kyoto Protocol units in Ireland's retirement account at the end of the true-up period, in accordance with paragraph 49(b) of the Annex to decision 13/CMP.1 totalled 308,508,846, comprising 280,189,478 AAUs; 4,294,121

ERUs; 17,901,299 RMUs; 11,811,627 CERs; 1,221,981 tCERs. No ICERS are held on the retirement account.

Reference should be made to the final report on the individual review of the report upon expiration of the additional period for fulfilling commitments (true-up period) for the first commitment period of the Kyoto Protocol of Ireland.

The report is available on the UNFCCC webpage together with the true-up period assessment report (TUPAR) and the true-up period report submission by Ireland:

http://unfccc.int/kyoto_protocol/reporting/trueup_period_reports_under_the_kyoto_protocol/items/9049.php

Paragraph 47k

Ireland requests to carry over 7,816,073 AAUs; 5,255,000 CERs and 74,964 ERUs from the first to the second commitment period of the Kyoto Protocol.

Ireland did complete a carryover of 5,255,000 CERs and 74,964 ERUs from the first to the second commitment period of the Kyoto Protocol in December 2016.

Reference should be made to the final report on the individual review of the report upon expiration of the additional period for fulfilling commitments (true-up period) for the first commitment period of the Kyoto Protocol of Ireland.

The report is available on the UNFCCC webpage together with the true-up period assessment report (TUPAR) and the true-up period report submission by Ireland:

http://unfccc.int/kyoto_protocol/reporting/trueup_period_reports_under_the_kyoto_protocol/items/9049.php

Entities authorised to hold Kyoto Units (Paragraph 48)

In line with the data protection requirements of Regulation (EC) No 45/2001 and Directive 95/46/EC and in accordance with Article 110 and Annex III of the Commission Regulation (EU) no 389/2013, the legal entity contact information (required by paragraph 48) is considered confidential.

The most up-to-date information may be accessed via the homepage of Ireland's domain on the Union Registry and on the website of Ireland's Environmental Protection Agency using the above referenced links.

h) The Internet address of the interface to its national registry;

No change of the registry internet address occurred during the reporting period. Ireland's domain of the Union Registry can be found at this link:

<https://ets-registry.webgate.ec.europa.eu/euregistry/IE/index.xhtml>

i) A description of measures taken to safeguard, maintain and recover data to ensure the integrity of data storage and the recovery of registry services in the event of a disaster;

No change of data integrity measures occurred during the reporting period

j) The results of any test procedures that might be available or developed with the aim of testing the performance, procedures and security measures of the national registry undertaken pursuant to the provisions of decision 19/CP.7 relating to the technical standards for data exchange between registry systems.

Both regression testing and tests on the new functionality are carried out prior to release of the new versions in Production. The site acceptance tests are carried out by quality assurance consultants on behalf of and assisted by the European Commission.

Annex H testing is carried out on an annual basis.

4. Policies and Measures

4.1 Introduction

Ireland's policy-making process in the area of mitigation has undergone a significant evolution in recent years, recognising the need for a coordinated approach across the key sectors with responsibility for Irish emissions. The following Chapters outline the evolution in policy and the central role played by Ireland's first statutory National Mitigation Plan, published in July 2017 pursuant to the Climate Action and Low Carbon Development Act 2015. This Chapter provides an overview of Ireland's overarching approach to reducing its greenhouse gas emissions, and gives a detailed breakdown of policies and measures at a cross-sectoral level, and in the areas of the built environment, transport, industry, renewable energy, agriculture, waste and forestry. The Chapter gives an outline of the evolution of policy in each area and describes the measures in place at end 2017.

4.2 Policy Making Process

4.2.1 National Policy Position

Ireland's National Policy Position on Climate Action and Low Carbon Development (2014) sets out the fundamental national objective of transitioning to a competitive, low carbon, climate-resilient and environmentally sustainable economy by 2050. It sets out the context for the objective, clarifies the level of greenhouse gas mitigation ambition envisaged and establishes the process to pursue and achieve the overall objective. Specifically, the National Policy Position envisages that policy development will be guided by a long-term vision based on:

- An aggregate reduction in CO₂ emissions of at least 80% (compared to 1990 levels) by 2050 across the electricity generation, built environment and transport sectors; and
- In parallel, an approach to carbon neutrality in the agriculture and land-use sector, including forestry, which does not compromise capacity for sustainable food production.

The National Policy Position envisages that the evolution of Irish climate policy will be a dynamic, iterative process, with the ultimate objective of successive mitigation plans and adaptation

frameworks incrementally achieving the required transition. It underlines the need to take a long-term view having regard to, inter alia, current and future obligations under EU or international agreements as well as the economic imperative for early and cost-effective action.

4.2.2 Climate Action and Low Carbon Development Act 2015

Ireland's *Climate Action and Low Carbon Development Act 2015* provides the statutory basis for the national transition objective – the goal of progressively pursuing a low carbon, climate resilient and environmentally sustainable economy by 2050. To enable achievement of this objective, the 2015 Act provides the legislative framework for the development and submission to Government for approval of national mitigation plans and national adaptation frameworks. This includes the institutional and governance framework for the development of these plans on a regular basis, together with independent advisory and accountability arrangements.

Ireland's policies in relation to adaptation and mitigation are given legislative underpinning by the 2015 Climate Act, and are driven in the main through the National Mitigation Plan and the National Adaptation Framework structures. Management of the majority of policies and measures implemented through these structures takes place at a national level, reflecting the limited role of regional and local government in Ireland.

4.3 Policies and Measures at the National Level

4.3.1 National Mitigation Plan

Ireland's first National Mitigation Plan, under the Climate Action and Low Carbon Development Act 2015, was published in July 2017, and represents an initial step to set the country on the pathway to achieve the level of decarbonisation required in order to achieve the national transition objective. The Plan contains a series of mitigation measures covering greenhouse gas emissions in the Electricity Generation, Built Environment, Transport and Agriculture sectors. These measures are outlined in greater detail later in the National Communication.

The Plan sets out an extensive list of mitigation measures already in place across the four sectors concerned, including measures introduced at EU level and domestic measures. The Plan also presents a range of proposals for further measures to reduce emissions.

The National Mitigation Plan recognises that the Irish Government has already implemented a wide range of policies and measures to reduce greenhouse gas emissions across the economy, and that proposals to further expand measures in place were under active consideration at the time of its publication. In addition to setting out the full range of measures that the Irish Government has already implemented or is considering to reduce Ireland's greenhouse gas emissions, the Plan includes over 100 individual actions to be implemented across Government in order to advance the national transition agenda. These actions are the individual building blocks that will enable the Government and wider society to implement deeper reductions in emissions in the years ahead. This will be an ongoing process aimed at incremental and permanent decarbonisation.

The National Mitigation Plan is subject to formal review under the 2015 Act at least once every five years and will also be updated on an on-going basis as analysis, dialogue and technological innovation generate further cost-effective sectoral mitigation options. In this respect, the Plan is a work in progress reflecting the reality of Ireland's decarbonisation transition. Following from its publication in July 2017, the Plan will be updated on an on-going basis as analysis, dialogue and technological innovation generate further cost-effective sectoral mitigation options. The actions outlined in this Chapter are in line with the "With Existing Measures" approach adopted for Ireland's National Mitigation Plan and as reported on under the Climate Action and Low Carbon Development Act 2015.

The National Mitigation Plan also identifies the need for a sustained, considered and strategic approach to incremental and permanent decarbonisation involving all of Government and society. Recognising that the climate challenge cuts across all sectors of society, concerted engagement by citizens, communities and wider civil society is needed.

In this regard, Ireland established a National Dialogue on Climate Action in 2017, the primary objective of which is to ensure an inclusive process of engagement and consensus building across society towards enabling the transformation to a low carbon and climate resilient future. The Dialogue will seek to create awareness, engagement and motivation to act (at local, regional and national levels) in relation to the challenges presented by climate change and to establish, on a long term basis, appropriate networks for people to meet periodically to consider evidence-based inputs on the economic, social, behavioural, environmental and public aspects of climate and energy policy.

4.4 Cross Sectoral Policies and Measures

4.4.1 Carbon Tax

A carbon tax of €15 per tonne was introduced in December 2009, initially solely on liquid based fuels for transport. In 2010, the tax was extended to liquid fuels for space and water heating in buildings. The rate at which the tax is set was increased to €20 per tonne in December 2011 for transport fuels and May 2012 in regards liquid fuels for space and water heating. The Carbon Tax was further revised in 2013 and was extended to include solid fuel products on a phased basis, at €10 per tonne from May 2013 and increased to €20 per tonne from May 2014.

Following the introduction of the carbon tax, the Sustainable Energy Authority of Ireland introduced a suite of Better Energy Schemes, the objectives of which include protecting those at risk of fuel poverty or, exposure to carbon tax in their homes.

Installations operating within the EU Emissions Trading System are exempt from the carbon tax as they already face a carbon price for their emissions. Additionally, installations involved in electricity generation, biofuels and the power used by CHP plants are exempt from the tax.

Carbon pricing will have a key role to play in Ireland's transition to a low carbon economy and has been recognised by the Climate Change Advisory Council as an important tool for Ireland to achieve its decarbonisation objective in a cost-effective manner by 2050.

The rate at which carbon tax is set will be kept under review to ensure that it is able to send a sufficiently strong signal to drive changes in household and business behaviour. As a first step towards the development of clear long-term signalling on the future evolution of carbon tax, Ireland's Department of Finance has commissioned further analysis to inform the policy direction of the tax, with an examination of the mitigation and distributive impacts of the carbon tax as implemented and an assessment of its possible future price evolution

4.4.2 EU Emissions Trading System

The EU Emissions Trading System (ETS) is a cornerstone of the European Union's policy to combat climate change and its key tool for reducing greenhouse gas emissions in a cost-effective manner. The EU ETS was launched in 2005 and is now in its third phase to cover the period 2013-2020. It covers CO₂ emissions from power and heat generation, energy-intensive industry sectors including oil refineries, steel works and production of iron, aluminium, metals, cement, lime, glass, ceramics, pulp, paper, cardboard, acids, bulk organic chemicals and aviation.

The ETS includes some 11,000 installations (101 currently in operation in Ireland of which 75 are industrial installations) with an installed capacity of more than 30MW. The majority of emissions covered by the ETS in an Irish context relate to certain aviation emissions and to those from dairy, refining, mining and power generation sectors and to the production of cement, aluminium, lime and pharmaceutical goods. Approximately 100 of Ireland's largest energy users across the power generation and industrial sectors are ETS participants. The EU ETS covers about 45% of EU emissions, but only 28% of total emissions in Ireland, reflecting the relatively limited heavy industrial base in Ireland.

4.4.3 Effort Sharing Decision

Emissions not covered by the ETS are legislated for under the EU Effort Sharing Decision (ESD), Decision 406/2009/EC. The European Union aims to reduce emissions from the non-ETS sector by 20% by 2020, compared with 1990 levels. The ESD established binding annual greenhouse gas emissions targets for EU Member States for the period 2013 to 2020. For the year 2020 itself, the target set for Ireland is that emissions should be 20% below their level in 2005..

The latest projections of greenhouse gas emissions by Ireland's Environmental Protection Agency indicate that emissions from those sectors of the economy covered by Ireland's 2020 targets could be between 4% and 6% below 2005 levels by 2020. The projected shortfall to Ireland's targets in 2020 reflects both the country's constrained investment capacity over the past decade due to the economic crisis, and the extremely challenging nature of the target itself.

The legislative framework of the ESD includes a number of flexibility mechanisms to enable Member States to meet their annual emissions targets, including provisions to bank any excess allowances to future years and to trade allowances between Member States. Using banked emissions from the period to 2015, Ireland is projected to comply with its emission reduction targets in each of the years 2013 to 2018. However, cumulative emissions are expected to exceed targets for 2019 and 2020, which will result in a requirement to purchase additional allowances.

Emissions covered by the ESD in Ireland relate in the main to the transport, agricultural and built environment sectors.

4.4.4 Flexible Mechanisms of the Kyoto Protocol

In accordance with Ireland's obligations under the first commitment period of the Kyoto Protocol, Ireland's Carbon Fund Act 2007 designated the National Treasury Management Agency as the Irish Government's purchasing agent. An assessment of the cross-sectoral measures in place at that time under the National Climate Change Strategy 2007 suggested that Ireland would require the use of flexible mechanisms including the purchase of Kyoto Protocol units in order to comply with its targets. Accordingly Ireland invested in three funds created by the World Bank and the European Bank for Reconstruction and Development. The subsequent economic downturn, however, reduced the requirement for these units significantly. Ireland's compliance strategy oversaw the purchase and cancellation of a number of units generated by these funds during the 2008-2012 compliance period and holds circa 5.3 million units in its national registry. These can be used to assist with compliance under the Effort Sharing Decision in future years.

4.4.5 Spatial Policy

Good spatial planning has the potential to deliver emission reductions through developing integrated and efficient transport systems that reduce dependence on the private car. Ireland's National Spatial Strategy, published in 2002 and covering the period to 2020, aimed to improve the balance of social, economic and physical development across Ireland by providing a framework for planning at national, regional and local level.

The National Spatial Strategy was superseded in February 2018 by the launch by the Irish Government of Project Ireland 2040. This overarching policy initiative consists of a National

Planning Framework which sets out a spatial strategy for the country, and a national infrastructure investment programme, the National Development Plan 2018-2027. Project Ireland 2040 includes a national strategic outcome of the transition to a low-carbon and climate-resilient society, in line with Ireland's National Policy Position, and sets out a planned €21.8 billion investment over the 2018-2027 period. This will seek to reduce Ireland's carbon emissions over the period to 2030 and to ensure that Ireland is on a sustainable trajectory towards securing the National Policy Position. The initiative adopts a cross-sectoral approach encompassing taxation measures, expenditure, regulation and behavioural change, targeting emissions from the transport, energy and agriculture sectors while also recognising the need to invest in climate resilience including substantial investment in flood relief schemes to minimise the impact of river and coastal flooding.

The National Planning Framework is based on a set of values that will ensure Ireland's long term economic, environmental and social progress for all parts of our country. In framing a new way forward, the National Planning Framework draws upon lessons learned from the National Spatial Strategy and highlights a vision of success based on better choices compared to a 'business as usual' approach.

The ultimate objective of the NPF is to guide the future development of Ireland, taking into account a projected 1 million increase in the country's population, the need to create 660,000 additional jobs to achieve full employment and a need for 550,000 more homes by 2040;

- Of the 1 million extra people,
 - 25% of the population increase is planned for Dublin, recognised as the country's key international and global city of scale and principal economic driver,
 - 25% is planned across Ireland's other four cities combined (Cork, Limerick, Galway and Waterford), enabling all four to grow their population and jobs by 50-60%, and become cities of greater scale, i.e. growing by twice as much as they did over the previous 25 years to 2016, and
 - the remaining 50% of growth will occur in key regional centres, towns, villages and rural areas, to be determined in the forthcoming regional plans – Regional Spatial and Economic Strategies (RSEs).

- The NPF aims to enable people to live closer to where they work, moving away from the current unsustainable trends of increased commuting;
- The Framework will regenerate rural Ireland by promoting environmentally sustainable growth patterns;
- The NPF plans for and will implement a better distribution of regional growth, in terms of jobs and prosperity;
- The Framework aims to transform settlements of all sizes through imaginative urban regeneration and bring life / jobs back into cities, towns and villages;
- The NPF will co-ordinate delivery of infrastructure and services in tandem with growth, through joined-up NPF/National Investment Plan and consistent sectoral plans, which will help to manage this growth and tackle congestion and quality of life issues in Dublin and elsewhere

The location of schools, jobs, shops, local services and other land uses relative to the location of residential developments are critical determinants of the need to travel, the distances to be travelled and the modes of transport chosen. The provision of sustainable transport alternatives can only be effective if matched with complementary development patterns which support and facilitate their use. Public transport use and modal shift can be encouraged through efficient planning.

4.5 Built Environment

4.5.1 New Buildings

More Energy Efficient Building Regulations

Part L – Conservation of Fuel and Energy in Buildings, one of twelve parts comprising the Second Schedule of the Building Regulations, is in place to limit the energy use and carbon dioxide emissions from a building as far as is practicable and requires an energy performance and carbon dioxide emissions performance that is 60% better than the 2005 Part L requirements. This is recognised as an advanced energy performance requirement for buildings.

The Energy Performance of Buildings Directive requires that all new buildings (public and private) are Near Zero Energy Building Standard (NZEB)³⁴ by 2020. It also requires that new buildings owned and occupied by public authorities are NZEB after 2018.

Part L of the Building Regulations for Dwellings sets the NZEB performance for buildings completed after the 31st December 2020, which represents a 70% improvement in energy performance when compared with the 2005 Part L requirements.

This measure will bring about significant reductions in carbon emissions from all new buildings other than dwellings completed after the 31st December 2020.

4.5.2 Existing Buildings

The Sustainable Energy Authority of Ireland, Ireland's national sustainable energy authority, is responsible for the administration of schemes aimed at improving the energy efficiency of buildings in the country.

Public Sector Buildings

SEAI Public Sector Energy Programme: This Programme offers comprehensive support and engagement to guide public bodies in reaching their energy saving targets. The SEAI Public Sector Energy Programme is an essential pillar of Ireland's National Energy Efficiency Action Plan and the Irish Government's Public Sector Energy Efficiency Strategy. SEAI provide the tools, training, and advice to integrate energy management into the general management of public sector organisations. Examples of resources provided include: Energy management training and mentoring (ISO50001 or Energy MAP); Onsite energy assessments; Energy efficient design; Energy project implementation; Dedicated energy advisor; Energy reporting advice; and Best practice guidance and networking.

Residential Buildings

SEAI Better Energy Communities Programme:

³⁴ The Directive defines a NZEB as a building that has a very high energy performance and that the nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby. This definition was incorporated in the Building Regulations earlier this year by way of Statutory Instrument (S.I. No. 4 of 2017 Building Regulations (Amendment) Regulations)

This national retrofit initiative is aimed at upgrading building stock and facilities to high standards of energy efficiency and renewable energy use, thereby reducing reliance on fossil fuels, reducing both energy costs and GHG emissions. The Programme supports community energy projects in Ireland and has supported 300 community energy efficiency projects since 2012. As a result over 15,000 homes and hundreds of community, private and public buildings have received energy efficiency upgrades, supporting several hundred jobs each year.

In 2016 funding provided for energy efficiency upgrades to more than 2,600 homes and almost 300 community and commercial facilities. The total investment in energy efficiency is almost €48 million, supporting more than 700 direct and indirect jobs right across the country.

SEAI Better Energy Homes Programme: The SEAI Better Energy Homes Programme is a Government programme which gives fixed cash grants for insulation and heating system upgrades, helping to make your home more comfortable and cheaper to run. It is available to all owners of homes built before 2006.

SEAI Better Energy Warmer Homes Programme: The Better Energy Warmer Homes scheme (BEWH) funds energy efficiency improvements in the homes of the elderly and vulnerable, making the homes more comfortable, healthier and more cost effective to run. BEWH measures are installed at no cost to the recipient household.

SEAI EXEED (Excellence in Energy Efficient Design) Programme: The key objective of this grant scheme is to incentivise and support the uptake and application of EXEED Certified projects. The EXEED Grant Scheme provides grant support of up to €250,000. It covers up to 50 % for professional services in the pre-investment stage and also up to 30 % of additional capital being expended on opportunities identified through the process and being implemented. The grant scheme is relevant to: new design projects of any scale complexity and sector; and major energy upgrades of existing workplaces and assets. SEAI also provides mentoring, information and advice both at group and individual project levels.

Warmth & Wellbeing Programme: The Warmth and Wellbeing Scheme aims to make homes warmer and healthier to live in. It does this by providing extensive energy efficiency upgrades to those in energy poverty, which are living with Chronic Obstructive Pulmonary Disease (COPD) and Asthma. The initiative is led by the Department of Communications, Climate Action and Environment in conjunction with the Department of Health and the Health Services Executive (HSE). The scheme carries out home energy upgrades delivered through SEAI's 'Better Energy Warmer Homes'

contractors. Works include: Standard attic insulation and appropriate ventilation; wall insulation: cavity, dry lining or external; boiler replacement as appropriate (oil or gas); and draught proofing as appropriate.

Social Housing

Energy Efficiency Retrofitting Programme

Ireland's local authority network is currently undertaking an ambitious programme of insulation retrofitting, with the support of the Department of Housing, Planning and Local Government, on the country's least energy efficient social homes. The purpose of this Programme is to ensure that the stock of over 130,000 local authority-owned dwellings achieves an improved level of energy performance, reduces emissions and yields an important fuel poverty dividend for low income households.

This Programme is aided by the local authorities engaging in partnerships with "participating energy suppliers" under an SEAI incentive for "obligated parties" to collect KWhr credits (Kilowatt-hour). It resulted in local authorities gaining assistance and valuable experience in modern retrofitting methods, free pre-works inspections and post-works Building Energy Ratings (BERs) for their upgraded stock.

An Energy Efficiency Retrofitting Programme, which started in 2013, has seen successful improvements to over 65,000 dwellings under Phase 1 which provides basic easy-to-install insulation and ventilation control packages to existing uninsulated dwellings. Success is based on the overall objective of reducing greenhouse gas emissions and measured with the National Building Energy Rating Certificate. Phase 2 will continue the process of 'wrapping' all types of dwellings with a high level of insulation which will enable Ireland to proceed to reduce heating input elements with a more significant reduction in energy demand.

4.6 Transport

Reducing emissions in the transport sector will require a significant step-change in how we travel, how we do business and the types of fuels and technologies we employ. A number of successful measures have already been introduced to reduce transport emissions including: sustained investment in the public and sustainable transport network to increase capacity and promote modal shift; implementation of EU regulations limiting tail pipe emissions; redesigning the Vehicle Registration Tax (VRT) and motor tax regimes to promote low carbon emitting vehicles; incentives to encourage alternative fuel and technologies; and the introduction of a Biofuel Obligation Scheme.

4.6.1 Investment in Sustainable Transport and Promoting Modal Shift

Transport climate emission reduction efforts must be reinforced by continued investment in sustainable (public and active) transport capacity increases and quality improvements to secure high levels of modal shift. It is essential, where feasible, to supply a meaningful alternative to the car which accounted for 74% of all journeys in Ireland in 2015. The allocation of capital funding for public transport under the Government's Capital Plan "*Building on Recovery Infrastructure and Capital Investment 2016-2021*" is €3.6 billion, funding capacity enhancements to the public transport system including a new light rail line expected to provide an additional ten million passenger journeys annually; renewal and replacement of bus fleets; extending electrification of the rail network; commencing construction of a new Metro link between the city centre and the airport; and other improvements to the bus and rail networks to improve efficiency and capacity. A Green Public Transport Fund was also established in 2017 to provide funding for pilot low emission vehicle programmes in the public transport fleet.

In addition, the Department of Transport, Tourism and Sport is focused on the promotion of walking and cycling through the provision of funding for infrastructure as well as behavioural change programmes to encourage the use of more sustainable transport modes. This Smarter Travel is allocated €100m funding under the *Capital Plan Building on Recovery: Infrastructure and Capital Investment 2016-2021*. According to the findings of the annual City Centre Cordon Count (2016) sustainable travel (public transport, walking or cycling) accounted for over two thirds of all journeys into Dublin at peak morning times, up from 59% of journeys in 2010.

Census results indicate that cycling to work has shown the largest percentage increase of all means of transport, rising from 39,803 in 2011 to 56,837 in 2016, an increase of 42.8% over five years. The Public Bikes scheme has been a great success, there are c. 65,000 registered users in Dublin with a

further 14,500 users in the regional cities. There are a number of policy developments on-going and underway in the cycling sphere, namely: the roll-out of a new national cycling standard, '*Cycle Right*', to provide a consistent approach to cycle training in national schools and a review of the *National Cycle Policy Framework* due for publication later in 2017. Likewise, the number of people recorded as walking into Dublin City Centre during the City Centre Cordon Count has also risen significantly from 19,711 in 2014 to 21,473 in 2016 indicating that continued investment in enhancing the capacity of sustainable transport options has provided viable alternatives to private car use.

Investment continues into integrated ticketing, journey planners, on-board Wi-Fi and real time passenger information help to make public transport an attractive travel mode. The integrated ticketing system – the Leap card - has been a resounding success since its launch in December 2011. By end-2016 approximately half of all passenger journeys were taken using Leap Cards. The Real Time Passenger Information (RTPI) programme continues to be rolled out with over 700 RTPI signs in operation nationally displaying easy-to-read departure times and passenger information. The National Journey Planner, available online and as an app, provides door-to-door information for all journeys in Ireland including journeys on foot and by all modes of public transport. Usage of the software is growing and during November 2016 alone the system received 3.8 million requests and calculated 1.2 million trips.

Tax incentives have been successfully employed to promote sustainable transport usage. The Cycle to Work Scheme was established in 2009 to encourage more people to cycle to work, thereby contributing to lowering emissions, reducing congestion and improving health and fitness levels. Under the scheme, employees can save up to 52% of the retail price of bike and equipment and Employer's Pay Related Social Insurance (PRSI) is not payable on the cost of the bicycle and/or safety equipment. The Tax saver Scheme was introduced in 1999 to incentivise the use of public transport for commuting. Currently, over 3,500 companies are registered with the Scheme saving up to 10.75% in PRSI, while employees can save between 29% - 52% on the regular transport ticket price.

DTTAS continues to support mobility management programmes through the NTA. The NTA administers the Green Schools Travel Programme (run by An Taisce), which engages the country's school children with regard to sustainable transport – and is currently being rolled out to 210,000 pupils and 20,000 teachers in the period 2015 to 2018. 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 of the environmental impacts of our transport choices. The 2015 -2018 programme places a particular focus on schools located in areas that have the infrastructure available to them to support sustainable modes of travel to and from schools.

Smarter Travel schemes continue to be rolled out in workplaces for large employers, employment clusters and third level institutions. As of October 2016, 274 employers and 30 third level institutions were actively engaged with finding and promoting alternative and sustainable modes to travel to work or college. Survey results across these organisations would indicate that while 50% of people use the car as their main travel mode, 4% car share the other 46% are using more sustainable modes of travel with 29% using public transport and a further 16% either walking or cycling to their destination on a daily basis.

4.6.2 Improving Energy Efficiencies in the Public Transport System

Within public transport a number of energy saving initiatives have been undertaken by service providers/operators through adopting various technological solutions and instigating driver behaviour change programmes. Many public transport operators carry out eco-driving programmes as part of their driver training programmes. Eco-driving is the energy efficient use of vehicles through altered driving techniques that can lead to average fuel savings of 5-10% and corresponding CO₂ emissions reductions. Sustained investment in fleet replacement also continues to yield ongoing fuel savings. The new vehicles are more efficient than the vehicles being replaced and are compliant with the latest Euro engine standards.

Technological advances in the production of newer buses also had the benefit of reduced maintenance requirements and energy resource consumption. Bus Éireann have noted that typical fuel savings on their Euro VI vehicles tend to be 6-8% when compared to Euro V equivalents. Other energy saving initiatives include the reconfiguration of train carriages to effectively match passenger numbers; new traction control software; Automatic Engine Start Stop (AESS) systems; regenerative braking systems and generally reducing rolling resistance and overall un-laden vehicle weight. Developing technologies and alternative fuel sources will also continue to be monitored including hybrid, CNG and full electric systems. It is estimated that collectively through modal shift to sustainable travel means, improved behaviour and infrastructure a total of 159 kt CO₂eq can be saved between 2017 and 2020.

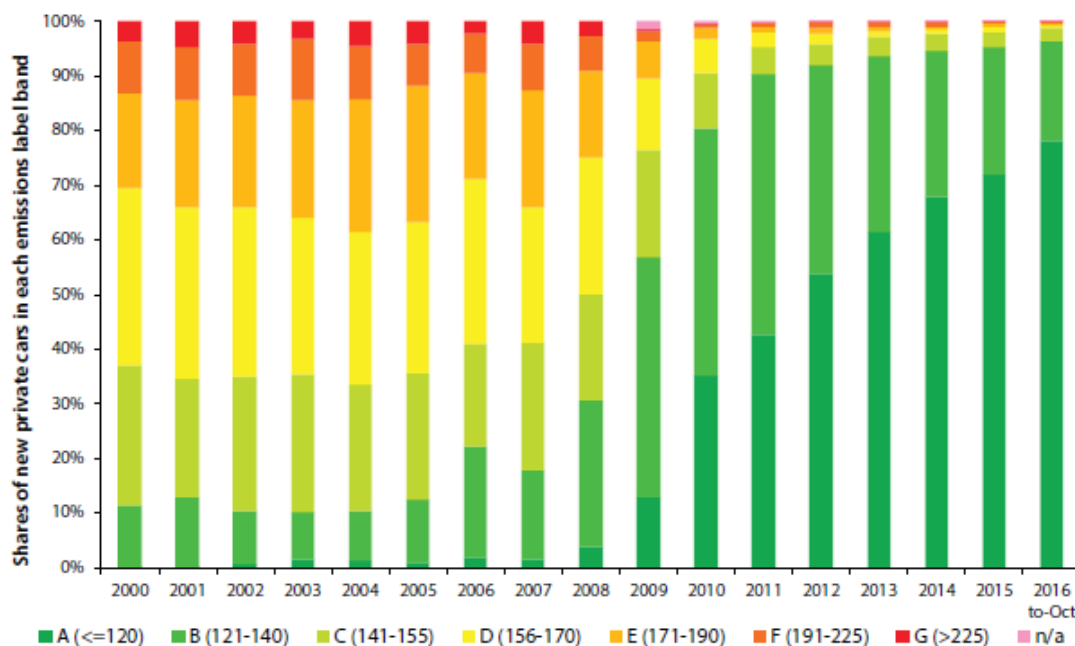
The Public Sector Energy Efficiency Strategy, published in January 2017, highlights the role that the public sector fleet can play in testing new technologies, facilitating and accelerating market uptake of new technologies such as alternative fuels usage and improving the environmental performance and fuel efficiency of the sector at the same time. Beyond fleet focused measures, there is also

scope for the promotion of energy efficient measures through modal shift with a focus on travel choices made by public servants.

4.6.3 Implementation of EU Regulations and Rebalancing VRT and Motor Tax

EU legislation sets mandatory emission reduction targets for new cars and vans sold in Europe. A complementary suite of national tax policies were introduced to ensure that these EU driven technology improvements were impacting on the composition of the national car fleet more quickly compared to EU measures alone. The EU legislation required that average emissions from new cars registered in the EU would be less than 130g CO₂/km by 2015. By 2021, phased in from 2020, the fleet average to be achieved by all new cars is 95g CO₂/km. The 2015 and 2021 targets represent CO₂ reductions of 21% and 42% respectively compared with the 2007 new passenger car fleet average of 164g CO₂/km. The regulation has driven car manufacturers to develop innovative energy efficient technologies and has greatly increased the availability of lower emission vehicles in the Irish market. Similar targets have been set for new commercial vans with a requirement that they do not emit more than an average of 175g CO₂/km by 2017 and that by 2021 the average emissions fall to a target of 147g CO₂/km (19% less than the 2012 average). The successful implementation of these regulations in the short to medium term is fundamental in reducing carbon emissions.

In 2008, to achieve the maximum impact of the EU drive to reduce vehicle emissions, the Irish vehicles registration and annual motor taxation systems were transformed to a CO₂ emissions rather than engine size basis. The tax changes had an immediate and substantial positive effect in changing buyer behaviour encouraging the take up of low CO₂ emission vehicles, with those choosing to purchase lower-emission vehicles paying less in VRT and motor tax. In 2013 further revisions to the structure were implemented, splitting the lowest CO₂ Band 'A' (1 - 120g/km) into four new bands and Band 'B' (121 - 140g/km) into two new bands. A zero emissions band for electric vehicles was also introduced for motor tax purposes. There has been a marked change in the proportion of new cars purchased within the lower emission bands as shown in Figure 4.1; new private cars sold in the A emission band rose from just 1.5% in 2007 to 78% in 2016. Cars with CO₂ emissions of 140 g/km or higher now comprise just 4% of new car purchases.

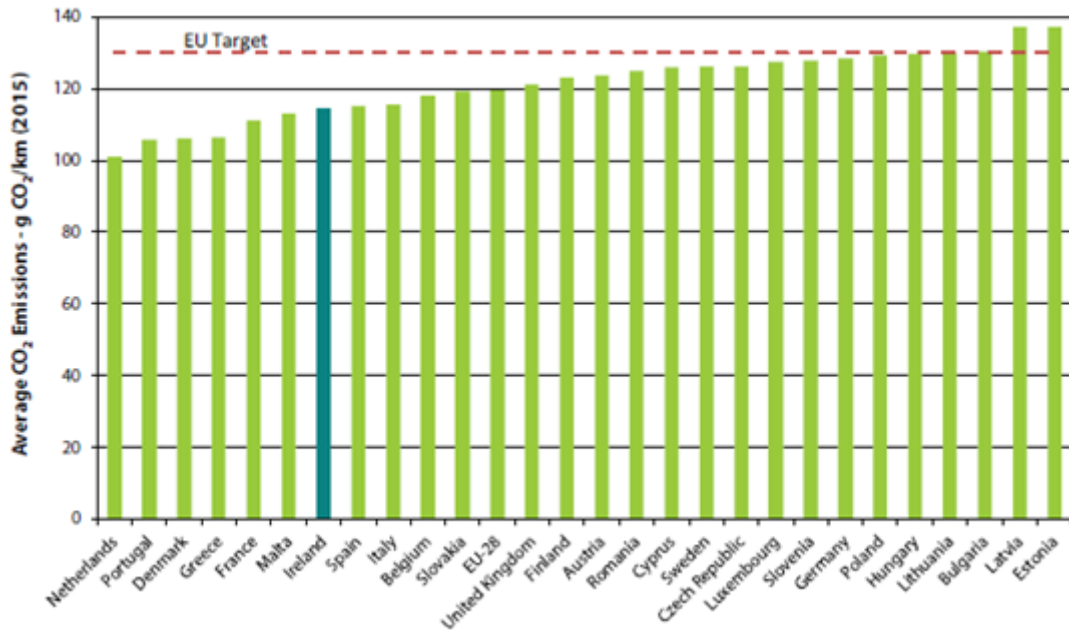


* Source: Based on Vehicle Registration Unit data

Figure 4.1: Share of New Private Cars in each Emissions Band 2000 – 2015 (+2016 to October)

The net effect of rebalancing the motor tax and VRT regimes was a significant change in purchasing behaviour towards lower emitting vehicles. This has accelerated the reduction of carbon emissions within the national fleet and significantly improved fuel and energy savings over the lifetime of each vehicle. New cars entering the fleet are now approximately 25% more energy efficient than they were in 2007. In Ireland, the average new car purchased in 2007 produced 164g CO₂/km, by 2015 this had fallen to c. 116g CO₂/km. As Figure 4.2 shows, this puts Ireland ahead of many EU Member States.

However, the impact of the measure was curtailed due to the dramatic decrease in new car sales during the recession; as of 2015 only 41% of the national fleet had transitioned to the new taxation system. With car sales back on the rise it is expected that the effect of rebalancing the system will develop further, helping to make the car fleet more CO₂ efficient. Estimates in the National Mitigation Plan suggest that the continued implementation of EU legislation alongside the rebalanced tax policies will yield a reduction of 3,013 and 677 kt CO₂ eq respectively between 2017 and 2020.



Source: European Environment Agency

Figure 4.2: Average CO₂ Emissions of New Passenger Cars by Member State, 2015

4.6.4 Incentives to Encourage Alternative Fuel and Technologies

A transition to alternatively fuelled vehicles will be required to effect a transformative reduction in national transport emissions. Ireland's *National Policy Framework on Alternative Fuels Infrastructure for Transport in Ireland: 2017-2030* sets an ambitious target that from 2030 all new cars and vans sold in Ireland will be zero emission (or zero emission capable) and that other technologies, perhaps still unknown, will be fuelling larger vehicles, so that by 2050, the nation's car fleet, along with much of our public transport buses and rail lines, will be low/near zero emissions. In the meantime, Ireland is seeking greater diversification of fuels in the freight sector to include a mix of natural gas, biogas, electricity (light vans) and renewable diesel or other biofuels.

The *Framework* includes a range of measures aimed at supporting the uptake of low emission vehicles and addresses infrastructure requirements to ensure an appropriate level national recharging network, including electric vehicle (EV) charging points and natural gas refuelling stations; it is expected the implementation of similar Frameworks across Europe will reassure car manufacturers and investors of the EU's long term commitment to the adoption of vehicles powered by alternative fuels. In addition a number of fiscal incentives have been put in place to support the uptake of alternative fuel vehicles and technologies, predominately relating to electric vehicles (EVs) for the car fleet and natural/bio- gas for the HGV and bus fleets.

Ireland's *Programme for a Partnership Government* commits to become a leader in the take-up of EVs. A dedicated Low Emission Vehicle Taskforce was established in December 2016 to consider a range of measures and options available to Government to accelerate this uptake; it is expected that the Taskforce will make their EV recommendations over the coming months. There are a number of supports already in place to stimulate the market for EVs in Ireland; in April 2011 a purchase grant programme was launched consisting of a €5,000 grant as well as VRT relief of up to €5,000. Relief from VRT is also available for hybrids up to €1,500 and plug-in electric hybrid vehicles up to €2,500. Additionally, Ireland's Finance Act 2017 provided for a 0% taxation rate to apply to benefit-in-kind for EVs. A nationwide rollout of EV charging points was undertaken with over 1,200 public, standard and fast charge points across the country. In addition, domestic chargers and installation costs were provided free of charge for the first 2,000 successful applicants.

Despite the suite of generous incentives available, by Q3 of 2017 there were just over 3,000 EVs licensed in Ireland. There are a range of factors accepted internationally as being barriers to transition to EV technology including limited vehicle choice, range anxiety and low consumer awareness. This slower than anticipated transition is not Ireland-specific and does not indicate a lack of ambition or support. It is expected that increasing range performances, technology advancements, greater affordability and improved consumer choice will trigger large-scale change in EV purchasing patterns.

In the HGV and bus sector full electrification is not expected in the short/medium term, instead a range of alternative fuels such as biogas, biofuels, hydrogen, compressed natural gas (CNG) and liquid natural gas (LNG) are likely to power the sector in the shorter term. In order to support development of alternative fuels for the freight sector the excise rate for natural gas (NG) and biogas was set at the EU minimum rate for a period of eight years and the accelerated capital allowance scheme will be broadened to include vehicles and refuelling equipment powered by NG in the coming months. These measures should incentivise the adoption of NG as a transport fuel by putting CNG in a competitive position in relation to diesel. Importantly, the uptake of NG is seen as providing a pathway for the future use of biogas in the transport sector.

4.6.5 Biofuels Obligation Scheme

The biofuels obligation scheme commenced on 1 July 2010, and is administered by the National Oil Reserves Agency. The Scheme was launched to ensure that a proportion of the transport fuel used in the State consists of environmentally sustainable biofuels by placing an obligation on suppliers of road transport fuels to ensure that a proportion of the fuels they place on the market here are produced from renewable sources. The initial rate of the obligation has increased over time from a share of 4.166% in 2010 to 8.695% (by volume) from 2017. This obligation scheme will be a key component to achieving a 10% penetration of renewable energy in transport by 2020 – to which the Government has committed under the Renewable Energy Directive.

A weighting system is applied whereby biofuels produced from wastes and residues qualify for two biofuel obligation certificates per litre. The weighted share of biofuels in transport energy in 2015 was 5.7% over half way towards meeting the 2020 target of 10%. The avoided CO₂ emissions associated with biofuels usage in transport are calculated on the basis of an assumed 100% displacement of emissions from conventional fuels. It was estimated that the scheme reduced CO₂ emissions by 356 kilotonnes in 2015 alone. It was estimated that the scheme reduced CO₂ emissions by 356 kilotonnes in 2015 alone. It is anticipated that implementation of the biofuel obligation scheme will yield cumulative GHG emissions reduction of 2,161kt CO₂ eq between 2017 and 2020; if the obligation rate was increased to 10.3% by volume in order to reach the 10% RES-T target a further 322 kt CO₂ eq would be saved. While other forms of renewable energy will play an important role in transport by 2020, it is expected that biofuels will retain a substantial role, and that successively higher obligations rates will be required to deliver that 10% target.

4.6.6 The National Car Test (NCT)

The NCT is conducted every 2 years for vehicles 4 years and older, and annually for vehicles 10 years and older. This regular roadworthiness testing of cars is aimed at improving vehicle safety standards and includes a 'Tail Pipe Opacity Test' to determine, in as far as possible (the test is in compliance with Directives 2009/40/EU and 2010/48/EU, but does not provide a chemical analysis of the emissions from the vehicle), that engines are operating normally.

These checks help to reduce fuel consumption and the environmental impact of private vehicles used on Ireland's roads. Heavy vehicle (HGVs) roadworthiness testing, which also include such 'Tail Pipe Opacity Tests', are conducted through the Commercial Vehicles Roadworthiness Testing (CVRT)

regime. 'Eco-driving' of HGVs has been by way of targeted projects within commercial fleets through Sustainable Energy Authority of Ireland projects.

4.7 Industry & Commercial

The economy of Ireland is a modern knowledge economy, focusing on services and high-tech industries, and dependent on trade, industry and investment. Key sectors include Food & Drink, Pharmaceuticals, Financial Services, Aircraft Leasing, ICT (including Software), Medical Devices and Engineering. Primary production (Agriculture, Fishing and Forestry) contributes almost 6% of GDP in Ireland (2016). Ireland's comparatively light industrial base is a direct result of the low levels of industrialisation during the 19th and 20th centuries that occurred throughout much of Western Europe, with only moderate levels of industrialisation occurring since the 1980s. This has benefitted Irish industry as regards its environmental performance and is a key factor in explaining the relatively low emissions intensity of the sector thanks to its relative modernity and high levels of ongoing investment in decarbonisation technologies which have been aided by a strong Irish innovation performance. A significant challenge now exists following a recent period of under-investment in the private sector resulting from the economic crisis which has resulted in a pent-up need to invest in further industrial decarbonisation and RD&I in low-carbon technologies to decrease the carbon footprint of Irish industry further

As illustrated in Chapter 3, Ireland's industry sector has demonstrated an impressive level of decarbonisation over the past 25 years, which has led to an effective decoupling of energy consumption (and related emissions) and economic output. Since 1990, GDP in Ireland has increased more than four-fold, while greenhouse gas emissions have risen only very slightly (up 6.7% in 2015), and emissions from industrial processes have fallen by 38% over the same time period.³⁵ This success has been supported by the SEAI, as outlined in **section 4.5.2**, and also by general awareness-raising among the wider business and industrial community about the many benefits (e.g. financial, improved corporate social responsibility) of reducing energy use and related emissions.. Participation in the EU Emissions Trading System (ETS) has also played a significant role in curbing greenhouse gas emissions across Europe. The EU ETS is the main mechanism by which the EU aims

³⁵ <http://www.epa.ie/pubs/reports/air/airemissions/ghgemissions/>

to reduce industrial emissions. Its application in an Irish context, including to Irish industry, is outlined in Chapter 4.4.2

4.7.1 Energy Efficiency in Industry

Ireland provides a number of state-funded supports for businesses to improve energy efficiency and decarbonise their activities. Some of these supports, such as the Accelerated Capital Allowance scheme, are cross sectoral and are outlined in Chapters 4.4 and 4.5.2. Additionally, a targeted approach aimed at a network of the largest industrial energy users (LIEN) has identified best practice on energy management and energy cost reduction. The LIEN comprises almost 200 of Ireland's largest energy users, accounting for 19% of TPER and 55% of industrial energy requirement. Participation in the LIEN requires a commitment from individual companies to set annual targets in relation to their energy performance and then to report against that target. Members have access to a range of best practice initiatives including networking event, case studies, training and awareness supports, guides and tools, while a more structured approach to energy management is encouraged through support for the ISO50001 Standard. This National Standard Authority of Ireland certification has since been augmented by the Energy Efficiency Management Standard IS399. These industrial standards have received a significant degree of international interest.

Small and medium-sized enterprises (SMEs) in Ireland have also benefitted from advice and training support on energy management; SMEs account for the vast bulk of the enterprise sector in Ireland. Continuation of the Accelerated Capital Allowances for energy-efficient equipment in businesses to support reduced energy use is also seen as an important support for the enterprise sector.

4.7.2 Accelerated Capital Allowances

The Accelerated Capital Allowance (ACA) scheme introduced in the Finance Act 2008 provides for a system of accelerated capital allowances for the purchase of energy efficient capital assets. This scheme enables businesses to write off the entire cost of a specified set of energy efficient products in the first year of purchase. Normally depreciation or wear and tear of assets can only be written off against profits gradually over eight years. The Minister for Communications, Climate Action and Environment, with the consent of the Minister for Finance designates equipment as allowable under

this scheme. The coverage of asset type extends across motor vehicles (including EVs), hotel and catering equipment, refrigeration and cooling systems, ICT and other sectors. The full list of allowable investments is maintained on the website of the Sustainable Energy Authority of Ireland³⁶.

A database of products eligible for the Accelerated Capital Allowance (ACA) tax incentive, the TripleE register, aims to increase awareness and improve access to energy-efficient equipment, leading to increased market penetration. Combined with increased interest from the private sector, a particular driver for this activity is the European Union Energy Efficient Public Procurement Regulations 2011³⁷ which requires public bodies to only procure equipment or vehicles that are listed on the register.

The ACA scheme was extended to run until end 2020.

4.7.3 Green Public Procurement

The European Union administers a Green Public Procurement (GPP) policy, which is voluntary but underpinned by legislative requirements for certain sectors. GPP was introduced in Ireland in 2012, requiring that all public authorities seek to source goods, services or works with a reduced environmental impact. Ireland's GPP strategy, administered by the Department of Communications, Climate Action and Environment in association with the Office of Government Procurement (under the aegis of the Department of Public Expenditure and Reform), covers 50% of all goods and services tendered annually. Public bodies also play their part in applying the guidance prepared by the EPA on GPP as a policy tool to drive energy efficiency and to deliver key elements of the Plan.

4.7.4 Eco-Design

There is worldwide demand for more efficient products to reduce energy and resource consumption. The EU legislation on eco-design and energy labelling is an effective tool for improving the energy efficiency of products. It helps eliminate the least performing products from the market, significantly contributing to the EU's 2020 energy-efficiency objective. It also supports enterprise

³⁶ http://www.seai.ie/Your_Business/Accelerated_Capital_Allowance/ACA_Categories_and_Criteria/

³⁷ EU (Energy Efficient Public Procurement) Regulations 2011, S.I. No. 151 of 2011

competitiveness and wider innovation by promoting better environmental performance of products throughout the EU's Internal Market.

4.7.5 Green Finance

The International Financial Services (IFS2020) Strategy is a whole-of-Government approach to driving the growth and development of international financial services in Ireland. The Strategy builds on previous policy by raising the profile of Ireland's green finance sector, working with international funds and developing the green agenda at a national and regional level. In 2015, Sustainable Nation Ireland was created with the objective of stimulating greater investment into smart innovations, new enterprises and sustainable business practices. It brings stakeholders from a range of finance industries together with industries working in the low-carbon sector to create domestic and international opportunities.. Its Sustainable Finance programme, mandated by Ireland's Department of Finance, aims to raise awareness of the Sustainable and Responsible Investment agenda and to promote and position Ireland as an international hub for Green Finance.

In this regard, Sustainable Investment Ireland oversees two initiatives, SIF Ireland ³⁸and Finance Green Ireland³⁹.

SIF Ireland provides a platform for policy makers, capital providers and intermediaries to advance responsible and sustainable investment. Finance Green Ireland represents Ireland's response to the global call to mobilise investment to tackle climate change. In line with a commitment in Ireland's National Mitigation Plan, it advocates for policy and regulatory certainty to support domestic and international capital to contribute to Ireland as a Sustainable Nation..

4.7.6 Bioeconomy

In July 2017 the Irish Government published a discussion document on the bioeconomy – those parts of the economy that use renewable resources from land and sea. Submissions have been invited on the document, which will inform a National Policy Statement to drive developments in the

³⁸ <https://www.sustainablenation.ie/sifireland/>

³⁹ <https://www.sustainablenation.ie/finance-green-ireland/>

area. The Irish National Mitigation Plan, Action Plan for Jobs and Action Plan for Rural Development all contain commitments to the strategic development of Ireland's bioeconomy.

The Department of Business, Enterprise and Innovation (DBEI) undertook a Technology Futures analysis that identified technologies that will have a significant impact on Ireland including in the area of the bioeconomy. Enterprise opportunities in the bioeconomy have also been identified in the DBEI Markets Horizon Scan. This revealed that Ireland has numerous renewable biological resources with the potential for the creation of high-value products. The bioeconomy uses these resources to produce food, feed, biomaterials, chemicals, pulp and paper, energy and fuels. Developing Ireland's bioeconomy will help reduce carbon emissions, create high-skilled engineering and science jobs and contribute to global food security. It also presents an opportunity for indigenous economic development, exports and job creation while reducing our dependency on natural resources and imported materials. Relevant submissions will input into the drafting of a National Policy Statement on the Bioeconomy.

As the bioeconomy cuts across a number of sectors and Departments, the objective of the policy statement is to ensure greater policy coherence and assign responsibility to Departments for specific elements of the bioeconomy.

4.8 Renewable Energy & Heat

Energy is indispensable to contemporary social and economic functioning, while energy policy seeks to balance the sometimes competing aspects of sustainability, competitiveness and security of supply. Given the scale, scope and extent of energy use, it inevitably has significant environmental aspects including greenhouse gas emissions arising from power generation, heating and transport. Harnessing our renewable energy resources will play a key role in the transition towards a sustainable energy system.

A report by the Sustainable Energy Authority of Ireland in 2016 on energy-related emissions in Ireland found that reliance on fossil fuels had reduced significantly over the period 2005 - 2015⁴⁰ Energy-related emissions (excluding aviation) decreased by 18.6% over this period, while the

⁴⁰ <https://www.seai.ie/resources/publications/Energy-Related-Emissions-in-Ireland-2016-report.pdf>

economy grew by 40%. Emissions from power generation over this period saw significant decreases, particularly in the area of coal use. The EU ETS has been a key driver in this regard since 2005.

Ireland's National Mitigation Plan states that Ireland will move from a centralised fossil fuel-based electricity system to a low carbon power system between now and 2050. In this regard, increased levels of renewable generation will be accompanied by the development of large scale technology solutions while coal and peat burning generation will gradually be replaced by sustainable biomass.

Electricity generation represents just under a third of Ireland's energy sector emissions, with the majority attributable to fuel combustion. Under the Renewable Energy Directive 2009/28/EC, Ireland is legally bound to deliver 16% of its final energy requirements from renewable sources by 2020. Ireland has committed to meeting this overall renewable target by achieving 40% renewable electricity, 12% renewable heat and 10% renewable transport by 2020.

4.8.1 Support Schemes for Renewable Electricity

Internationally, support schemes are widely used to incentivise the growth of renewable electricity technologies, recognising the necessity to finance the cost differential between fossil and renewable energy resources. An Alternative Energy Requirement (AER) scheme and three REFIT schemes, namely REFIT 1, REFIT 2 and REFIT 3, have been in place in Ireland for a number of years. The cost of the support schemes is recovered directly via the annually set PSO levy, payable by all electricity consumers.

The AER scheme was launched by the then Department of Transport, Energy and Communications in 1996 and was the first step towards a market support for wind energy as part of the Department's programme to promote the generation of electricity from renewable resources. The programme involved the tendering for contracts of certain fixed amounts of capacity, by potential renewable energy generators. The AER will remain in place until 2021, resulting in estimated cumulative greenhouse gas emissions reductions of 6.51 MtCO₂eq over the period 2016 to 2030.

The REFIT schemes effectively provide a floor price for renewable electricity, guaranteeing a minimum return to investors in the various technologies. Different rates are set for different technologies and successful applicants must complete the development of their projects within a specified time period. REFIT 1, REFIT 2 and REFIT 3 will remain in place until 2027, 2032 and 2030 respectively, and are estimated to result in combined cumulative greenhouse gas emissions reductions of 59.09 MtCO₂eq over the period 2016 to 2030.

The support schemes aim to encourage, in particular, onshore wind, hydro and biomass technologies. It is envisaged that the relevant generation units will remain in operation post the ending of the support payments, and continue to contribute to the transition to a low carbon electricity system.

In 2017, Ireland also began the process of designing a Renewable Energy Support Scheme to promote community ownership in Ireland's renewable energy sector. This Scheme will play a key role in assisting Ireland to meet its renewable energy obligations under the Renewable Energy Directive.

4.8.2 Support for Ocean Research, Development and Demonstration (OREDPP)

Ireland's Offshore Renewable Energy Development Plan (OREDPP) (2014) sets out a framework for the sustainable development of Ireland's offshore renewable energy resources. The Plan aims to increase the indigenous production of renewable energy, to contribute to reductions in greenhouse gas emissions, to improve the security of energy supply and to create employment in the green economy. It provides for Exchequer support for ocean energy test sites and for prototype development. With regard to the latter, the SEAI manages the Prototype Development Fund on behalf of DCCAE. The main focus of the fund is on stimulating industry-led projects for the development and deployment of ocean energy devices and systems.

4.8.3 Support Scheme for Renewable Heat

As outlined, Ireland is aiming under the 2009 Renewable Energy Directive, to have 16% of gross final energy consumption come from renewable sources in 2020, with a sub-target for the heat sector of 12%. In 2016, Ireland had reached a level of 6.8% in this sector.

Ireland launched a Support Scheme for Renewable Heat in 2017 to increase the level of renewable energy in the heat sector and to contribute to meeting Ireland's 2020 renewable energy targets and reduce greenhouse gas emissions. The Scheme is designed to financially support the replacement of fossil fuel heating systems with renewable energy for large heat demand non-domestic users. This covers commercial, industrial, agricultural, district heating, public sector and other non-domestic businesses and sectors (in the non-emissions trading sector).

4.9 Agriculture

Ireland's National Policy Position (outlined in Chapter 4.2.1) sets out a long-term objective of a transition to a low-carbon and climate resilient economy by 2050. In this regard, an approach to carbon neutrality in the agriculture and land use sector, including forestry, which does not compromise capacity for sustainable food production is envisaged.

National policies on agricultural research and technology transfer in conjunction with the successful uptake of payment for environmental services schemes have made a significant contribution to reducing agricultural greenhouse gas emissions and increasing the levels of carbon sequestration. Decoupling livestock numbers from greenhouse gas emissions remains a sizeable challenge for Ireland and the challenge of maintaining a downward trajectory in overall emissions is a significant one.

The long-term policy vision for the sector is an approach to carbon neutrality in the agriculture and land use sector including forestry which does not compromise the capacity for sustainable food production. This means that in addition to reducing emissions from the agricultural and land use sector, Ireland is aiming to achieve a balance of residual emissions by enhancing afforestation, enhancing soil sequestration and mobilising biomaterials and residues to displace fossil fuel and other energy intensive materials.

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.

Not all the mitigation measures related to agriculture outlined in this section are included individually in the projections (Chapter 5), due to the complexity of the interactions between different measures and greenhouse gases (N₂O, CH₄ and CO₂). However, their combined effect will exert a downward pressure on overall agricultural greenhouse gas emissions. Ireland's National

Mitigation Plan contains a comprehensive analysis of the role of the agriculture sector in Ireland's approach to reducing its emissions, and will be updated continually as ongoing analysis, dialogue and technological innovation generate more cost-effective sectoral mitigation options.

The circular economy and particularly the bioeconomy, can provide opportunities in Ireland's agriculture sector. Forest based biomass (FBB) and residues and agriculture residues such as from crops, animal and dairy by-products can be used to produce biomaterials and biochemicals through biorefining or to produce heat and/or power through combustion or anaerobic digestion. Biorefining provides a strategic opportunity for large-scale sustainable use of biomass in the bioeconomy resulting in cost-competitive co-production of food and feed ingredients and also biobased products and bioenergy with optimal socioeconomic and environmental impacts (e.g. efficient use of resources and reduced greenhouse gas emissions). The Government, led by the Department of the Taoiseach, is currently developing a National Policy Statement on the Bioeconomy.

Many of the mitigation measures listed below also have a positive effect on building agriculture's resilience and adaptive capacity. In addition to those listed below, some specific agricultural adaptive measures are described in an Example box in Chapter 6.

4.9.1 European Common Agricultural Policy

The development of the Irish agriculture sector is supported by the European Union's Common Agriculture Policy (CAP) through a combination of direct payments to farmers, financial assistance towards investments in rural development and environmental protection and market support measures. The current programming period covers from 2014 to 2020.

The CAP has made an increasingly significant contribution to the environmental sustainability of the European agri-food sector in recent years through its two pillars:

- Pillar One provides a level of income support to farmers while introducing practices that are beneficial for the environment and climate on most of the utilised agricultural area.
- Pillar Two – The Rural Development Plan (RDP) – is the framework for sustainable management of the natural environment in which agricultural activity takes place.

The CAP's green credentials is strengthened through the linkage of 30% of the annual national ceiling for direct payments to the delivery of agricultural practices beneficial for the climate and the

environment. A minimum level of environmental protection has been enshrined in direct payments under Pillar 1. Farmers have to comply with three compulsory green measures, namely, the retention of permanent grassland, crop diversification and the establishment of ecological focus areas. As an alternative to these criteria, farmers can also qualify for greening by participating in agri-environment or national certification schemes that are deemed by the Commission to be at least equivalent in terms of benefit to the environment.

Environmental measures also continues to be a strong feature of Member States' Rural Development Programmes under Pillar 2. One of the three key objectives to be achieved by Pillar 2 funding is the sustainable management of natural resources, and climate action. This is pursued through Union priorities that include the restoration, preservation and enhancement of agriculture and forest ecosystems, the promotion of resource efficiency, and support for the shift towards a lower carbon economy. A minimum spend of 30% of total funding on agri-environment measures is required, and Member States' Rural Development Programmes include a measure aimed at preserving and promoting the changes necessary in agricultural practices that make a positive contribution to the environment and climate. Other measures available include support for conversion to, or maintenance of, organic farming, and support to cover the costs associated with the implementation of Natura 2000 and the Water Framework Directive.

Consultation for CAP reform post 2020 was launched by DG agri during 2017 and resulted in a CAP communication in Nov 2017. Overall the communication outlines the need to take into account societal demands to better integrate climate and environmental priorities in an inclusive and comprehensive manner.

In light of the climate challenge and other environmental concerns, DAFM seek to explore and encourage opportunities in the reform process for the CAP to further enhance its support for sustainable intensification, sustainable land management and diversification opportunities to improve the income resilience of farming families and rural areas. DAFM will seek to keep opportunities for further policy and measure evolution under regular review so as to maximise ways to explore and experiment options to drive our approach to carbon neutrality.

4.9.2 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 CH₄ and N₂O emissions.

Targeted Agricultural Modernisation Schemes (TAMS II)

This scheme supports capital investment in a number of target areas which will promote, inter alia, sustainability (e.g., low emissions slurry spreading equipment, farm nutrient storage, and renewable energy and energy efficiency).

The Green Direct Payment Scheme and Cross-Compliance

Since 1 January, 2005 direct payments to farmers under the 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. Applicants under the various Direct Payments Schemes are required to comply with the requirements of cross compliance as detailed in EU governing regulations. Cross compliance involves two elements:

- A requirement for farmers to comply with 13 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.

If an applicant is found to be non-compliant with any element of these requirements, sanctions as provided for in the governing EU regulations, which will be applied to all of an applicant's area, based payments under the Direct Payments regime.

Agri-environment Options Scheme

AEOS replaced REPS in 2010. The Scheme builds on the principle of respect for and protection of the environment which started with the first REPS scheme in 1994. Under the Scheme 20,000 farmers are paid to undertake actions which specifically target three environmental challenges namely those of:

- Halting the loss of Biodiversity
- Contributing to the improvement of Water Quality

➤ Combating Climate Change.

Unlike REPS, AEOS is not based on a whole farm approach with farmers having the option of choosing to implement those measures which are best suited to their individual circumstances. Primary actions addressing Climate Change promote the reduced and most efficient use of fertilisers, thus reducing the nitrous oxide emissions and also supporting measures to protect and enhance soil carbon levels. These actions include the following:

- Arable margins
- Green Cover Establishment from a Sown Crop
- Minimum Tillage
- Use of new technologies for slurry spreading

Other actions such as tree and hedgerow planting contribute to the overall objective of climate change through carbon sequestration, and in general actions within the Scheme involve less fertiliser use. Approximately 2,200 remaining in the scheme now and all their contracts are due to run until December 2018.

Organic Farming

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, therefore contributing to 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.

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 2,127 organic operators in Ireland with c. 72,000 hectares of land under organic production methods. The market value of the organic sector in Ireland grew by 24% in 2016 to €142 million. The Organic Farming Scheme is currently closed to new applications, as all funds allocated under the RDP have been fully committed and all targets set have been achieved.

Green, Low Carbon, Agri-Environment Scheme (GLAS)

GLAS is an agri-environmental scheme that incentivises agricultural production methods to address issues of climate change, water quality and biodiversity loss. The scheme supports low carbon agriculture through a range of cross cutting measures and promotes the delivery of targeted environmental advice and best practice at farm level.

[Business, Environment and Technology through Training Extension and Research \(BETTER\) Farms Programme](#)

This programme includes a number of working farms as a means of demonstration, channelling research knowledge and outputs to practising farmers via discussion group networks and farming media. The programme focuses in particular on areas of animal breeding, grassland management and herd wealth, all of which promote resource efficiency.

[Areas of Natural Constraints Scheme \(ANC\)](#)

The Areas of Natural Constraints Scheme (ANC) replaced the Disadvantaged Areas Compensatory Scheme (DAS). The Areas of Natural Constraint Scheme manages areas of land situated on the mainland which are designated as Disadvantaged. The Areas of Specific Constraints scheme (Island Farming Scheme) deals with areas of land situated on offshore islands. These designations are pending the delineation of the Areas of Natural Constraints in accordance with the provisions of Regulation (EU) No 1305/2013. The lands situated on offshore islands are designated as Areas of Specific Constraints in accordance with the provisions of Article 32 of Regulation 1305/2013.

The scheme was designed due to the fact that farmers in particular areas were confronted with challenges relating to lower productivity and higher production costs than farmers in other areas where levels of disadvantage were not as prevalent. This financial support aids farmers by ensuring continued agricultural land use, while also contributing to the maintenance of a viable rural society; management of the countryside; and maintaining and promoting sustainable farming systems which include environmental protection.

ANCs are divided into three main areas

- mountain areas,
- severely handicapped,
- less severely handicapped

[The Sheep Welfare Scheme 2017](#)

The Sheep Welfare Scheme 2017 has been introduced to contribute to the sustained development in animal and health welfare in the sheep sector. It will entail farmers going beyond the relevant compulsory standards to improve the principles of animal welfare in the Irish Sheep flock. This new scheme is designed in keeping with Article 33 of Regulation (EC) No 1305/2013 in particular and with the range of European Regulations underpinning the provision of support for Rural Development. This scheme will offer targeted support to those areas of animal welfare recognised in making a significant positive contribution to sheep welfare, having regard to the systems of production in Ireland and the environment in which Irish sheep production is practiced.

Knowledge Transfer programme

A collection of Knowledge Transfer measures is included in the new Rural Development Programme 2014-2020, and will involve support for Knowledge Transfer Group across the Beef, Sheep, Dairy, Poultry, Tillage and Equine Sectors.

The Knowledge Transfer Beef Programme shall be administered by the Department of Agriculture, Food and the Marine (DAFM) and is delivered by a group of approved Knowledge Transfer Facilitators.

The common objectives of the Programme across all sectors are to:

- Encourage efficiency and effectiveness of work
- Help farmers to deal with complex issues
- Build capacity of individuals in a group environment
- Ensure farmers engage in a process of continuous improvement
- Encourage innovation and new ideas
- Enhance the delivery of other related measures proposed under the RDP

The participants in the programme will be required to attend five knowledge exchange (group) meetings and/or four meetings plus one Department-approved national event.

Pasture Profit Index

This guide assists farmers planning to re-seed in order to maximise yield. By increasing the quantity of grass available for in situ grazing by livestock and reducing the need for external concentrate inputs it provides climate mitigation co-benefits.

Origin Green

The Origin Green sustainability development programme unites government, the private sector and food producers in a common vision to improve the environmental performance of individual farms and food producers⁴¹.

4.9.3 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 greenhouse gas emissions per unit of output for both milk and meat production.

Beef Data and Genomics Programme

This livestock improvement scheme aims to improve animal husbandry with breeding efficiencies. This Scheme provides suckler farmers with an incentive to take samples from stock bulls and a selection of suckler cows (4/5 cows with best genetic linkages) for genotyping. This helps to accelerate the kind of genetic improvement that will drive efficiency and increase profitability at farm level. The Irish Cattle Breeding Federation is a world leader in the area of Genomics, and Ireland was the second country to introduce Genomic selection in dairy animals. Genetic gain in the Beef herd lags that in the Dairy herd, mainly due to poor use of genomic selection. This needs to be addressed by collecting Genomic data on stock & AI bulls, and the genetically best connected

⁴¹ www.origingreen.ie

females in herds around the country. Improving beef efficiency at farm level will help to reduce dependence on direct payments and increase the contribution of the beef sector to job creation and the wider economy.

The Carbon Navigator

The Carbon Navigator provides feedback and advice on practices that effectively reduce the carbon footprint of farm produce and improve the economic performance of the farm.

4.9.4 Research

Animal Diet Research

Research is ongoing to evaluate a range of measures that could be used to reduce CH₄ 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 grammes 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.

Soil research

Ireland's Food Wise 2025 plan was published in 2015 and aims to develop the agri-food sector strategically over a ten year period. The plan's Quality Assessment Research Project (SQUARE) addresses objectives for sustainable soil management that will support the intensification of agriculture to meet global food security objects. To meet Ireland's productivity and environmental targets there is a need to understand the key issues impeding production as well as issues affecting soil quality. The project seeks to:

- Develop a toolbox for farmers to assess soil structural quality
- Further develop understanding of the soil functional capacity and quality concept

- Evaluate the status of soil structural quality in grassland and tillage soils across Ireland
- Assess the impact of soil structural degradation on the functional capacity of the soil

4.9.5 Manure Management and Agricultural Soils

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.

Anaerobic Digestion

There is potential to supply energy through the use of animal manures as feedstock in anaerobic digesters. Ireland has supported the development of on-farm anaerobic digestion facilities through the ‘Scheme of Investment Aid for Demonstration On-Farm Waste Processing Facilities’, since 2007. The Assessment of Cost and Benefits of Biogas and Methane in Ireland (SEAI, 2017)⁴² identifies significant potential for the role of the agriculture sector in this regard and will inform future policy development in this area.

4.10 Waste – Waste Measures

4.10.1 Policy and Measures to Reduce Municipal Solid Waste and Biodegradable Municipal Waste to Landfill

National Waste Prevention Programme

⁴² <https://www.seai.ie/resources/publications/Assessment-of-Cost-and-Benefits-of-Biogas-and-Biomethane-in-Ireland.pdf>

Irish and regional waste policy is predicated on the waste hierarchy, which accords the highest priority to waste prevention followed by preparing for reuse; recycling; and energy recovery; with disposal (landfill) being the least desirable option. Since 2013, EU Member States have been required to have a national waste prevention programme (NWPP) in place to provide leadership on decoupling economic growth from the environmental impacts of waste generation. Ireland's NWPP has been in operation since 2004. The current cycle of Ireland's NWPP is called *Towards a Resource Efficient Ireland*⁴³ and it runs from 2014-2020.

The Irish national waste prevention programme has developed a number of prevention initiatives targeting:

- business (the Green Business Initiative, the Green Hospitality Award, SMILE, the Green Enterprise programme, local authority prevention network (LAPN));
- households (Livegreen.ie, Stop Food Waste, LAPN);
- hospitals (green healthcare programme);
- retail (green business programme, Stop Food Waste, LAPN);
- packaging (packaging waste prevention programme);
- local authorities (LAPN, Stop Food Waste);
- Communities (LAPN, Stop Food Waste, LiveGreen.ie).

Landfill levy

A landfill levy (currently at €75 a tonne for liable waste disposed at landfill) has been accredited with diverting large amounts of Municipal Solid Waste (including Biodegradable Municipal Waste) from landfill to recovery options. The level of the levy is kept under regular review.

Collection of Municipal Solid Waste, including Biodegradable Municipal Waste

Collectors of waste must conduct their activities in accordance with the relevant legislation and the conditions of their waste collection permits which require that waste is managed in line with the waste hierarchy.

⁴³ <https://www.epa.ie/pubs/reports/waste/prevention/TowardsAResourceEfficientIreland.pdf>

In line with the commitment set out in *A Resource Opportunity - Waste Management Policy in Ireland* and in the interest of encouraging further waste prevention and better segregation, 'flat-rate fees' for kerbside household waste collection are being phased out over the period autumn 2017 to autumn 2018. Operators are required to offer an incentivised usage pricing plan to new or renewing customers over that period, i.e., a plan which contains a per lift or weight related fee for the collection of residual waste.

Information and awareness campaigns have been, and will continue to be, rolled out by the Department of Communications, Climate Action and Environment and the Regional Waste Management Planning Offices to take account of the new approach to waste reduction, increased recycling and charging. In particular, the Regional Waste Management Planning Offices will continue to roll out waste awareness and education initiatives re-focussing on the use of the brown bin (for food and bio-waste), but also concentrating on improving and increasing recycling, waste prevention and the correct use of the kerbside collection system.

The European Union (Household Food Waste and Bio-waste) Regulations 2015 are designed to promote the segregation and recovery of household food waste, in line with the national policy and the Waste Framework Directive objectives of maximising the resource which can be extracted from waste and minimising the disposal of waste.

Their aim is to increase the amount of food waste that is recovered through the production of energy, compost and digestate, thereby creating opportunities for added jobs and value and to facilitate the achievement of the targets set out in the Landfill Directive (Directive 99/31/EC) for the diversion of biodegradable municipal waste from landfill sites by directing source-segregated household food waste to composting and to other forms of treatment.

The Regulations impose obligations on both householders and waste collectors. Householders are obliged to segregate their food waste, and make it available for separate collection. Alternatively, householders may compost the food waste at home; or bring it themselves to authorised treatment facilities (such as civic amenity sites or anaerobic digestion sites). Householders are supported and encouraged to use their food waste bins through a number of education and awareness initiatives.

The Waste Management (Food Waste) regulations 2009 are designed to promote segregation and recovery of *food waste arising in the commercial sector* and reduce disposal to landfill.

[Regional Waste Management Plans](#)

Three Regional Waste Management Plans (2015-2021⁴⁴) were published in May 2015 and focus very much on preventing waste generation and viewing waste streams (which cannot be prevented or reduced) as valuable resources. The plans have three over-arching strategic targets as follows:

- 1% reduction per annum in the quantity of household waste generated per capita over the period of the plans;
- recycling rate of 50% of managed municipal waste by 2020; and
- reduction to 0% the direct disposal of residual Municipal Solid Waste to landfill in favour of higher value pre-treatment processes and indigenous recovery practices.

The above targets will be achieved through the implementation of a comprehensive list of policies set out in the plans, which include the development of additional biological treatment capacity for the treatment of bio-wastes (food and green wastes) and in particular, anaerobic digestion to primarily treat suitable agri-wastes and other organic wastes.

Circular Economy Package

The legislative proposals currently under consideration at EU level on waste include long-term targets to reduce landfilling and increased preparation for reuse and recycling of key waste streams such as municipal waste and packaging waste. The implementation of national policy and programmes, as well as regional waste management plans will help ensure that Ireland will continue its transition to a resource efficient and circular economy and that it should be well placed to embrace and meet any new targets which emerge. Further policy measures will be considered in the context of the final agreed Circular Economy Package.

4.11 Forestry

4.11.1 Restoring Forest Cover and the Afforestation Programme

⁴⁴ <http://www.epa.ie/waste/policy/regional/>

One of the aims of Ireland's forest policy is to encourage planting by private landowners in order to achieve a forest cover of 18% over the long term. This aim is supported by a set of measures in the current *Forestry Programme 2014-2020* which cover the cost of afforestation, and an annual forest premium to land owners to compensate for income foregone as a result of converting farm land to forest. Ireland has had, on a per capita basis and as a proportion of land area, one of the most intensive afforestation programmes in the developed world since 1990, funded by the Government, and in the past jointly with the EU. Since 1990, over 318,000 ha have been afforested, with the majority of this increase being undertaken by farmers. Despite this rate of planting, however, Ireland remains one of the least forested countries in the EU. In 2012, the national forest estate stood at 731,652 ha, which represents about 10.5 % of the area of the country, compared to an average of 42% for the 27 Member States of the European Union in 2012.

New forestry legislation came into force in 2017, the Forestry Act 2014 and Forestry Regulations 2017 (SI No 191 of 2017), which replaced earlier legislation. Under the Forestry Regulations all applications for licences for afforestation, forest road construction projects, whether grant-aided or not, and for aerial fertilisation and tree felling operations, require the prior written approval of the Minister for Agriculture, Food and the Marine. Landowners are obliged to replant their forests after clear-felling, unless an exemption is provided by the Minister. This helps to ensure that deforestation is very limited. It is estimated to have averaged 860 ha per year over the period 2008-2015, based on latest estimates from data submitted to the UNFCCC for the inventory year 2017.

4.11.2 Forest Management Initiatives

Forest owners are required to draw up a forest management plan in collaboration with a professional forester to continue to receive annual premium payments. This helps to make forest owners aware of the benefits of managing their forests, including thinning at the appropriate time. Thinning can increase the cumulative carbon sequestered by a forest and associated forest products. Tending and thinning of broadleaf plantations also qualifies for grant aid. This measure has resulted in substantial mobilisation of additional firewood, principally for domestic use.

4.11.3 Forest Infrastructure

Forest roads provide access to forests for management and harvesting activities such as inspections, thinning and clear-felling, which can increase total cumulative carbon sequestration in the long term and including through the use of long lived wood products. This measure also aids in the mobilisation of timber and forest-based biomass and creates amenity opportunities. The construction of forest roads is supported through grant-aid available under the Forest Roads Scheme of the Forest Service. This scheme provides grants to cover 100% of costs, up to a forest road length threshold, incurred in building such roads to ensure that the requisite access and infrastructure are put in place. In 2015, this support resulted in the construction of over 60km of roads in private forests.

4.11.4 Bioenergy, Forest-Based Biomass & Related Measures

A dedicated web site, woodenergy.ie, is run by the Department of Agriculture, Food and the Marine and provides advice on wood fuel specification and use, as well as on supply chain technologies and costs. This is complemented by wood fuel workshops run annually to provide knowledge support to forest owners and the wood fuel industry.

DAFM launched an Exchequer funded Bioenergy Scheme on a pilot basis from 2007 to 2009 to provide farmers with establishment grants to plant the energy crops willow and miscanthus (biomass crops) for use as a renewable fuel. This was followed since 2010 by an EU co-funded Bioenergy Scheme. The scheme is currently closed for new applications and is under review.

Additional options have been included in the afforestation measure of the Forestry Programme to cover agro-forestry and short rotation forestry, forestry for fibre, which aim to broaden the appeal of afforestation to landowners.

Policies currently under consideration by the Department of Communications, Climate Action and Energy are aimed at promoting renewable energy (in the form of heat and electricity) from biomass. It is envisaged these will create a market for thinnings and residues (both in-forest and from sawmilling). DAFM funds research on the wood energy supply chain and related topics under the national forest research programme. Teagasc, the farm advisory service, provides advice and information on the harvesting and processing of forest-based biomass. DAFM also supports a wood fuel quality assurance scheme in partnership with the Irish Bioenergy Association, and an advisory service on wood fuels at woodenergy.ie.

The measures outlined complement a number of demand side measures. REFIT 3 is a feed-in tariff scheme which is designed to stimulate the installation of biomass electricity, including CHP and co-firing of biomass with peat. Furthermore, the carbon tax (details in Chapter 4.4) does not apply to biomass products.

In 2016, the use of forest-based biomass for energy grew by 21% with supply primarily coming from domestic sources (Table 1). Some 237,000 m³ of firewood was used in the Republic of Ireland, to a value of €34 million, showing that it is providing a steady and a growing market for first thinning's from forest plantations. In 2016, 34% of the round wood harvested was used for energy generation, mainly within the forest products sector.

The use of forest based biomass has increased annually for the proceeding decade in line with increased domestic supply. Between 2006 and 2016, the use of forest based biomass for energy has resulted in an estimated greenhouse gas emission saving of 5.5 million tonnes of CO₂.

Table 4.2 Use of forest-based biomass and as a proportion of total round wood harvest (2012-2016).

Item	2012	2013	2014	2015	2016
	000 m ³				
Wood-biomass use by the energy and forest products industry	611	704	760	796	1,049
Roundwood chipped for primary energy use	30	100	100	114	117
Domestic firewood use	225	230	235	237	237
Short rotation coppice (SRC)	5	5	5	5	20
Wood pellets and briquettes	144	161	150	154	160
Charcoal	2	1	1	1	1
TOTAL	1,017	1,201	1,251	1,307	1,584
Of which supplied from domestic resources	910	1,034	1,166	1,132	1,139
Roundwood available for processing	2,594	2,852	2,975	3,016	3,104
Firewood used	225	230	235	237	237
Total roundwood use	2,819	3,082	3,210	3,253	3,341
Domestic wood-biomass use as a % of roundwood used	32.3	33.5	36.3	34.8	34.1

4.12 Policies and Measures No Longer in Place

There are a number of policies and measures which expired during the period covered by the Seventh National Communication. Other measures may no longer directly yield any new and additional mitigation reductions. In this respect one would distinguish between measures which were time limited by design, those that have been superseded, and some which have been halted for other reasons.

4.12.1 Time Limited Schemes

Some policies and measures are designed to give an initial impetus to some kind of change of behaviour. The idea being that one would subsidise early movers in a transition towards energy efficient solutions and thereby help to create supply chains for these goods and services. In some cases these apply to goods and services where changes would be cost negative and as such it does not make sense to subsidise them beyond a short introductory period. The following policies and measures either have recently terminated or are scheduled to do so.

- Greener Homes Scheme (subsidy for domestic renewable heating systems) 2011
- SEEP and EERF –support scheme for demonstration projects 2011
- Public Sector Building Programme – support for market development for retrofit in public buildings 2009
- CHP (Public & Private Sector support schemes) 2011
- Directive 2000/25/EC (limit values for emissions from Agricultural machinery – related to targets for 2010)
- The Smarter Travel Areas Programme is due to conclude in 2018

4.12.2 Superseded Policies and Measures

Other policies and measures typically in the area of standard setting or implementation targets are subsequently superseded by more onerous or ambitious standards or targets. Nonetheless these policies and measures have played an important role in beginning the process of decarbonisation of the Irish economy. The following is a list of such policies which have since been superseded.

- 2002 Residential Building Regulations - Part L Conservation of Fuel and Energy in Dwellings
- 2007 Residential Building Regulations - Part L Conservation of Fuel and Energy in Dwellings
- 2011 Residential Building Regulations - Part L Conservation of Fuel and Energy in Dwellings

- 2005 Non-residential Building Regulations - Part L Conservation of Fuel and Energy in Buildings other than Dwellings
- 2008 Non-Residential Building Regulations - Part L Conservation of Fuel and Energy in Buildings other than Dwellings
- 2017 Non-Residential Building Regulations - Part L Conservation of Fuel and Energy in Buildings other than Dwellings

The most up-to-date listing of Ireland's Building Regulations can be found at

<http://www.housing.gov.ie/housing/building-standards/building-regulations/building-regulations>

4.12.3 Other Policies and Measures no Longer in Place

A final category would be made up of those policies and measures which expire and are replaced by similar schemes but with different design. The following list includes such policies and measures.

- Warmer Homes Scheme (aimed at retrofitting measures for those of low incomes)
- Home Energy Saving Scheme (subsidy for retrofitting improvements)
- ReHeat – supports for energy efficiency retrofits in public and commercial buildings

Each of these schemes is now covered by a single retrofitting scheme known as the Better Energy Scheme.

Table 4.3 List of existing and planned policies and measures

This table is produced in accordance with Section V of the National Communications Guidelines and is drawn from Ireland’s official submission to the EU in 2017. Additional Policies and Measures, including policies and measures under consideration, can be found in Ireland’s National Mitigation Plan.

Descriptive Data								Estimate of mitigation impact (not cumulative, in kt CO ₂ eq)			
Sector	Name of Policy or Measure	Existing Measure ?	Objective and/or activity affected	GHGs affected	Type of instrument	Status of implementation	Implementing entity or entities	2020	2025	2030	2035
Energy Consumption	Sustainable Energy Authority of Ireland Large Industry Programme	*	Efficiency improvement in industrial end-use sectors (Energy consumption)	CO ₂ , CH ₄ , N ₂ O	Voluntary /negotiated agreements	Implemented	Sustainable Energy Authority of Ireland	486.0	483.0	486.6	492.5
Energy Consumption	Accelerated Capital Allowance for energy efficient equipment	*	Efficiency improvement of appliances (Energy consumption), Efficiency improvement in services/ tertiary sector (Energy consumption), Efficiency improvement in industrial end-use sectors (Energy consumption)	CO ₂ , CH ₄ , N ₂ O	Fiscal	Implemented	Department of Finance, The Office of the Revenue Commissioners	141.9	138.9	142.6	148.5

Energy Consumption	Better Energy Workplaces - Public and Business sectors	*	Efficiency improvements of buildings (Energy consumption), Efficiency improvement in services/ tertiary sector (Energy consumption)	CO ₂ , CH ₄ , N ₂ O	Economic	Expired	Sustainable Energy Authority of Ireland	97.2	96.4	97.3	98.8
Energy Supply	CHP Deployment - Public and Business sectors	*	Switch to less carbon-intensive fuels (Energy supply), Increase in renewable energy (Energy supply), Efficiency improvements of buildings (Energy consumption)	CO ₂ , CH ₄ , N ₂ O	Economic	Expired	Sustainable Energy Authority of Ireland	150.3	150.3	150.3	150.3
Energy Consumption	Renewable Heat (ReHeat) Deployment Programme - Public and Business sectors	*	Efficiency improvement in services/ tertiary sector (Energy consumption), Increase in renewable energy (Energy supply), The ReHeat programme provided grant aid towards the installation of renewable and alternative heating technologies in the tertiary sector	CO ₂ , CH ₄ , N ₂ O	Economic	Expired	Sustainable Energy Authority of Ireland	101.3	101.3	101.3	101.3

Energy Consumption	Carbon Tax	*	Efficiency improvements of buildings (Energy consumption), Demand management/reduction (Energy consumption), Demand management/reduction (Transport), Cross sectoral tax on fuel used for heating and transport	CO ₂ , CH ₄ , N ₂ O	Fiscal	Implemented	Revenue Commissioners	325.6	325.6	325.4	324.7
Energy Consumption	Public Sector Retrofit (including Sustainable Energy Authority of Ireland Public Sector Programme)	*	Efficiency improvement in services/ tertiary sector (Energy consumption), Efficiency improvements of buildings (Energy consumption)	CO ₂ , CH ₄ , N ₂ O	Economic, Information, Education	Implemented	Department of Communications, Climate Action and Environment. Sustainable Energy Authority of Ireland	398.9	396.3	399.5	404.6
Energy Consumption	Supports for Exemplar Energy Efficiency Projects (SEEEP) and Energy Efficiency Retrofit Fund (EERF) - Public and Business sectors	*	Efficiency improvement in services/ tertiary sector (Energy consumption), Efficiency improvements of buildings (Energy consumption)	CO ₂ , CH ₄ , N ₂ O	Economic	Expired	Department of Communications, Climate Action and Environment. Sustainable Energy Authority of Ireland	52.3	51.9	52.4	53.0

Energy Consumption	Public Sector Building Demonstration Programme	*	Efficiency improvements of buildings (Energy consumption), Efficiency improvement in services/ tertiary sector (Energy consumption)	CO ₂ , CH ₄ , N ₂ O	Economic, Information, Research, Education	Expired	Department of Communications, Climate Action and Environment. Sustainable Energy Authority of Ireland	27.6	27.5	27.7	28.0
Energy Consumption	Small and Medium Enterprises (SME) Programme	*	Efficiency improvement in services/ tertiary sector (Energy consumption), Efficiency improvements of buildings (Energy consumption), Demand management/reduction (Energy consumption)	CO ₂ , CH ₄ , N ₂ O	Education, Information	Implemented	Sustainable Energy Authority of Ireland	62.6	62.2	62.6	63.4
Energy Consumption	2005 Building Regulations Part L Conservation of Fuel and Energy - Buildings other than dwellings	*	Efficiency improvements of buildings (Energy consumption)	CO ₂ , CH ₄ , N ₂ O	Regulatory	Expired	Department of Housing, Planning, Community and Local Government	313.5	313.5	313.5	313.5

Energy Consumption	2002 Building Regulations - Part L Conservation of Fuel and Energy in Dwellings	*	Efficiency improvements of buildings (Energy consumption)	CO ₂ , CH ₄ , N ₂ O	Regulatory	Expired	Department of Housing, Planning, Community and Local Government	443.1	443.1	443.1	443.1
Energy Consumption	2008 Building Regulations Part L Conservation of Fuel and Energy in Dwellings	*	Efficiency improvements of buildings (Energy consumption)	CO ₂ , CH ₄ , N ₂ O	Regulatory	Expired	Department of Housing, Planning, Community and Local Government	160.3	160.3	160.3	160.3
Energy Consumption	2011 Part L Conservation of Fuel and Energy in Dwellings	*	Efficiency improvements of buildings (Energy consumption)	CO ₂ , CH ₄ , N ₂ O	Regulatory	Implemented	Department of Housing, Planning, Community and Local Government	50.9	50.9	50.9	50.9
Energy Consumption	Energy Efficient Boiler Regulation	*	Efficiency improvements of buildings (Energy consumption)	CO ₂ , CH ₄ , N ₂ O	Regulatory	Implemented	Department of Communications, Climate Action and Environment	142.6	142.6	142.6	142.6
Energy Consumption	Domestic Lighting (Eco-Design Directive)	*	Demand management/reduction (Energy consumption)	CO ₂	Regulatory	Implemented	Department of Jobs, Enterprise & Innovation	42.1	41.2	42.4	44.3

Energy Consumption	Greener Homes Scheme	*	Efficiency improvements of buildings (Energy consumption)	CO ₂ , CH ₄ , N ₂ O	Economic, Voluntary /negotiated agreements, Information, Education	Expired	Sustainable Energy Authority of Ireland	26.6	26.6	26.6	26.7
Energy Consumption	Warmer Homes Scheme	*	Efficiency improvements of buildings (Energy consumption)	CO ₂ , CH ₄ , N ₂ O	Economic, Voluntary/negotiated agreements, Information, Education	Implemented	Sustainable Energy Authority of Ireland	82.8	82.7	82.8	82.6
Energy Consumption	Better Energy Homes (Residential retrofit)	*	Efficiency improvements of buildings (Energy consumption)	CO ₂ , CH ₄ , N ₂ O	Economic, Information, Education	Implemented	Department of Communications, Climate Action and Environment, Sustainable Energy Authority of Ireland	293.8	293.6	293.7	293.6
Transport	Public Transport efficiency	*	Improved behaviour (Transport), Modal shift to public transport or non-motorized transport (Transport), Improved transport infrastructure (Transport)	CO ₂ , CH ₄ , N ₂ O	Voluntary/negotiated agreements, Information, Education	Implemented	Irish Rail, Bus Eireann, Dublin Bus, Sustainable Energy Authority of Ireland	41.6	41.6	41.6	41.6
Transport	Electric vehicle deployment		Low carbon fuels/electric cars (Transport)	CO ₂ , CH ₄ , N ₂ O	Economic, Fiscal	Planned	Department of Communications, Climate Action and Environment. Sustainable Energy Authority of Ireland	-0.9	-0.6	-0.8	-1.1

Transport	Vehicle Registration Tax and Annual Motor Tax	*	Efficiency improvements of vehicles (Transport), Demand management/reduction (Transport)	CO ₂ , CH ₄ , N ₂ O	Regulatory, Education, Fiscal	Implemented	Department of Finance	172.2	172.3	172.2	172.2
Transport	Improved fuel economy of the private car fleet (EU Regulation)	*	Efficiency improvements of vehicles (Transport)	CO ₂ , CH ₄ , N ₂ O	Regulatory	Implemented	European Commission, National Standards Authority of Ireland	227.0	227.1	227.1	227.0
Transport	Aviation Efficiency	*	Demand management/reduction (Transport)	CO ₂ , CH ₄ , N ₂ O	Voluntary/negotiated agreements	Implemented	Irish Aviation Authority, UK National Air Traffic Services	66.5	66.5	66.5	66.5
Transport	Reduction in natural gas combusted at compressor stations for natural gas pipeline transport		Reduced natural gas demand under the with additional measures scenario	CO ₂ , CH ₄ , N ₂ O	Other	Planned	Bord Gais Energy, Department of Communications, Climate Action and Environment	7.6	8.7	9.3	10.8
Energy supply	Energy Efficiency in Power Generation	*	Increase in renewable energy (Energy supply), Reduction of losses (Energy supply), Efficiency improvement in the energy and transformation sector (Energy supply)	CO ₂ , CH ₄ , N ₂ O	Planning, Economic	Implemented	Department of Communications, Climate Action and Environment, Commission for Energy Regulation	827.1	862.6	862.5	862.4

Energy supply	Energy Efficiency in Electricity Transmission and Distribution	*	Reduction of losses (Energy supply)	CO ₂ , CH ₄ , N ₂ O	Planning, Economic	Implemented	Department of Communications, Climate Action and Environment, Commission for Energy Regulation	39.2	38.3	39.4	41.2
Energy supply	Replacement of coal fired electricity generation with natural gas		Switch to less carbon-intensive fuels (Energy supply)	CO ₂ , CH ₄ , N ₂ O	Research, Planning	Planned	Department of Communications, Climate Action and Environment, Commission for Energy Regulation	N/A	587.1	920.4	1512.7
Industrial processes	Mobile Air Conditioning Directive (Directive 2006/40/EC)	*	Reduction of emissions of fluorinated gases (Industrial processes)	HFC	Regulatory	Implemented	Department of Transport, Tourism and Sport	65.9	123.1	206.6	229.3
Waste	Landfill Directive (1999/31/EC)	*	Improved landfill management (Waste), Reduced landfilling (Waste), Enhanced CH ₄ collection and use (Waste)	CH ₄	Regulatory, Planning	Implemented	Department of Communications, Climate Action and Environment, Environmental Protection Agency	80.5	313.5	420.8	492.0
Agriculture	Nitrogen Fertilizer Use Efficiency in Agriculture		Reduction of fertilizer/manure use on cropland (Agriculture)	N ₂ O, CO ₂	Voluntary/negotiated agreements, Education	Planned	Department of Agriculture, Food and the Marine	156.8	156.8	156.8	156.8
Energy supply	Renewables - With Measures scenario (Electricity Generation)	*	Increase in renewable energy (Energy supply)	CO ₂ , CH ₄ , N ₂ O	Regulatory, Economic	Implemented	Department of Communications, Climate Action and Environment, Commission for Energy Regulation	1381.8	1370.1	1364.5	1358.8

Transport	Renewables - With Measures scenario (Transport)	*	Low carbon fuels/electric cars (Transport)	CO ₂ , CH ₄ , N ₂ O	Regulatory, Economic	Implemented	Department of Transport, Tourism and Sport	430.6	490.2	484.5	477.7
Energy supply	Directive 2009/28/EC on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC-Heat component		Increase in renewable energy (Energy supply)	CO ₂ , CH ₄ , N ₂ O	Regulatory	Planned	Department of Communications, Climate Action and Environment. Sustainable Energy Authority of Ireland	488.3	626.1	776.0	958.5
Energy supply	Directive 2009/28/EC on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives		Increase in renewable energy (Energy supply)	CO ₂ , CH ₄ , N ₂ O	Regulatory	Planned	Department of Communications, Climate Action and Environment. Commission for Energy Regulation	1535.9	1440.9	1440.9	1440.9

	2001/77/EC and 2003/30/EC - Electricity component										
Transport	Directive 2009/28/EC - on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC- Transport component		Low carbon fuels/electric cars (Transport)	CO ₂ , CH ₄ , N ₂ O	Regulatory	Planned	Department of Transport, Tourism and Sport	193.8	218.7	216.7	214.2
Cross-cutting	Better Energy Communities	*	Multi-sectoral policy (Cross-cutting)	CO ₂ , CH ₄ , N ₂ O	Fiscal	Adopted	Sustainable Energy Authority of Ireland	96.4	96.3	96.3	96.4
Cross-cutting	Energy Efficiency Obligation Scheme	*	Multi-sectoral policy (Cross-cutting)	CO ₂ , CH ₄ , N ₂ O	Regulatory	Implemented	Department of Communications, Climate Action and Environment. Sustainable Energy Authority of Ireland	523.2	520.8	523.3	526.2

Cross-cutting	Buildings remainder		Multi-sectoral policy (Cross-cutting)	CO ₂ , CH ₄ , N ₂ O	Economic, Fiscal, Regulatory	Planned	Department of Communications, Climate Action and Environment. Sustainable Energy Authority of Ireland	83.6	83.4	83.5	83.5
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Table 4.4 Estimated percentage proportion of CO₂eq savings by gas by sector for years 2020, 2025, 2030 2035 where savings for Policies and Measures have been estimated⁴⁵ (see also Table 4.3)

Sector	2020				2025				2030				2035			
	CO ₂	CH ₄	N ₂ O	HFC	CO ₂	CH ₄	N ₂ O	HFC	CO ₂	CH ₄	N ₂ O	HFC	CO ₂	CH ₄	N ₂ O	HFC
Industry	99.7%	0.1%	0.2%	0%	99.7%	0.1%	0.2%	0%	99.7%	0.1%	0.2%	0%	99.7%	0.1%	0.2%	0%
Services	99.6%	0.2%	0.2%	0%	99.6%	0.2%	0.2%	0%	99.6%	0.2%	0.3%	0%	99.5%	0.2%	0.3%	0%
Residential	98.9%	0.9%	0.2%	0%	98.9%	0.9%	0.2%	0%	98.9%	0.8%	0.3%	0%	98.9%	0.8%	0.3%	0%
Transport	99.1%	0.1%	0.8%	0%	99.1%	0.1%	0.8%	0%	99.1%	0.1%	0.8%	0%	99.1%	0.1%	0.8%	0%
Powergen supply / Electricity	99.1%	0.1%	0.8%	0%	99.2%	0%	0.7%	0%	99.3%	0%	0.7%	0%	99.3%	0%	0.6%	0%
Industrial Processes (MAC Directive)	0%	0.0%	0%	100%	0%	0%	0%	100%	0%	0%	0%	100%	0%	0%	0%	100%
Waste (Landfill Directive)	0%	100%	0%	0%	0%	100%	0%	0%	0%	100%	0%	0%	0%	100%	0%	0%
Agriculture Fuel (fuel combustion)	100%	0%	0%	0%	100%	0%	0%	0%	100%	0%	0%	0%	100%	0%	0%	0%
Agriculture (non fuel combustion)	1.6%	0.0%	98.4%	0%	1.6%	0%	98.4%	0%	1.6%	0%	98.4%	0%	1.6%	0%	98.4%	0%

⁴⁵ This information relates to Policies and Measures that have been reported under the Monitoring Mechanism Regulation in 2017.

5. Projections and the Total Effects of Policies and Measures

5.1 Introduction

The National Climate Change Strategy (2007)⁴⁶ designated the Environmental Protection Agency (EPA) responsible for developing annual national emission projections for greenhouse gases for all key sectors of the economy, in collaboration with relevant State and other bodies. In addition to informing national policy development, projections are compiled to meet EU reporting obligations (Monitoring Mechanism Regulation No 525/2013⁴⁷). The latest projections were published in April 2017 and projected Irish GHG emissions out to 2035⁴⁸ using two scenarios: a With Measures scenario and a With Additional Measures scenario:

- The With Measures scenario assumes a business as usual scenario, based on measures already put in place at the end of 2015. It assumes that no additional policies and measures beyond these are implemented.
- The With Additional Measures scenario assumes implementation of the With Measures scenario along with additional policy measures being brought forward by 2020, particularly in relation to the Irish Government's renewable energy and energy efficiency targets. In respect of 2017, this scenario takes account of an expected shortfall in achieving full energy efficiency targets and renewable energy targets for electricity, transport and heat as set out in Ireland's National Renewable Energy Action Plan⁴⁹ (NREAP) and National Energy Efficiency Action Plan (NEEAP⁵⁰).

5.2 Projections of Greenhouse Gas Emissions

Figure 5.1 shows historical and projected greenhouse gas emissions for the 'With Measures' and 'With Additional Measures' scenarios (without LULUCF).

⁴⁶ National Climate Change Strategy 2007-2012. Department of Environment, Heritage and Local Government. (2007).

⁴⁷ Regulation (EU) No 525/2013 of the European Parliament and of the Council of 21 May 2013 on a mechanism for monitoring and reporting greenhouse gas emissions and for reporting other information at national and Union level relevant to climate change and repealing Decision No. 280/2004/EC

⁴⁸ For 2017 reporting the Monitoring Mechanism Regulation (Regulation (EU)) No. 525/2013) requires Member States to report greenhouse gas emission projections out to 2035

⁴⁹ [https://www.dccae.gov.ie/en-ie/energy/topics/Renewable-Energy/irelands-national-renewable-energy-action-plan-\(nreap\)/Pages/Action-Plan.aspx](https://www.dccae.gov.ie/en-ie/energy/topics/Renewable-Energy/irelands-national-renewable-energy-action-plan-(nreap)/Pages/Action-Plan.aspx)

⁵⁰ [https://www.dccae.gov.ie/en-ie/energy/topics/Energy-Efficiency/national-energy-efficiency-action-plan-\(neeap\)/Pages/National-Energy-Efficiency-Action-Plan-\(NEEAP\).aspx](https://www.dccae.gov.ie/en-ie/energy/topics/Energy-Efficiency/national-energy-efficiency-action-plan-(neeap)/Pages/National-Energy-Efficiency-Action-Plan-(NEEAP).aspx)

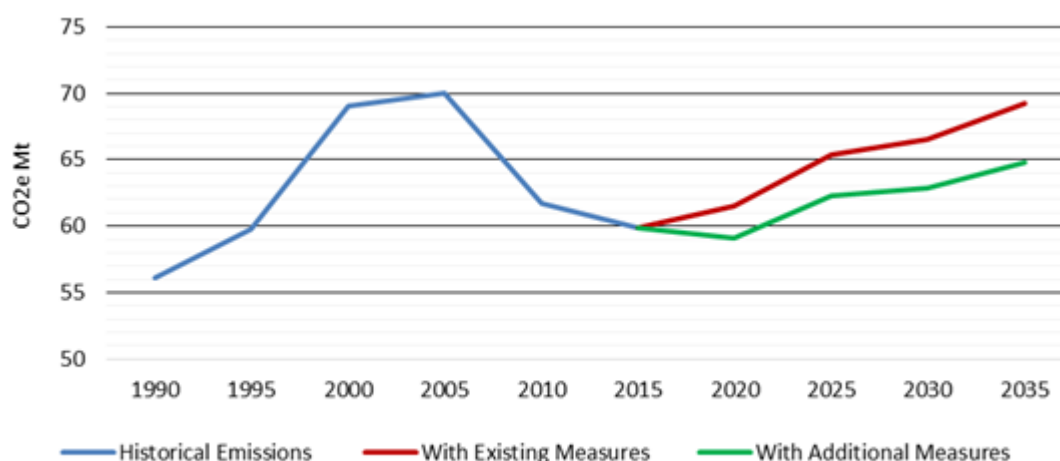


Figure 5.1 - Historical and projected greenhouse gas emissions for the ‘With Measures’ and ‘With Additional Measures’ scenarios⁵¹.

By 2020 total emissions are set to increase by 10% and 5% on 1990 levels under the With Measures and With Additional Measures scenarios respectively. By 2030 total emissions are set to increase by 19% and 12% respectively, relative to 1990 levels.

Over the longer term to 2030, and based on the same expectations of policy implementation for 2020, the EPA projects that total non-ETS emissions will be 1% - 3% below 2005 levels, i.e. that emissions will continue to increase after 2020. This should be considered a conservative outlook which understates the likely progress by 2030, as these projections imply that no additional policies or measures will be implemented after 2020.

The EU’s Effort Sharing Decision (Decision No 406/2009/EC) set 2020 targets for EU Member States including Ireland. These targets cover greenhouse gas emissions from sectors that are not included in the EU Emissions Trading Scheme (ETS). For Ireland these sectors cover agriculture, transport, built environment (residential, commercial/institutional), waste and non-energy intensive industry – collectively referred to as non-ETS sector emissions – and Ireland’s target is to achieve a 20% reduction by 2020 on 2005 levels.

⁵¹ Total without LULUCF

In addition, there are annual emission limits for the period 2013-2020 for the non ETS sector to ensure a gradual move towards the 2020 target. Any overachievement of the binding emission limit in a particular year can be banked and used towards compliance in a future year.

Figure 5.2 shows projected emission levels for non-ETS sector emissions under the With Measures⁵² and With Additional Measures scenarios. In addition, it shows the annual compliance/non-compliance in relation to the annual emission limits.

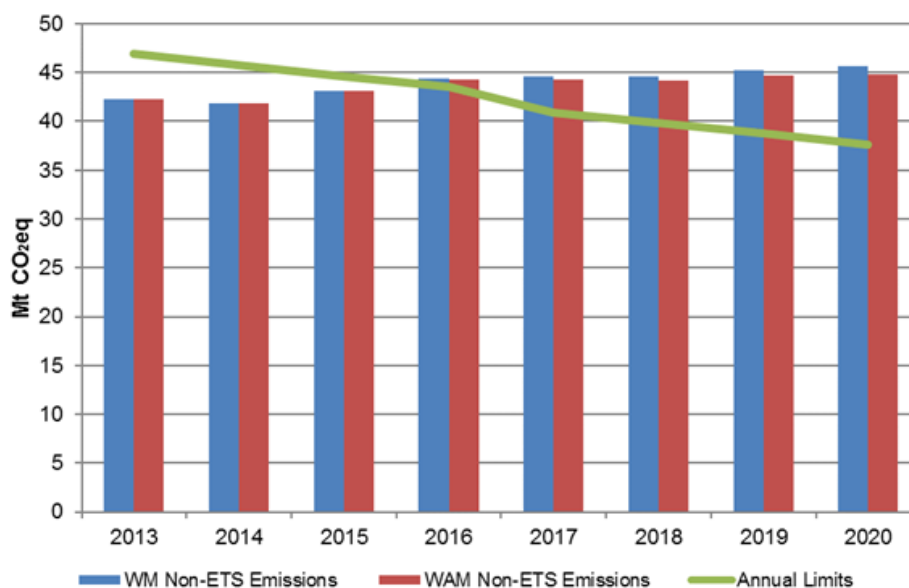


Figure 5.2 - With Measures and With Additional Measures greenhouse gas emissions projections and comparison with the reduction pathway required between 2013 and 2020

Under the With Measures scenario, Ireland is projected to cumulatively exceed its obligations by 13.7 Mt of CO₂ eq over the period 2013-2020. Under the With Additional Measures scenario, Ireland is projected to cumulatively exceed its obligations by 11.5 Mt of CO₂ eq over the period 2013-2020. This takes into account the overachievement of the annual limits in the period 2013-2015 which is banked and used in the years 2016-2020. By utilising this mechanism, Ireland is not expected to exceed its annual obligations until 2019.

⁵² The “With Measures” scenario is reported as a “With Existing Measures” scenario in Ireland’s National Mitigation Plan

5.3 Projections by Sector

5.3.1 Projections by Sector (with measures scenario)

Sectoral emissions in this Chapter are presented in line with the sectoral breakdown as published in the most recent national EPA greenhouse gas emission projections publication⁵³. See Appendix 3 in this national publication for further explanation of the categories.

Sectoral shares for the ‘With Measures’ scenario are presented in Table 5.1 for historical and projected years. The single largest source of emissions in 2015 was the agriculture sector which contributed to 33% of total national emissions (excluding LULUCF). By 2020 its share is projected to increase to 34%. The second largest source of emissions in 2015 is the Transport sector accounting for 19.8% of total national emissions. In 2020 it is projected to account for nearly 22%.

Table 5.1 Sectoral share (With measures scenario)

Percentage	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035
Energy Industries	20.4%	22.7%	23.5%	22.7%	21.7%	19.7%	16.6%	17.7%	19.3%	21.1%
Residential	13.4%	10.8%	9.4%	10.4%	12.7%	10.1%	10.0%	9.7%	9.6%	9.3%
Manufacturing Combustion	7.1%	7.3%	8.2%	8.4%	7.3%	7.6%	8.6%	8.3%	8.4%	9.0%
Commercial / Public Services	4.0%	3.5%	3.4%	3.5%	3.8%	2.9%	3.1%	3.3%	3.4%	3.5%
Transport	9.2%	10.5%	15.6%	18.8%	18.7%	19.8%	21.6%	23.1%	22.5%	21.4%
Industrial Processes	5.8%	5.0%	5.5%	3.9%	2.4%	3.3%	3.8%	4.1%	4.5%	4.9%
F-Gases	0.1%	0.5%	1.4%	1.5%	1.6%	1.9%	1.5%	1.3%	1.1%	1.0%
Agriculture	37.4%	36.7%	30.9%	29.1%	31.1%	33.1%	33.8%	31.8%	30.6%	29.3%
Waste	2.8%	3.1%	2.2%	1.9%	0.9%	1.6%	1.0%	0.8%	0.8%	0.7%

⁵³ <http://www.epa.ie/pubs/reports/air/airemissions/ghgprojections/>

The Energy industries sector is the third largest source of emissions in 2015 accounting for 19.7% of emissions. By 2020 its sectoral share is projected to decrease by 3%. Emissions from Manufacturing Combustion accounted for 7.6% of total emissions in 2015 and are projected to increase to 8.6% and 8.4% share of total emissions in 2020 and 2030 respectively.

Emissions from Industrial Processes accounted for 3.3% of total emissions in 2015 and the projected share is projected to be 3.8% and 4.5% in 2020 and 2030 respectively.

Emissions from Commercial and Public Services accounted for 2.9% of total emissions in 2015 and are projected to increase to 3.1% and 3.4% share of total emissions in 2020 and 2030 respectively.

Emissions from Residential Sector accounted for 10.1% of total emissions in 2015 and are projected to remain static at 10% and 9.6% share of total emissions in 2020 and 2030 respectively. In 2015 the waste sector accounted for 1.6% of national total emissions, and is projected to account for 1% and 0.8% in 2020 and 2030 respectively.

In 2015 the ETS accounted for 28% of national total emissions and is projected to account for 26% and 29 percent of total emissions in 2020 and 2030 respectively.

5.3.2 Projections by Sector (with additional measures scenario)

Sectoral shares for the 'With Additional Measures' scenario are presented in Table 5.2 for historical and projected years. The single largest source of emissions in 2015 was Agriculture when it contributed to 33% of total national emissions (excluding LULUCF). Under the With Additional Measures scenario the share of emissions from agriculture is projected to increase to 35%. The second largest source of emissions in 2015 (Transport sector) is projected to account for 22.1% of emissions in 2020.

Table 5.2 Sectoral share (With Additional Measures scenario)

Percentage	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035
Energy Industries	20.4%	22.7%	23.5%	22.7%	21.7%	19.7%	14.7%	15.4%	16.7%	17.9%
Residential	13.4%	10.8%	9.4%	10.4%	12.7%	10.1%	10.3%	9.9%	9.7%	9.4%
Manufacturing Combustion	7.1%	7.3%	8.2%	8.4%	7.3%	7.6%	8.7%	8.4%	8.6%	9.3%
Commercial / Public Services	4.0%	3.5%	3.4%	3.5%	3.8%	2.9%	2.7%	2.8%	2.9%	2.9%
Transport	9.2%	10.5%	15.6%	18.8%	18.7%	19.8%	22.1%	23.8%	23.4%	22.4%
Industrial Processes	5.8%	5.0%	5.5%	3.9%	2.4%	3.3%	3.9%	4.3%	4.8%	5.2%
F-Gases	0.1%	0.5%	1.4%	1.5%	1.6%	1.9%	1.6%	1.3%	1.2%	1.1%
Agriculture	37.4%	36.7%	30.9%	29.1%	31.1%	33.1%	34.9%	33.2%	32.1%	31.1%
Waste	2.8%	3.1%	2.2%	1.9%	0.9%	1.6%	1.1%	0.9%	0.8%	0.7%

The Energy industries sector is the third largest source of emissions in 2015. By 2020 its sectoral share is projected to decrease to 14.7% in 2020 following by an increase to 16.7% in 2030 under the With Additional Measures Scenario. Emissions from Manufacturing Combustion accounted for 7.6% of total emissions in 2015 and are projected to increase to 8.7% and 8.6% share of total emissions in 2020 and 2030 respectively.

The projected share from Industrial Processes is projected to be 3.9% and 4.8% in 2020 and 2030 respectively.

Emissions from Commercial and Public Services accounted for 2.9% of total emissions in 2015 and the projected share is projected to remain static at 2.7% and 2.9% in 2020 and 2030 respectively.

Emissions from Residential Sector accounted for 10.1% of total emissions in 2015 and the projected sectoral share is projected to remain static at 10.3% and 9.7% share of total emissions in 2020 and 2030 respectively. In 2015 the waste sector accounted for 1.6% of national total emissions, and is

projected to account for 1.1% and 0.8% share in 2020 and 2030 respectively under the With Additional Measure Scenario.

In 2015 the ETS accounted for 28% of national total emissions and is projected to account for 24% and 27 percent of total emissions in 2020 and 2030 respectively under the With Additional Measures Scenario.

Table 5.3 presents the breakdown of greenhouse gas emissions by ETS and non ETS sector for the period 2015 to 2035.

Table 5.3 Breakdown of greenhouse gas emissions by ETS and non ETS sector for the period 2015 to 2035

ETS/Non ETS Breakdown under With Measures Scenario					
Year	2015	2020	2025	2030	2035
ETS Total (kt CO ₂ e)	16785.49	15914.41	17645.87	19345.51	21899.65
Non ETS Total (kt CO ₂ e)	43082.80	45635.55	47736.31	47137.54	47305.03
ETS/Non ETS Breakdown under With Additional Measures Scenario					
Year	2015	2020	2025	2030	2035
ETS Total (kt CO ₂ e)	16785.5	14257.20	15479.18	16840.50	18791.92
Non ETS Total (kt CO ₂ e)	43082.80	44827.62	46781.83	46039.83	46036.46

5.4 Projections by Gas

Projections by gas are only discussed for the ‘With Measures’ scenario. Information by gas for the ‘With Additional Measures’ scenario is presented in Annex B of this report.

5.4.1 Projections by Gas (with measures scenario)

CO₂ emissions accounted for 64% of national total (excluding LULUCF) emissions in 2015, with CH₄ and N₂O contributing 22% and 12%, respectively. The combined emissions of HFC, PFC, SF₆ and NF₃ accounted for approximately 2% of total emissions in 2015. By 2020 emissions of CO₂ are projected

to remain at 64% of national total emissions, with CH₄ and N₂O accounting for 21% and 12% respectively. Table 5.4 below provides historical emissions and projections by gas for the 'With Measures' scenario.

Table 5.4: Historical emissions and projections by gas for the With Measures scenario (Mt CO₂ eq)

Gas	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035
Carbon Dioxide	32.84	35.79	45.19	48.03	41.63	38.39	39.71	43.69	45.48	48.36
Methane	14.80	15.00	14.29	13.51	11.98	13.26	13.24	13.11	12.62	12.47
Nitrous Oxide	8.42	8.70	8.64	7.42	7.07	7.08	7.69	7.76	7.68	7.69
F-gases	0.04	0.28	0.95	1.01	1.01	1.14	0.92	0.84	0.72	0.69
Total	56.10	59.77	69.07	69.98	61.69	59.88	61.56	65.39	66.49	69.22

In 2015 the largest source of CO₂ emissions was Transport accounting for 30.5%. By 2020, Transport remains the largest contributor to CO₂ emissions at 33%. The second most significant contributor to greenhouse gas emissions in Ireland is CH₄ accounting for 22.1% of emissions in 2015 and 21.5% of emissions in 2020. The main driver behind CH₄ emissions in Ireland is CH₄ emissions from cattle from enteric fermentation and manure management. Emissions from the agriculture sector are projected to increase as a result of expansion plans in the sector⁵⁴.

Similar to emissions of CH₄, the agriculture sector is the largest source of N₂O emissions in Ireland reflecting the significant quantities of nitrogen from animal manures and synthetic fertilizers applied to agricultural soils. Nitrous oxide emissions accounted for 11.8% of national total emissions in 2015 and are projected to account for 12.5% in 2020.

Emissions of the F-gases (HFCs, PFCs, SF₆ and NF₃) were 1142 kt CO₂ equivalent in 2015. F-gas emissions account for approximately 1.9% of the national total in 2015 and are projected to

⁵⁴ Food Wise 2025. A 10-year vision for Irish agri-industry. Department of Agriculture, Food and the Marine, 2015. <https://www.agriculture.gov.ie/foodwise2025/>

decrease to 916 Kt CO₂ equivalent in 2020. Table 5.5 provides historical and projected emissions of F-gas in the With Measures scenario.

Table 5.5 Historical emissions and projections by F-gas for the With Measures scenario (kt CO₂eq)

F-gas	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035
HFCs	1.23	103.19	456.66	678.41	932.02	1076.80	838.73	751.80	629.57	590.29
PFCs	0.12	97.61	397.76	216.39	46.58	20.50	24.63	28.89	32.83	37.31
SF₆	33.88	79.11	51.76	96.78	33.09	44.49	51.17	54.40	57.71	62.43
NF₃	NO	4.37	49.17	28.38	NO	0.96	1.15	1.35	1.54	1.75

See also summary of Greenhouse Gas Emissions by sector and gas for the With Measures and With Additional Measures Scenario in Annex B.

5.5 Methodological Approach

Sustainable Energy Authority of Ireland (SEAI) publishes national energy forecasts⁵⁵ showing future energy trends. Energy forecasts, most recently completed in 2017, form the basis for almost all energy-related emission projections discussed.

SEAI compiles a number of energy forecasts scenarios, two of which are used in national emission projections to 2035: *Baseline* and *Current Trajectory*:

- The *Baseline* energy forecast projects forward Ireland’s energy demand, incorporating the expected impacts of policies and measures that were in place (e.g. legislatively provided for) by the end of 2015. It represents a hypothetical future scenario in which no further policy actions or measures have been taken. It excludes policies that are committed to but which do not yet have measures in place to deliver them.
- The *Current Trajectory* energy forecast presents an alternative view of future energy demand that accounts for further implementation of the National Renewable Energy Action

⁵⁵ http://www.seai.ie/Publications/Statistics_Publications/Energy_Forecasts_for_Ireland/

Plan⁵⁶ (NREAP) and the 3rd National Energy Efficiency Action Plan⁵⁷ (NEEAP) based on current progress. Therefore this forecast includes existing and further implementation of planned policies and measures based on current progress. For 2017 projections, the *Current Trajectory* reflects an expected shortfall in achieving full energy efficiency targets and renewable energy targets for electricity, transport and heat. It recognises that the current rates of energy efficiency improvements and deployment of renewable energy technologies are not sufficient to meet Ireland's 2020 targets.

The *Baseline* energy forecast underpins Ireland's With Measures emission projection for the energy sector and the *Current Trajectory* energy forecast (based on current progress) underpins the *With Additional Measures* projection for the energy sector.

The *Baseline* energy forecast compiled by SEAI provides future energy demand to 2035 for the following IPCC sectors: 1.A.1.a, 1.A.2, 1.A.3.b, 1.A.3.e, 1.A.4.a, 1.A.4.b and 1.A.4.c. The *Current Trajectory* energy forecast provides future energy demand for the above sectors to 2035 whilst accounting for Ireland's targets, and policies and measures presented in Ireland's NEEAP and NREAP, to the extent that are expected to be achieved and implemented based on current progress.

Article 4 of Directive 2009/28/EC on renewable energy requires each Member State to adopt a NREAP and submit it to the European Commission. The NREAP sets out the Member State's national targets for the share of energy from renewable sources consumed in transport, electricity and heating and cooling in 2020, demonstrating how the Member State will meet their overall national target established under the Directive.

Ireland submitted its NREAP to the European Commission in July 2010. Three progress reports have subsequently been submitted, one in January 2012, the second in February 2014 and the third in April 2016.

The NEEAP sets a clear vision for each of the sectors covered by the Action Plan, around which public and private sector actors can mobilise. Ireland's first NEEAP was published in May 2009, which built on the Energy Efficiency Action Plan submitted to the Commission in 2007 and was required as part of Ireland's obligations under the Energy Services Directive⁵⁸. Subsequently three further iterations

⁵⁶ <http://www.dccae.gov.ie/energy/en-ie/Renewable-Energy/Pages/Action-Plan.aspx>

⁵⁷ <http://www.dccae.gov.ie/energy/SiteCollectionDocuments/Energy-Efficiency/NEEAP%203.pdf>

⁵⁸ Directive 2006/32/EC on energy end-use efficiency and energy services and repealing Council Directive 93/76/EEC

have been published, Ireland's NEEAP 2 in 2012 and NEEAP 3 in 2014 in addition to NEEAP 4 which was published subsequent to the most recent projections prepared by EPA in 2017.

For the *Baseline* energy forecast, the Economic and Social Research Institute (ESRI) use macro-economic projections which are produced using the COSMO model⁵⁹. The baseline projections and underlying assumptions are described here in Chapter 1 of "Ireland's Economic Outlook: Perspectives and Policy Challenges", which was published on 5 December 2016⁶⁰. Projections on the global economic environment, including oil prices, as based in simulations using the NiGEM model (National Institute Global Econometric Model⁶¹) maintained by the National Institute of Economic and Social Research⁶². Projections from the COSMO model were used to produce projections of the energy demand equation time series variables (i.e. demand equations by fuel and sector).

Annual electricity demand, which is an output of the electricity demand equations/COSMO was transferred, as well as fuel prices, as an input into an electricity dispatch model to determine fuels used at an hourly level to service aggregate electricity demand. This process provides a high level of accuracy on the fuels used in the electricity sector. The software used for the energy forecasts to model the Irish Electricity Market is PLEXOS 7.4 R01. PLEXOS is a power systems modelling tool used for electricity market modelling and planning.

The energy forecast includes sectoral output figures and other relevant key variables such as price, economic growth, population and housing stock. To produce the finalised *Baseline* energy forecast, SEAI amends the output of the energy demand produced by ESRI (described above) to take account of the expected impact of energy efficiency measures put in place before the end of 2015 but which are considered too recent to be detectable in any time-series analysis. The *Current Trajectory* energy forecast builds on the *Baseline* forecast with adjustments made to account for further implementation of additional policies and measures outlined in the NEEAP and NREAP. For 2017 projections, the *Current Trajectory* energy forecast reflects current progress and the trajectory towards achieving 2020 targets. This includes an expected shortfall in achieving energy efficiency and renewable energy targets.

⁵⁹ <https://www.esri.ie/projects/modelling-the-irish-economy/>

⁶⁰ <http://www.esri.ie/pubs/EO1.pdf>

⁶¹ <https://nimodel.niesr.ac.uk/>

⁶² <http://www.niesr.ac.uk/>

Details regarding energy related policies and measures are available online in a number of SEAI reports⁶³.

The energy forecasts that underpin the energy-related emissions projections are based on macroeconomic projections as described above. Table 5.6 shows the key parameters underlying the macroeconomic outlook and therefore the *With Measures* and *With Additional Measures* emission projections scenarios. The forecasts are based on international fuel import oil prices. Coal and gas prices were published by the United Kingdom’s Department of Business, Energy and Climate Change. The carbon prices are those circulated by the European Commission in June 2016. Carbon dioxide price assumptions in the non-ETS sectors are based in the Carbon Tax in Ireland (see Chapter 4.1). In the longer term the carbon tax is assumed to follow the EU ETS carbon price.

Table 5.6 Key assumptions underpinning Ireland’s 2017 energy forecasts

	2016 – 2020	2021- 2025	2026- 2030	2031- 2035
Average Annual % Growth Rate				
GDP	+3.74%	+3.24%	+2.59%	+2.59%
GNP	+3.42%	+3.32%	+1.97%	+1.97%
Personal Consumption	+2.97%	+2.57%	+1.11%	+1.11%
	2016	2020	2025	2030
Housing Stock ('000)	1,967	2,018	2,112	2,206
Population ('000)	4,674	4,834	5,027	5,209
EUETS: Carbon	9	15	22.5	33.5

⁶³ <https://www.seai.ie/resources/seai-statistics/energy-data/>

€₂₀₁₃/tCO₂				
Carbon tax €₂₀₁₃/tCO₂	18.3	15	22.5	33.5
Coal \$₂₀₁₃/boe	9.8	9.9	11.6	10.6
Oil \$₂₀₁₃/boe	40.5	56.8	62.8	69.4
Gas \$₂₀₁₃/boe	27.0	20.4	24.6	27.3
Peat €/MWh	25	25	25	25

Ireland's Environmental Protection Agency (EPA) has been designated the responsibility to develop, prepare and publish periodic projections of greenhouse gas emissions. For estimating the latest emissions projections, Ireland uses global warming potential values presented in the 4th Assessment Report of the Intergovernmental Panel on Climate Change. Further detailed information on the methodological approach (e.g. approach in relation to emission factors, source and sink categories, gases) used by the EPA in preparing the projections presented in this chapter is available at the following link:

<http://www.epa.ie/pubs/reports/air/airemissions/ghgprojectionsmethodologyandapproach.html>

Further details on Ireland's modelling systems can be found in Ireland's submission to the European Union under Article 14 of the Monitoring Mechanism Regulation (Regulation 525/2013)⁶⁴.

The energy forecasts completed in 2017, which follow the 2015 national energy balance⁶⁵, form the basis for the majority of fuel combustion activities (1.A) emissions projections namely:

- Energy Industries (1.A.1.a)
- Manufacturing Industries and Construction (1.A.2)
- Road transportation (1.A.3.b)

⁶⁴ http://cdr.eionet.europa.eu/ie/eu/mmr/art04-13-14_lcds_pams_projections/projections/envwotdlg/

⁶⁵ <https://www.seai.ie/resources/seai-statistics/energy-data/>

- Other transport (1.A.3.e)
- Commercial /Institutional (1.A.4.a)
- Residential (1.A.4.b)
- Agriculture/Forestry/Fishing (1.A.4.c)

Emissions from these sectors accounted for approximately 98% of fuel combustion-related emissions in 2015. Emission projections for the remaining fuel combustion activities (i.e. oil refining (1.A.1.b), peat briquetting (1.A.1.c), rail transport (1.A.3.c), domestic aviation (1.A.3.a), and navigation (1.A.3.d)) are calculated separately and are based on data provided to the EPA and from EPA databases. Emissions from 1.A.5 (Non-Specified) combustion are reported as “IE” (Included elsewhere) as emissions from combustion are accounted for in the other sectors as listed above.

5.6 Sectoral Analysis and Total Effects of Policies and Measures

5.6.1 Energy Industries

Power generation covers all electricity generation including electricity generated from renewable sources. The Plexos_Ireland model was used to model electricity generation for each year to 2035. As an electrical systems model, the core input data comprises technical details of generators, transmission lines and loads as well as fuel costs, operational costs and emission reduction rates and costs.

In the *Baseline* energy forecast the renewable energy generated shows Ireland reaching 22.7% of electricity consumption from renewable energy by 2020. Renewable electricity generation capacity is dominated by wind but also includes, for example, the operation of a second waste to energy incinerator and the continued development of landfill gas electricity generation. It is also assumed that electricity trading occurs through the 500 MW East-West interconnector. In 2030 it is estimated that renewable energy generation increases to 25% of electricity consumption and returns to 22% in 2035.

Ireland’s *With Additional Measures* projections assume that for 2020 there is a 37.3% share of renewable energy in electricity generation as a result of additional expansion in wind energy, biomass electricity generating capacity in addition to solar photo voltaics and the continued development of landfill gas electricity generation. The largest contribution is from wind which at 896 ktoe in 2020 is 62% above that included in the *Baseline* and therefore the *With Measures Scenario*. This falls short of the full target of 40% share of renewable energy in electricity generation in 2020.

In 2030 it is estimated that renewable energy generation reduces to 29% of electricity consumption and 26% by 2035.

The impacts of existing and planned policies and measures that will impact the power generation sector are listed below in Table 5.8 with the anticipated emissions savings estimated.

In terms of the differences between the projections in this National Communication and Ireland’s previous National Communication (6th National Communication), updated activity data, methodology and approach have been used for the projections included in this National Communication. The starting point for the latest projections is the latest inventory 1990-2015. In terms of the key differences, the energy forecasts that underpin the emission projections in the 6th National Communication were prepared using a HERMES model (refer to 6th National Communication for further information) whereas the latest energy forecasts that underpin the emissions projections presented in this National Communication were produced using the COSMO model (as described above). In terms of agriculture, the projections presented in the 6th National Communication takes in account meeting targets set out in Food Harvest 2020 whereas the agriculture projections presented in this National Communication takes into account the proposed activity for meeting the overarching objectives of Ireland’s Food Wise 2025 plan (further details described in Section 5.6.8 below).

Table 5.7 below presents the estimated CO₂eq savings by gas where savings for Policies and Measures have been estimated in the With Measures scenario.

Table 5.7 Estimated CO₂eq savings by gas where savings for Policies and Measures have been estimated in the With Measures scenario

Year	Gas	<i>With Measures (kt CO₂eq savings)</i>
2015	CO ₂	6341.6
	CH ₄	13.8
	N ₂ O	32.1
	HFC	41.6
	Total	6429
2020	CO ₂	7160.7
	CH ₄	101.6
	N ₂ O	33.3

	HFC	65.8
	Total	7361
2025	CO ₂	7230.3
	CH ₄	334.1
	N ₂ O	33.8
	HFC	123.1
	Total	7721
2030	CO ₂	7236.9
	CH ₄	441.4
	N ₂ O	33.6
	HFC	206.6
	Total	7918
2035	CO ₂	7251.9
	CH ₄	512.6
	N ₂ O	33.4
	HFC	229.3
	Total	8027

The table below summarises the results of the projections up to 2020 in this National Communication compared to the projections included in the 6th National Communication.

Table 5.8: National Communication Emission projections comparison

National Communication	1990	2000	2010	2015	2020
6 th National Communication (Total <i>With Measures</i> Scenario kt CO ₂ eq (without Article 3.3 sinks))	55,247.2	68,203.7	61,494.6	59,734.8	62,832.8
7 th National Communication (Total <i>With Measures</i> Scenario kt CO ₂ eq (excluding LULUCF))	56,102.7	69,075.6	61,691.9	59,878.2	61,561.4

Table 5.9 Emissions savings due to policies and measures included in the With Measures and With Additional Measures scenarios for the power generation sector

Policy and measure	CO ₂ e (Kt)				
	2015	2020	2025	2030	2035
With Measures					
Increased efficiency in power generation	605.9	827.1	862.5	862.4	862.4
Reduced transmission and distribution losses	45.7	39.1	38.3	39.3	41.1
22.7% renewables by 2020	1,569.6	1,381.7	1,370.1	1,364.4	1,358.8
Reduced electricity demand from energy efficiency measures	547.8	605.6	591.9	608.7	636.2
Domestic Lighting (Eco-Design Directive) – <i>included in reduced electricity demand from energy efficiency measures above</i>	114.8	42.1	41.2	42.4	44.3
Total	2,769.0	2,853.5	2,862.8	2,874.8	2,898.5
With Additional Measures					
Reduced electricity demand from additional energy efficiency measures in industry, services and residential	-	2.15	1.98	2.02	2.06
Increased electricity demand from electric vehicles roll-out	-	-6.29	-5.96	-6.23	-6.55
Replacement of coal fired generation with natural gas	-	-	587.06	920.36	1512.73
37.3% renewable by 2020	-	1,535.9	1,440.9	1,440.9	1,440.8
Total		1,531.7	2,023.9	2,357.0	2,969.64

Sectoral analysis and details on total effects of policies and measures are presented in this section. For energy related policies and measures, energy savings associated with related policies and

measures are estimated by the Sustainable Energy Authority of Ireland. Further information on individual energy related policies and measures including the method for monitoring/measuring the resultant savings can be found in Ireland's National Energy Efficiency Action Plans (for example see Appendix to Ireland's National Energy Efficiency Action Plan⁶⁶). The EPA uses the energy savings that are supplied by the Sustainable Energy Authority Ireland to estimate emission savings associated with the relevant energy related policies and measures (e.g. by applying relevant emission factors).

Projections for oil refining and solid fuel manufacture are based on data provided by the relevant operators as energy demand from these sectors is not covered in SEAI's energy forecasts. The oil refining sector (1.A.1.b) in Ireland consists of a single installation. Carbon dioxide emission projections, provided by the operator, are based on assumptions about future product specifications, crude oil qualities and market demand.

With respect to solid fuel manufacture (1.A.1.c), one large operator produces a range of peat based fuels for domestic and industrial customers including the electricity generation sector. Carbon dioxide emission projections for solid fuel manufacture are provided to the EPA by the operator.

The main source of emissions from the energy industries sector (1.A.1) is power generation, accounting for 96.3% of emissions from this sector in 2015. Projected emissions from solid fuel manufacture and oil refining remain static with emissions projected to be 335 and 100 kt CO₂eq from 2020 onwards respectively.

Under the With Measures, emissions from power generation are projected to decrease by 13.6% between 2015 and 2020 while fuel used in electricity generation is projected to increase by approximately 1.6% over the same period. Over the period 2015 to 2035, emissions from the sector are projected to increase by 24.7% to 14.1 Mt CO₂ eq.

Under the With Additional Measures, emissions from power generation are projected to decrease by 27.2% between 2015 and 2020 while fuel used in electricity generation is projected to increase by approximately 1.9% over the same period. This reflects more renewables such as wind and biomass being used for electricity generation in the With Additional Measures Scenario compared to the With Measures scenario. The forecasts assume a replacement of coal fired electricity generation in 2025 with natural gas. Emissions from the sector are projected to decrease by 1.3% between 2015 and 2035.

⁶⁶ <http://www.dccae.gov.ie/energy/SiteCollectionDocuments/Energy-Efficiency/NEEAP%203.pdf>

Fugitive emissions of greenhouse gases cover those associated with natural gas distribution and production (1.B.2) and historical coal mining (1.B.1). In relation to natural gas distribution, ERVIA (formerly Bord Gais Éireann (BGE)), Ireland's gas company, assessed methane losses in the pipeline network in the context of the needs of annual greenhouse gas inventory reporting. A long-term programme to replace cast-iron mains with polyethylene pipe in all urban areas served by natural gas is underway. Projections made by BGE for five-year intervals from 2000 show losses decreasing to negligible amounts by 2020 on completion of the pipe replacement programme. Methane emissions from natural gas production relate largely to gas extraction.

In determining future emissions from domestic gas production, it is assumed that 3% of gas demand in 2015 comes from domestic sources rising to 36% in 2020 as a new gas field on the west coast of Ireland is exploited. Emissions associated with this level of gas production are calculated. Coal mining ceased in Ireland in 1995, however emissions can still occur. Emissions from this sector are estimated using the default methodology as presented in the 2006 IPCC Guidelines and follows the approach undertaken in the national greenhouse gas emission inventory.

5.6.2 Manufacturing Industries and Construction

The *Baseline* energy forecast underpins the *With Measures* emission projection for the industrial sector. The *Current Trajectory* energy forecast underpins the *With Additional Measures* emission projection. Existing and planned policies and measures are listed, with the anticipated emissions savings estimated, in Table 5.10. These measures were included in the *Baseline* and *Current Trajectory* energy forecasts and therefore the *With Measures* and *With Additional Measures* emission projections.

Projected greenhouse gas emissions in the Manufacturing Industries and Construction sector (IPCC sector 1.A.2)

Under the *With Measures* emission projection, emissions from industrial combustion in this sector are projected to increase by 16.8% between 2015 and 2020 while final energy demand is projected to increase by 19% over the same period. Emissions in 2035 are projected to be 16.8% higher than in 2020 with approximately 22% increase in final energy demand in the sector over the same period.

Under the *With Additional Measures* emission projection, emissions from industrial combustion are projected to increase by 13.3% whilst final energy demand increases by 19.5% by 2020. The level of projected emissions under the *With Additional Measures* scenario is lower compared with the *With*

Measures scenario as a result of the additional policies and measures outlined in Table 5.10. In 2035 emissions from industrial combustion are projected to be 16.9% higher than in 2020. Final energy demand increases by approximately 22% over the same period.

Table 5.10 Emissions savings due to policies and measures included in the With Measures and With Additional Measures scenarios for the industrial sector

Policy and measure	CO ₂ e (Kt)				
	2015	2020	2025	2030	2035
<i>With Measures</i>					
SEAI Large Industry Programme	312.92	356.73	356.73	356.73	356.73
CHP deployment	87.73	106.13	106.13	106.13	106.13
Accelerated Capital Allowance (ACA)	1.87	4.2	4.2	4.2	4.2
Renewable Heat	71.5	71.51	71.51	71.51	71.51
Carbon tax	132.25	132.26	132.26	132.26	132.26
Better Energy Workplaces	17.8	17.8	17.8	17.8	17.8
Total	624.07	688.63	688.63	688.63	688.63
<i>With Additional Measures</i>					
RES-H*	-	129.44	136.99	141.57	152.87
Buildings remainder	-	28.41	28.41	28.41	28.41
Total		157.8	165.4	169.9	181.2

*The projected rate of thermal energy sourced from renewable sources is 9% (across the residential, commercial services and industrial sectors) by 2020 based on current forecasts. This is referred to as RES-H.

5.6.3 Transport

Transport emissions cover road transportation; rail; domestic and international aviation; navigation and other transportation (pipeline compressors). The *With Measures* and *With Additional Measures* emissions projections for road transportation and gas transmission are based on the *Baseline* and *Current Trajectory* energy forecasts, respectively, published by SEAI. Energy forecasts for the aviation

sector were developed separately in consultation with the relevant bodies i.e. individual Airport Authorities.

Road Transportation

The biofuels obligation scheme was established to ensure that a proportion of the transport fuel used in the State consists of environmentally sustainable biofuels e.g. ethanol and biodiesel. The scheme places an obligation on suppliers of mineral oil to ensure that 8.695% (by volume) of the motor fuels (generally Gasoline and Motor Diesel) they place on the market in Ireland is produced from renewable sources. This obligation rate has increased over time from a share of 4.166% in 2010. This obligation scheme will be a key component to achieving a 10% penetration of renewable energy in transport by 2020.

In the energy forecast underpinning the *With Measures* emission projection for road transport, it is forecasted that renewables (biofuels) account for 5.5% of road transport fuel in 2020 thus increasing from the 2015 level of renewables penetration (5.1%).

In the energy forecast underpinning the *With Additional Measures* emission projection for road transport, it is assumed that renewables will account for 8% road transport fuel by 2020 (which includes the penetration of electric vehicles into the national car fleet) in line with the EU renewables target in Directive 2009/28/EC16. In addition, the impact of transport measures from the NEEAP4 and NREAP3 are included.

It is projected that the 8% renewables in 2020 is largely maintained out to 2035. This falls short of the full NREAP 10% target. Existing and planned measures to 2020 are listed with the anticipated emissions savings, as estimated by SEAI and the EPA in Table 5.11.

Rail (IPCC Sector 1.A.3.c)

For Ireland's emission projections, it is assumed that fuel use in the sector will remain constant at 2015 levels for each year out to 2035.

Navigation (IPCC Sector 1.A.3.d)

Emissions from navigation have remained relatively static over the last number of years. Projected fuel combustion from navigation is assumed to be equal that combusted in the sector in 2015 for each projected year to 2035.

Projected greenhouse gas emissions from the Transport sector

The main source of emissions from the transport sector is road transportation, accounting for 95.7% of emissions in 2015. Under the *With Measures* emission projection, emissions from transport are projected to increase by 12.2% between 2015 and 2020. Emissions are projected to increase by 11.3% between 2020 and 2035, the main driver being a projected increase of 11.4% in diesel. Petrol consumption remains relatively stable in the period to 2020.

Under the *With Additional Measures* emissions projections, emissions from transport are projected to increase by 10.5% between 2015 and 2020. The lower level of increase in emissions relative to the *With Measures* emission projections is primarily attributable to increased biofuel penetration and more efficient traffic movements projected to deliver additional savings. With respect to 2035, emissions are projected to increase by 11.3% between 2020 and 2035. The RES-T share of 8% for 2020 is largely maintained to 2035.

Table 5.11 Emissions savings due to policies and measures included in With Measures and With Additional Measures scenarios for the transport sector

Policy and measure	CO ₂ e (Kt)				
	2015	2020	2025	2030	2035
<i>With Measures</i>					
VRT and Motor Tax changes	200.0	172.1	172.2	172.2	172.2
Improved fuel economy of private cars	325.5	226.9	227.1	227.0	227.0
Public transport efficiency improvements	38.5	41.5	41.5	41.5	41.5
Aviation efficiency	66.4	66.4	66.5	66.5	66.5
Carbon tax	23.9	23.9	23.9	23.9	23.9
Renewables	393.1	430.6	490.1	484.5	477.6
Total	1047.4	961.4	1,021.3	1,015.6	1,008.7
<i>With Additional Measures</i>					

Electric vehicle deployment	-	5.41	5.41	5.41	5.41
Natural gas transport savings between scenarios	-	7.59	8.69	9.33	10.83
RES-T*	-	193.83	218.71	216.7	214.17
Total		206.83	232.81	231.44	230.41

* Renewables (biofuels and electric vehicle deployment) will account for 8% of road transport fuel by 2020

Other transport (IPCC sector 1.A.3.e)

Emissions in this sub-sector refer to the use of natural gas in pipeline compressor stations. Future gas demand for “own use and transformation” is inferred based on forecast gas demand in the residential, commercial and industrial sectors in both the *Baseline* and *Current Trajectory* energy forecasts. Subtracting the amount of gas estimated to be lost from the distribution network (reported in fugitive emissions section 12) allows “own use” gas demand and associated emissions to be estimated for the *With Measures* and *With Additional Measures* scenarios.

5.6.4 Residential

The *Baseline* energy forecast underpins the *With Measures* emission projection for the residential sector. The *Current Trajectory* energy forecast underpins the *With Additional Measures* emission projection. Existing and planned policies and measures are listed, with the anticipated emissions savings in Table 5.12. These measures were included in the *Baseline* and *Current Trajectory* energy forecasts and therefore the *With Measures* and *With Additional Measures* emission projection.

Projected greenhouse gas emissions from the Residential sector (IPCC sector 1.A.4.b)

Under the *With Measures* emission projection, residential sector emissions are projected to increase by 1.5% between 2015 and 2020 while final energy demand is projected to increase by approximately 8% over the same period. Final energy demand in 2035 is projected to be 22.3% above that in 2020, with an associated increase in emissions over the period by 5%.

Under the *With Additional Measures* emission projection, in 2020 residential sector emissions are projected to be at approximately the same level as emissions in 2015 with a 10% projected increase in energy demand in the same period. Savings are anticipated to be delivered through further energy efficiency measures and increased rate of thermal energy sourced from renewable sources. In 2035, residential sector emissions are projected to be at the same level as projected emission levels in 2020 with a 22% projected increase in energy demand in the same period. Deeper penetration of renewable sources of energy in the sector facilitates the relatively stable level of projected emissions in this period.

Table 5.12: Emissions savings due to policies and measures included in the With Measures and With Additional Measures scenarios for the residential sector

Policy and measure	CO ₂ e (Kt)				
	2015	2020	2025	2030	2035
<i>With Measures</i>					
2002 Building Regulations	415.2	443.0	443.0	443.0	443.0
2008 Building Regulations	109.8	160.3	160.3	160.3	160.3
2011 Building Regulations	25.6	50.9	50.9	50.9	50.9
Efficient Boiler Standard	166.3	142.6	142.6	142.6	142.6
Greener Homes Scheme	24.9	24.9	24.9	24.9	24.9
Warmer Homes Scheme	62.4	80.4	80.4	80.3	80.1
Better Energy Homes	215.7	285.1	285.0	284.9	284.4
Energy Supplier Obligation Scheme (residential)	46.13	177.7	177.6	177.2	175.5
Better Energy Communities	19.5	48.4	48.4	48.3	48.3
Carbon Tax	83.0	83.0	83.0	82.8	82.2
Total	1168.53	1496.3	1496.1	1495.2	1492.2

	<i>With Additional Measures</i>				
Buildings remainder	-	27.4	27.4	27.4	27.3
RES-H*	-	46.4	128.1	244.2	343.9
Total		73.8	155.5	271.6	371.2

* The projected rate of thermal energy sourced from renewable sources is 9% (across the residential, commercial services and industrial sectors) by 2020 based on current forecasts. This is referred to as RES-H.

5.6.5 Commercial / Institutional Services

The *Baseline* energy forecast underpins the *With Measures* emission projection for the commercial services sector. The *Current Trajectory* energy forecast underpins the *With Additional Measures* emission projection. Existing and planned policies and measures are listed, with the anticipated emissions savings, in Table 5.13. These measures were included in the *Baseline* and *Current Trajectory* energy forecasts and therefore the *With Measures* and *With Additional Measures* emission projections.

Table 5.13: Emissions savings due to policies and measures included in the With Measures and With Additional Measures scenarios for the commercial services sector

Policy and measure	CO ₂ e (Kt)				
	2015	2020	2025	2030	2035
<i>With Measures</i>					
Public Sector Programme	221.8	285.3	285.3	285.3	285.3
2005 Building Regulations	158.2	313.5	313.5	313.5	313.5
SEAI Small Business Support	42.17	46.2	46.2	46.2	46.2
SEEEP and EERF	37.29	37.4	37.4	37.4	37.4

Accelerated Capital Allowance (ACA)	3.33	7.61	7.61	7.61	7.61
Public Sector Building Demonstration Programme	19.7	19.7	19.7	19.7	19.7
CHP deployment	36.47	44.2	44.2	44.2	44.2
Renewable Heat	29.7	29.7	29.7	29.7	29.7
Carbon tax	68.9	69.1	69.1	69.1	69.1
Better Energy Workplaces	47.6	47.7	47.7	47.7	47.7
Energy Supplier Obligation Scheme (non-residential)	73.32	243.4	243.4	243.4	243.4
Better Energy Communities	18.1	45.0	45.0	45.0	45.0
Total	756.58	1188	1188	1188	1188
<i>With Additional Measures</i>					
Buildings remainder	-	25.6	25.6	25.6	25.6
RES-H*	-	312.4	360.9	390.1	461.7
Total		338	386.5	415.7	487.3

* Supports for Exemplar Energy Efficient Projects (SEEEP) and Energy Efficiency Retrofit Fund (EERF)

** The projected rate of thermal energy sourced from renewable sources is 9% (across the residential, commercial services and industrial sectors) by 2020 based on current forecasts. This is referred to as RES-H.

Projected greenhouse gas emissions from the Commercial Services Sector

Under the *With Measures* emission projection, emissions from the commercial services are projected to increase by 10.9% between 2015 and 2020 while final energy demand is projected to increase by 34.6% over the same period. It is projected that emissions from the commercial service sector will increase by 24% between 2020 and 2035 and energy demand will increase by 42.5% over the same period.

Under the *With Additional Measures* emission projection, commercial services sector emissions are projected to decrease by 8.5% as a result of the policies and measures outlined in Table 5.13. Between 2020 and 2035 emissions are projected to increase by 19.7%.

5.6.6 Industrial process

Industrial Processes and Product use includes cement and lime production, other product use of carbonates, non-energy products from fuels and the use of fluorinated gases. Major industrial processes within the chemical sector and metal production are no longer undertaken in Ireland.

Mineral Industries (IPCC sector 2.A)

Process emission projections were developed for the cement and lime industries (2.A.1 and 2.A.2) and other process use of carbonates (2.A.4) only. Only one projected scenario was developed for these sectors. The other industrial process emission source glass production (2.A.3) is no longer undertaken in Ireland therefore projected emissions are not estimated. Projected emissions from the cement industries are estimated using projected GDP data which is one of the macroeconomic inputs to the SEAI energy forecasts. Projected emissions from lime production are assumed to remain at 2015 levels.

Process emissions from mineral industries are projected to increase by 18.2% from 1.8 Mt of CO₂eq in 2015 to 2.1 Mt of CO₂e in 2020 under both the *With Measures* scenario, and *With Additional Measures* scenarios. Emissions are projected to grow by 47.2% between 2020 and 2035 to 3.1 Mt CO₂ eq.

5.6.7 Solvents and Other Product Use

Emissions projections of CO₂eq from solvent use for the following activities were developed:

- Paraffin wax use (candles and other uses)
- Lubricant use
- Solvent use

Projected emissions from Paraffin wax use (candles and other uses) and Lubricant use are assumed to remain at 2015 levels.

Only one scenario was developed for solvent use which uses the rate of population growth in determining projected emissions. Emissions of CO₂eq from solvent use is projected to increase by 4.3% between 2015 and 2020 to 83.69 Kt CO₂ eq and increases to 93.45 Kt CO₂ eq in 2035.

Only one Fluorinated-gas emission projection outlook is developed and used in the two scenarios: With Measures and With Additional Measures. Fluorinated gases accounted for 1.9% of Ireland's total national greenhouse gas emissions in 2015. The relevant source of fluorinated gas emissions in Ireland is production, use and disposal of equipment containing these fluids (e.g. refrigerators, mobile air conditioning systems, metered dose inhalers and electrical switch-gear).

Projections were developed for four fluorinated gases: HFC, PFC, SF₆ and NF₃. In 2015, HFCs accounted for 94.2% of total fluorinated gas emissions with 84.4% of HFC emissions estimated to come from stationary refrigeration and air conditioning systems in vehicles. Perfluorinated compounds, used in semi-conductor manufacturing, accounted for 1.7% of total fluorinated gas emissions in 2015 while SF₆ accounted for 3.8 and NF₃ accounted for less than 0.1%.

Projections were developed for all four fluorinated gases. Table 5.14 summarises the basis for developing projections for each F-gas from the relevant sector.

In the With Measures and With Additional Measures emission projection, the impact of Directive 2006/40/EC⁶⁷ relating to emissions from air-conditioning systems in motor vehicles is estimated as a result of SI No. 127 of 2009⁶⁸ which came into effect in April 2009. The savings associated with the impact of Directive 2006/40/EC are included in the With Measures and With Additional Measures scenario and are presented in Table 5.15. Under the With Measures and With Additional Measures emission projections, fluorinated-gas emissions are projected to decrease by over 19% to 915.69 Gg CO₂eq between 2015 and 2020 and are estimated to reduce by 24.4% between 2020 and 2035. The projected decrease is attributed to the impact of the Mobile Air Conditioning Directive (2006/40/EC) and the gradual replacement of older vehicles with air conditioning that has a higher GWP (>150) with newer vehicles with air conditioning that has a lower GWP (<150). A reduction in refill of HFCs

⁶⁷ Directive 2006/40/EC can be found here:

<http://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1516964180005&uri=CELEX:32006L0040>

⁶⁸ Statutory Instruments. S.I. No 127. European Communities (Motor Vehicles Type Approval) Regulations 2009 can be found here: <http://www.irishstatutebook.ie/eli/2009/si/127/made/en/print>

in refrigerant equipment is also assumed as leakage rates decrease from improved maintenance. In addition please note that Ireland also takes into account the Grade 2 approach described in Section 2.8.2 of the emission projection guidelines⁶⁹.

Table 5.14: Key assumptions underlying the F-gas projections

Sector	F-gases	Basis for projection
Refrigeration and air conditioning	HFC	Table 34 page 126 Emission Projections Guidelines
Mobile Air Conditioning (MAC)	HFC	Projected new car registrations and introduction of low (< 150) GWP fluids
Fire-extinguishers	HFC	Current disposal factor maintained with no net growth in the number of units installed as older units are replaced
Aerosols	HFC	Pro-rata basis using UK emission projections and UK and Irish population projections
Metered dose inhalers	HFC	Population projections and prevalence of asthma in the Irish population
Semi-conductor manufacture	HFC, PFC, SF ₆ and NF ₃	GDP
Electrical equipment	SF ₆	Projected use and stock of SF ₆ used in switchgear in the electricity transmission network provided by electricity distribution operator
Window sound-proofing	SF ₆	Projections are based on the known current stock of SF ₆ in installed windows, annual leakage and disposal factors
Medical Applications	SF ₆	The use of SF ₆ in Irish hospitals is assumed to remain constant at 2015 levels

⁶⁹ DRAFT Greenhouse Gas Projection Guidelines: https://ec.europa.eu/clima/sites/clima/files/strategies/progress/monitoring/docs/ghg_projection_guidelines_b_en.pdf

Table 5.15: Emissions savings due to policies and measures included in the With Measures and With Additional Measures scenarios for F-gases

Policy and measure	CO ₂ e (Kt)				
	2015	2020	2025	2030	2035
<i>With Measures and With Additional Measures</i>					
Directive 2006/40/EC	41.6	65.8	123.1	206.6	229.3

5.6.8 Agriculture

Emissions projections for CH₄ and N₂O were developed for the agricultural sector. The agricultural activities of particular importance in Ireland are:

- (i) enteric fermentation
- (ii) manure management and
- (iii) agricultural soils.

The key sources of CH₄ emissions in the agricultural sector are enteric fermentation and manure management. The key sources of N₂O emissions are manure management and agricultural soils. Estimates of historical N₂O emissions from these sources are determined using a Tier 1 or default approach in the inventory. The same methodology is used in developing emission projections.

Two scenarios were developed for agricultural emission projections, a *With Measures* scenario and a *With Additional Measures* scenario. Projected activity data (animal numbers, crop areas and fertiliser use) are provided by Teagasc (The Irish Agriculture and Food Development Authority) to the EPA in order to prepare agricultural emission projections. The emission projections discussed here are based on the activity supplied to the EPA in advance of emissions projections that were prepared in 2016. This includes the proposed national herd, crop areas and fertilizer use to meet the overarching objectives of Food Wise 2025.

The FAPRI-Ireland model was used for preparing agricultural forecast data to underpin the emissions projections. This model is linked to the FAPRI world modelling system and so takes account of and contributes to, the projections for prices obtained and quantities traded on the world markets. The activity data assumes that there is an expansion in the value of Irish agriculture over the period to

2025 to meet the targets set out in “Food Wise 2025”⁷⁰ published by the Department of Agriculture, Food and the Marine in 2015. The main growth projections set out in this document are as follows:

- Increasing the value of agri-food exports by 85% to €19 billion.
- Increasing the value added in the agri-food, fisheries and wood products sector by 70% to in excess of €13 billion.
- Increasing the value of Primary Production by 65% to almost €10 billion.

The *With Additional Measures* scenario includes an estimate of the savings associated with the introduction of nitrification and urease inhibitors in synthetic nitrogen fertilizer to meet nutrient efficiency gains in the Ireland’s Rural Development Programme 2014-2020⁷¹. It is envisaged that under this measure that there will be reduction in the requirement for nitrogen fertilizer by 10,000 tons nitrogen in 2018, increasing linearly to 30,000 tonnes reduction in 2020 and which is maintained at that level thereafter to 2035.

Enteric Fermentation (IPCC sector 3.A)

The FAPRI-Ireland model provides projected livestock population data for dairy cows and ‘other cattle’ (i.e. dairy heifers, other heifers, cattle < 1 years, cattle 1-2 years, cattle > 2 years, bulls and beef cows).

Country specific CH₄ emission factors for Irish cattle were developed as part of an in-depth analysis of cattle production systems and associated animal feed and energy required to improve the reporting of CH₄ emissions in the national greenhouse gas inventory⁷². For dairy cows, CH₄ emission factors have been increasing by an average of 0.4% per annum since 1990 which is primarily due to increasing milk yields. In developing the projections, it is assumed that the CH₄ emission factor for dairy cows continues to grow at 0.4% per annum reflecting projected continuing growth in milk yields. For other cattle categories, emission factors are held constant at 2015 levels.

FAPRI-Ireland also provide projected animal population for sheep, swine, horses, mules and goats which allowed projected CH₄ emissions from these livestock categories to be calculated. The type of information used to derive Tier 2 CH₄ emission factors for cattle is not available for sheep, swine,

⁷⁰ Food Wise 2025. A 10-year vision for Irish agri-industry. Department of Agriculture, Food and the Marine, 2015. <https://www.agriculture.gov.ie/foodwise2025/>

⁷¹ <http://agriculture.gov.ie/ruralenvironment/ruraldevelopmentprogrammerdp2014-2020/>

⁷² “Development of Emission Factors for Enteric Fermentation from the Irish Cattle Herd”. LS 5.1.1. Frank O’Mara. Environmental Protection Agency. (2006).

horses, mules and goats. Therefore, IPCC default CH₄ emission factors are used, adjusted were necessary to reflect national circumstances (following the approach of the national inventory).

CH₄ Emissions

The decomposition of organic material in animal manures can be a source of CH₄ emissions if anaerobic conditions prevail in the animal waste management systems being used. The estimation of such emissions requires information on the quantity of manure produced from the animal groups concerned, the type of waste management systems employed and the CH₄ production potential of the wastes. Information obtained from a farm facilities survey⁷³, and the development of country specific emission factors for enteric fermentation in cattle, mentioned above, are the basis for CH₄ emission factors for manure management used in the greenhouse gas inventory. Emission factors over the projection period are assumed to follow 2015 levels. The calculation of CH₄ emissions from manure management of sheep, swine, horse and poultry were determined using projected animal numbers and IPCC default emission factors (as used in the inventory).

N₂O Emissions

Nitrous oxide emission projections from manure management (i.e. liquid systems, solid storage and dry lot, pit storage, deep bedding and pasture) were determined using information on the allocation of animal manures to different animal waste management systems (taken from the farm facilities survey and the national greenhouse gas inventory), nitrogen excretion rates (from the Department of Agriculture Food and the Marine and the national greenhouse gas emission inventory) and projected animal numbers. Projected N excretion rates follow 2016 projections methodology, which are estimated for dairy cows based on projected feed intake and milk output contained in a dairy production roadmap for 2020 developed by Teagasc. Post 2020 nitrogen excretion from dairy cows is assumed to increase at 0.6% per year. IPCC default emission factors were used to determine the amount of nitrogen that is lost as N₂O (following the approach of the national inventory).

N₂O Emissions from Agricultural Soils (IPCC sector 3.D)

Nitrous oxide is produced naturally in soils through the processes of nitrification and denitrification. It is a gaseous intermediate in the reaction sequence of denitrification and a by-product of nitrification that leaks from microbial cells into the soil and ultimately into the atmosphere. One of

⁷³ Farm Facilities Survey – Ireland 2003. Report prepared for the Department of Agriculture by Teagasc, Johnstown Castle.

the main controlling factors in this reaction is the availability of inorganic nitrogen in the soil. Estimates of N₂O release from soils in the future is, therefore, based on human-induced net nitrogen additions to soils (e.g. synthetic or organic fertilisers, deposited manure, crop residues, sewage sludge).

Direct N₂O soil emissions are therefore calculated as the sum of

- Amount of fertiliser nitrogen applied to soils, adjusted for the amount that volatilises as NH₃ and NO_x. Projected synthetic nitrogen use was provided by Teagasc. Projected sludge production and the proportion applied on agricultural lands is taken from projected assumption in the treatment of wastewater (IPCC sectors 5.D.1 and 5.D.2).
- Amount of nitrogen fixed by nitrogen-fixing crops. Projected annual production of pulses was provided by Teagasc.
- Amount of nitrogen fixed in crop residues that is returned to the soils. Teagasc provided projected annual production of pulse, potatoes, barley, oats and wheat.

Indirect emissions of N₂O from agricultural soils also occur through two routes. The first of these pathways is the volatilisation of nitrogen, as NH₃ and oxides of nitrogen (NO_x), following the application of synthetic and organic nitrogen fertilisers and/or manure deposition from grazing animals. These gases and their products are deposited onto soils and the surface of lakes and other waters. The second pathway is the leaching and runoff from land of nitrogen from, for example, synthetic and organic fertiliser additions and manure deposition from grazing animals. Where nitrate is present in the soil in excess of biological demand, e.g. under cattle urine patches, the excess leaches through the soil profile and can be transformed to N₂O.

Indirect N₂O emissions are therefore calculated as the sum of:

- Emissions of N₂O from atmospheric nitrogen deposition and fraction of animal manure nitrogen and sewage sludge applied to agricultural land that volatilises.
- Emissions of N₂O from nitrogen leaching. This is assumed to be 10% of available nitrogen and assumed to remain constant over the projection period.

Liming and Urea Application to agricultural soils (IPCC sectors 3.G and 3.H)

Liming (3.G) accounted for approximately 0.4 Mt CO₂ in 2015 as a result of the application of approximately 892 kilo tonnes of lime to agricultural soils in 2015. This level of application is 23% lower than the peak amount applied in 2013. For each projected year it is forecasted that the

application of lime to agricultural soils will be at least equal to the average application rate historically and result in emissions of 0.35 Mt CO₂ in 2020 and 2035 respectively.

Projected fertilizer use for agricultural soils is provided by Teagasc. However, no information is currently available in relation to the forecasted breakdown of fertilizer application by product type (i.e. calcium ammonium nitrate, urea etc.). It is thus assumed that the proportion of urea fertilizer in the latest inventory year (2015) is maintained for each projected year to 2035.

Projected greenhouse gas emissions from the Agriculture sector (IPCC sector 3)

In the *With Measures* scenario total emissions from the agricultural sector are projected to increase by 4.9% between 2015 and 2020 as a result of proposed national herd, crop areas and fertiliser use to meet overarching objectives of Food Wise 2025. Dairy cow numbers are projected to increase by over 7% between 2015 and 2020. Fertilizer nitrogen use is projected to increase by 21% between 2015 and 2020. By 2035 it is estimated that dairy cow numbers will have increased to 1.46 million head (15% above 2015) and that fertilizer nitrogen use will be approximately 395,000 tonnes in 2035. There is projected to be a contraction in animal numbers in the less profitable other cattle sector between 2015 and 2020 and more significantly out to 2035. Projected emissions in 2035 are projected to be 19.5 Mt CO₂ eq in 2035 (1.5% higher than 2015).

Under the *With Additional Measures* scenario projected total emissions will increase by 4.1% between 2015 and 2020 (20.01 Mt CO₂ eq in 2020) and 0.7% between 2015 and 2035 (19.36 Mt CO₂ eq in 2035).

Table 5.16 Emissions savings due to policies and measures included in the With Additional Measures scenario for the agriculture sector

Policy and measure	CO ₂ e (Kt)				
	2015	2020	2025	2030	2035
<i>With Additional Measures</i>					
Nitrogen use efficiency	0	156.7	156.7	156.7	156.7

5.6.9 Land Use, Land Use Change and Forestry

The Land Use, Land Use Change and Forestry sector includes greenhouse gas emissions and removals due to land use and land use change. It consists of six subcategories: Forest Land (4.A),

Cropland (4.B), Grassland (4.C), Wetlands (4.D), Settlements (4.E) and Other Land (4.F). The 2015 submission under the MMR, was the first time that Ireland reported projections for the LULUCF sector. The approach taken in estimating greenhouse gas emission and removals from the sector utilises the approach used for the national greenhouse gas inventory in conjunction with a projected land use and land use change matrix developed with external consultants in 2014.

Emissions and removals from the sector follow a hierarchical approach in line with the greenhouse gas Projections Guidelines² (page 182 Grade 1 emission factors projections, Alternative 1 approach (emission factors for future years is based on the average of previous ten years)). In Ireland, projected forest land areas are the most developed, followed by wetland areas and areas under settlement. Projected cropland and grassland areas are supplied by Teagasc in conjunction with the activity data supplied for the agriculture sector. The remaining land areas are assumed to remain constant for the projected time series.

Forest Land (IPCC sector 4.A)

Projected emission and removal estimates are undertaken for the following activities Forest Land remaining Forest Land (4.A.1) and Land converted to Forest Land (4.A.2), as well as for activities Forest Land converted to Grassland (4.C.2.1), Forest Land converted to Wetlands (4.D.2.1), Forest Land converted to Settlements (4.E.2.1) and Forest Land converted to Other Land (4.F.2.1), Information on projected afforestation and deforestation is provided by the Department of Agriculture, Food and the Marine⁷⁴.

Cropland and Grassland (IPCC sectors 4.B and 4.C)

This Chapter covers both Cropland (CL) and Grassland (GL) land uses as these land uses are closely linked. Projected emission and removal estimates are undertaken for the following activities: Cropland remaining Cropland (4.B.1), Land converted to Cropland (4.B.2), Cropland remaining Grassland (4.C.1) and Land converted to Grassland (4.C.2). In addition, information in relation to Cropland converted to Forest Land (4.A.2.1), Cropland converted to Grassland (4.C.2.2), Cropland converted to Settlements (4.E.2.2), Grassland converted to Forest Land (4.A.2.2), Grassland converted to Cropland (4.B.2.2) and Grassland converted to Settlements (4.E.2.3) is also used.

Wetlands (IPCC sector 4.D)

⁷⁴ <http://www.coford.ie/>

Projected emission and removal estimates are undertaken for the following activities 4.D.1 (Wetland remaining Wetland) and 4.D.2 (Land converted to Wetland), as well as for activities 4.A.2.3 (Wetlands converted to Forest Land), 4.C.2.3 (Wetlands converted to Grassland) and 4.E.2.3 (Wetlands converted to Other). In addition it is expected that Bord na Mona⁷⁵, will exhaust their current peat reserves prior to 2030, therefore leading to land use change within this sector. The National Peatlands Strategy⁷⁶ details proposed future uses of peatlands and where relevant these proposed future land uses have been taken into account.

Settlements (IPCC sector 4.E)

As an initial approach the total area of Settlements (both remaining and in transition) has been estimated based on the GDP projections. Projected emission and removal estimates have been undertaken for the following 4.E.1 (Settlements remaining Settlements) and 4.E.2 (Land converted to Settlements). In addition it is assumed that as there is no land use change from Settlements to other lands in the historic national inventory estimates, which it will not occur into the future. The area under activity 4.E.1 is considered fixed, as in the historical series. Therefore, the increases in areas are disaggregated between the different land uses in 4.E.2 (Land converted to Settlements). Information in relation to deforestation of Forest Lands that convert to Settlements is already included in forest projections. The disaggregation between the remaining activities (4.E.2.2, 4.E.2.3 and 4.E.2.5) has been performed by applying the historical mix.

Other Land (IPCC sector 4.F)

Projected emission and removal estimates are undertaken for the following activities 4.F.1 (Other Lands remaining Other Lands) and 4.D.2 (Land converted to Other Lands), as well as for activities 4.A.2.5 (Other Lands converted to Forest Land) and 4.E.2.5 (Other Lands converted to Settlements). The only source of new Other Lands in the historical series is Forest Land. Deforestation of Forest Lands that convert to Other Lands are provided in forestry projections. In order to estimate the projection of the activity 4.F.1 (Other Land remaining Other Land), it is necessary to estimate the conversions from Other Lands to other land uses. Conversions to Settlements are already estimated and explained in the previous section on Settlements.

⁷⁵ <http://www.bordnamona.ie/>

⁷⁶ <https://www.npws.ie/sites/default/files/general/Final%20National%20Peatlands%20Strategy.pdf>

5.6.10 Waste

Emission projections for the waste sector are developed for CO₂, CH₄ and N₂O. Solid waste disposal to landfill (IPCC sector 5.A) is currently the main source of emissions from the waste sector. Methane emissions arise from (i) solid waste disposal in landfill sites and (ii) wastewater and sludge treatment (IPCC sector 5.D), whilst N₂O emissions also arise from the production of human sewage. In addition, CO₂, CH₄ and N₂O emissions arising from the incineration of hazardous wastes (solvents) in the pharmaceutical industry (IPCC sector 5.C) and the mechanical and biological treatment of waste (IPCC sector 5.B) are also estimated. The emissions associated with the incineration of municipal solid waste for electricity generation (WtE) are included in emissions estimates for electricity generation (IPCC sector 1.A.1.a). Only one scenario was developed for the waste sector.

Emissions are projected to decrease by 36.1% between 2015 and 2020. Emissions in 2035 are projected to be 26.1% lower than in 2020 at 0.45 Mt CO₂ eq. Emissions from solid waste disposal at landfill are projected to decrease by 47.8% between 2015 and 2020 and 49.8% between 2020 and 2035.

5.7 Memo Items

Projected emissions from international maritime transport and international aviation are estimated (see estimated emissions associated with Memo Items in the tables in Annex B of this report). Emissions from international aviation are estimated based on forecasted landing and take-off forecasts supplied to the inventory agency. Emissions from international maritime transport are assumed to equal 2015 levels for each projected year.

5.8 Sensitivity Analysis

A sensitivity analysis of the *Baseline* energy forecast (which underpin the *With Measures* emissions projection) was undertaken. Details of the assumptions used in the sensitivity analysis are presented in Table 5.17. Underlying fuel prices are based on the EU Reference Scenario 2016 values as circulated by the Commission in 2016 (recommended harmonised values for key supra-nationally determined parameters). The ETS EU Carbon Price is the same as what was used in the emissions projections. Sectoral and overall results of the sensitivity analysis split on emissions covered by Decision 406/2009/EC and total emissions included in the scope of the Union's emissions trading scheme established by Directive 2003/87/EC are provided in Tables 5.16 and 5.17.

Table 5.17 Key assumptions underpinning the energy forecasts sensitivity analysis

	2016-2020	2021 – 2025	2026-2030	2031-2035
	Average Annual % Growth			
GDP	3.0%	2.1%	1.9%	1.9%
GNP	2.6%	2.1%	1.3%	1.3%
Personal Consumption	2.7%	1.4%	0.4%	0.4%
	2016	2020	2025	2030
Housing Stock ('000)	1,967	2,016	2,068	2,104
Population ('000)	4,674	4,834	5,027	5,209
EUETS: Carbon €₂₀₁₃/tCO₂	9	15	22.5	33.5
Carbon tax €₂₀₁₃/tCO₂	18.3	15	22.5	33.5
Coal \$₂₀₁₃/boe	13.4	16.6	21.4	26.0
Oil \$₂₀₁₃/boe	59.7	87.2	106.3	118.9
Gas \$₂₀₁₃/boe	45.4	56.2	65.2	72.0
Peat €/MWh	25	25	25	25

In comparison with Table 5.6, there are marked differences in fuel prices in Table 5.17, in particular oil prices, with oil prices in the sensitivity analysis substantially higher than those used in the emission projections (e.g. \$106.3/boe in 2025 in the sensitivity analysis compared to €62.8/boe in the emissions projections) which inter alia will lead a decrease in emission levels in some sectors (e.g. Transport). Coal and gas prices are also significantly higher in the Sensitivity scenario. Lower economic growth is assumed in the sensitivity with a per annum increase in GDP of 3% compared to 3.7% in Table 5.6 in the period 2016-2020. Reduced economic growth is also evident in annual

average growth in personal consumption in the sensitivity analysis. In terms of ETS emissions, overall total emission levels are higher in the sensitivity scenario which is mainly driven the energy industries sector (e.g. power generation) for the years 2020, 2025 and 2030 as shown in Table 5.18. All other ETS sector emissions are lower in the sensitivity scenario.

In line with lower economic growth the resultant emission levels as presented in Table 5.19 show that total Non-ETS emissions under the *Sensitivity* scenario are approximately 8%, 12%, 13% and 14% lower in 2020, 2025, 2035 and 2035, respectively than emissions in the *With Measures* scenario. Reductions in emissions are particularly notable in the Manufacturing Industries and Construction, Transport Commercial/Institutional sectors.

For the agriculture sector, the sensitivity analysis undertaken assumes a reduction in the national herd (dairy and other cattle) in the *With Measures* scenario by 10%. Reductions in emissions in the agricultural sector amount to approximately 7.5% lower in the years shown. For the waste sector the management of an additional 350,000 tonnes of municipal waste per annum in solid waste disposal sites leads to a 7%, 13.6%, 18.9% and 23.4% increase in emissions from the waste sector in 2020, 2025, 2030 and 2035 respectively.

Table 5.18 Results of sensitivity analysis ETS emissions (Kt CO₂ eq)

	<i>With Measures ETS</i>			
	2020	2025	2030	2035
Energy Industries	9766.6	11085.2	12336.3	14054.0
Manufacturing Industries and Construction	3942.4	4007.3	4135.4	4605.9
Transport	14.1	16.0	17.1	19.8
Commercial/Institutional	28.3	31.2	32.9	35.1
Industrial Processes and Product Use	2163.0	2506.2	2823.9	3184.8
Total	15914.4	17645.9	19345.5	21899.7
	<i>With Measures Sensitivity ETS</i>			
	2020	2025	2030	2035
Energy Industries	12479.6	13650.8	14587.9	15663.9
Manufacturing Industries and Construction	2759.1	2827.7	2905.1	2993.5
Transport	9.7	10.6	11.7	12.3
Commercial/Institutional	23.4	25.1	25.8	27.2
Industrial Processes and Product Use	2093.5	2303.4	2523.2	2765.9
Total	17365.4	18817.6	20053.7	21462.8
	% Difference			
	2020	2025	2030	2035
Energy Industries	27.8%	23.1%	18.3%	11.5%
Manufacturing Industries and Construction	-30.0%	-29.4%	-29.8%	-35.0%
Transport	-31.2%	-33.4%	-31.9%	-37.8%

Commercial/Institutional	-17.2%	-19.7%	-21.4%	-22.5%
Industrial Processes and Product Use	-3.2%	-8.1%	-10.6%	-13.2%
Total	9.1%	6.6%	3.7%	-2.0%

Table 5.19 Results of sensitivity analysis Non-ETS emissions (Kt CO₂ eq)

	<i>With Measures Non ETS</i>			
	2020	2025	2030	2035
Energy Industries	448.4	477.5	490.7	507.5
Manufacturing Industries and Construction	1369.2	1391.8	1436.3	1599.7
Transport	13254.3	15045.5	14905.6	14750.9
Commercial/Institutional	1901.8	2099.1	2207.1	2357.6
Residential	6134.6	6344.2	6368.5	6444.3
Agriculture/Forestry/Fishing	633.2	674.4	709.5	775.2
Fugitive Emissions from Fuels	24.1	22.4	20.9	19.4
Industrial Processes and Product Use	1080.4	1006.0	895.8	870.7
Agriculture	20167.0	20128.9	19603.4	19519.9
Waste	622.6	546.7	499.7	459.9
Total	45635.6	47736.3	47137.5	47305.0
	<i>With Measures Sensitivity Non ETS</i>			
	2020	2025	2030	2035
Energy Industries	446.3	464.4	479.0	496.2
Manufacturing Industries and Construction	958.3	982.1	1009.0	1039.7
Transport	11657.9	12038.5	11591.8	11408.2
Commercial/Institutional	1574.9	1686.6	1735.2	1828.2
Residential	6327.2	6177.8	6044.4	5804.0
Agriculture/Forestry/Fishing	525.3	556.4	579.8	647.9
Fugitive Emissions from Fuels	24.0	22.3	20.8	19.3
Industrial Processes and Product Use	1076.8	998.7	887.5	859.1
Agriculture	18640.7	18601.4	18123.2	18046.4
Waste	666.1	620.8	593.9	567.6
Total	41897.4	42149.1	41064.6	40716.4
	<i>% Difference</i>			
	2020	2025	2030	2035
Energy Industries	-0.5%	-2.7%	-2.4%	-2.2%
Manufacturing Industries and Construction	-30.0%	-29.4%	-29.8%	-35.0%
Transport	-12.0%	-20.0%	-22.2%	-22.7%
Commercial/Institutional	-17.2%	-19.7%	-21.4%	-22.5%
Residential	3.1%	-2.6%	-5.1%	-9.9%
Agriculture/Forestry/Fishing	-17.0%	-17.5%	-18.3%	-16.4%
Fugitive Emissions from Fuels	-0.4%	-0.5%	-0.6%	-0.7%
Industrial Processes and Product Use	-0.3%	-0.7%	-0.9%	-1.3%
Agriculture	-7.6%	-7.6%	-7.6%	-7.5%
Waste	7.0%	13.6%	18.9%	23.4%

Total	-8.2%	-11.7%	-12.9%	-13.9%
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5.9 Supplimentarity

Use of flexibilities of the Kyoto Protocol should be **supplemental** to domestic actions on climate change.

Under the First Commitment Period of the Kyoto Protocol (2008-2013), Ireland had a national target to restrict the growth in its emissions to 13% above its base year emissions (generally 1990 levels). Ireland was required to retire units equating to 1.8 Mt CO₂E in order to address the small distance to its target of 314.18 Mt CO₂E at the end of the period. In respect of the Second Commitment Period (2013-2020), the most recent projections by the EPA indicate that Ireland will again require the use of flexibilities in order to comply with its target.

6. Vulnerability Assessment, Climate Change Impacts and Adaptation

Measures

Key Developments

- The Climate Action and Low Carbon Development Act 2015 (Climate Act)⁷⁷ provides for the statutory preparation of the National Adaptation Framework (NAF) in Ireland. Ireland's first statutory NAF was published in January 2018.
- The Climate Act also provides that relevant Government Ministers will be required to develop sectoral adaptation plans which will specify the adaptation policy measures the Minister in question proposes to adopt. This process will begin in 2018.
- Ireland has initiated a National Dialogue on Climate Action which will inform our national objective to transition to a low carbon and climate resilient economy and society.
- A number of non-statutory sectoral adaptation plans have been completed (i.e. Agriculture and Forestry, Transport, Energy and Flood risk Management) in line with Ireland's non-statutory *National Climate Change Adaptation Framework (2012)*⁷⁸.
- The research and development of the knowledge base has also been further improved through research developed under the Environmental Protection Agency's Climate Research Pillar. Key outputs and ongoing projects include:
 - Climate Ireland (Ireland's climate information platform)⁷⁹ has completed its initial research phase and is currently being examined with a view to putting it on a long term operational basis. Sectoral Guidelines for Planning for Climate Change Adaptation and Local Authority Climate Change Adaptation Strategy Guidelines have also been prepared to assist adaptation planning at sectoral and local level.

⁷⁷ <http://www.irishstatutebook.ie/eli/2015/act/46/enacted/en/html>

⁷⁸ <http://www.dccae.gov.ie/en-ie/climate-action/publications/Documents/4/National%20Climate%20Change%20Adaptation%20Framework.pdf>

⁷⁹ www.climateireland.ie

- The Urban Adapt⁸⁰ project is developing an innovative regional approach that allows for the integrated assessment and management of current and future climate vulnerabilities
- A National Risk Assessment of Impacts of Climate Change has commenced⁸¹ (EPA) the aim of which is to establish a national risk and impacts assessment of the effect upon Ireland of the current and future patterns in the 21st Century of climate warming.
- The CIVic study at NUIG is assessing the vulnerability of elements (water, energy, transport and communications) of Ireland's critical infrastructure to climate change.

6.1 Introduction

Climate change will have diverse and wide ranging impacts on Ireland's environment, society and economic development, including managed and natural ecosystems, water resources, agriculture and food security, human health and coastal zones. Sufficient robust information now exists nationally to further progress the process of implementing adaptation actions and increasing social, economic and environmental resilience to climate change.

Ireland is at the early stages of developing climate resilience; however there has been progress to date in building Ireland's levels of climate resilience through capacity building measures, improvements in the research and knowledge base, increased awareness of climate change and mainstreaming of adaptation relevant measures into a number of key national policies (flood risk management and spatial planning).

In terms of further developing Ireland's climate resilience (i.e. adapting to climate change impacts), the approval of Ireland's first statutory *National Adaptation Framework* in December 2017 will play a key role in further informing the development of national policy.

6.2 Projected Climate Change Impacts for Ireland





Ireland's climate is changing in line with global trends. Future changes are projected for temperature, precipitation, sea level rise and extreme events. Such changes will impact on all natural and managed systems, water resources, agriculture and food security, human health, and

⁸⁰ Further information on the Urban Adapt project may be found at <https://urbadapt.com/about/>

⁸¹ Further information on this risk assessment can be found at <http://www.marei.ie/national-risk-assessment-impacts-climate-change/>

coastal infrastructures and zones. Table 1 below summarises key observed and projected climate change impacts for Ireland.

Table 6.1: Summary of Observed and Projected Climate Changes and Impacts for Ireland

Parameter	Observed	Projected	Example of Biophysical Impacts
 <p>Temperature</p>	<ul style="list-style-type: none"> Average temperatures have increased by 0.8°C since 1900, an average of 0.07°C per decade. The number of warm days (over 20°C) has increased while the number of cold days (below 0°C) has decreased. 	<ul style="list-style-type: none"> Projections indicate an increase in average temperatures across all seasons (0.9 – 1.7°C). The number of warm days is expected to increase and heat waves are expected to occur more frequently. 	<ul style="list-style-type: none"> Incidences of cold stress are likely to decrease while incidences of heat stress will increase. The duration of the growing season will increase, occurring earlier and extending farther.
 <p>Precipitation</p>	<ul style="list-style-type: none"> Increase in average annual national rainfall of approximately 60mm or 5% in the period 1981-2010, compared to the 30 year period 1961-1990. The largest increases are observed over the west of the country. 	<ul style="list-style-type: none"> Significant reductions are expected in average levels of annual, spring and summer rainfall. Projections indicate a substantial increase in the frequency of heavy precipitation events in Winter and Autumn (approx. 20%). 	<ul style="list-style-type: none"> The increased occurrence of dry spells will result in increased pressure on water supply. An increase in the frequency of extreme precipitation events will result in increased fluvial and pluvial flood risk.
 <p>Wind Speed & Storms</p>	<ul style="list-style-type: none"> No long-term change in average wind speed or direction can be determined with confidence. The number and intensity of storms in the North Atlantic has increased by approx. 3 storms per decade since 1950. 	<ul style="list-style-type: none"> Projections indicate an overall decrease in wind speed and an increase in extreme wind speeds, particularly during winter. The number of very intense storms is projected to increase over the North Atlantic region. Projections suggest that the winter track of these storms may extend further south and over Ireland more often. 	<ul style="list-style-type: none"> Increases in extreme wind speeds may impact on wind turbines and the continuity of power supply. Infrastructure will be at risk due to the increased occurrence of intense storms (e.g. winter 2013/2014).
 <p>Sea Level & Sea Surface Temperature</p>	<ul style="list-style-type: none"> Historically, sea level has not been measured with the necessary accuracy to determine sea level changes around Ireland. However, measurements from Newlyn, in southwest England, show a sea level rise of 1.7cm per decade since 1916. These measurements are considered to be 	<ul style="list-style-type: none"> Sea levels will continue to rise for all coastal areas, by up to 0.8 m by 2100. The south of Ireland will likely feel the impacts of these rises first. Sea surface temperatures are projected to continue warming for the coming decade. For the Irish Sea, projections indicate a warming of 1.9°C by the end of the century. 	<ul style="list-style-type: none"> Significant increase in areas at risk of coastal inundation and erosion. Increased risk to coastal aquifers and water supply. Change in distribution fish species. Implications for fisheries and aquaculture industries.

	representative of the situation to the south of Ireland <ul style="list-style-type: none"> • Sea surface temperatures have increased by 0.85°C since 1950, with 2007 the warmest year in Irish coastal records 		
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6.3 Policy Developments at National Level

The non-statutory *National Climate Change Adaptation Framework* (NCCAF), which was published in 2012, was the first step in developing a national policy in Ireland to address the anticipated impacts of climate change. This non-statutory, but Government approved, Framework mandated the development and implementation of sectoral adaptation plans and local authority adaptation strategies which, together, would form part of the national response to the impacts of climate change. The NCCAF has succeeded in building the evidence base and in filling some of the knowledge and research gaps; it has also increased awareness and capacity within the sectors to help them to address climate change adaptation.⁸²

The policy in relation to climate adaptation, first set out in the 2012 NCCAF, was subsequently restated in the *National Policy Position on Climate Action and Low Carbon Development* published in April 2014.

“National climate policy in Ireland –

- *recognises the threat of climate change for humanity;*
- *anticipates and supports mobilisation of a comprehensive international response to climate change, and global transition to a low-carbon future;*
- *recognises the challenges and opportunities of the broad transition agenda for society;*
and
- *aims, as a fundamental national objective, to achieve transition to a competitive, low-carbon, climate-resilient and environmentally sustainable economy by 2050.”*

⁸² Implementation work under the NCCAF has been co-ordinated by the Department of Communications, Climate Action and Environment through a National Adaptation Steering Committee. The committee is chaired by the Department and includes membership from the relevant sectors as well as EPA, Department of Public Expenditure and Reform, with the local government sector represented through the County and City Management Association and the regional assemblies.

Ireland's *National Policy Position on Climate Action and Low Carbon Development* provides a high-level policy direction for the adoption and implementation by Government of plans to enable the State to pursue the transition to a low carbon, climate resilient and environmentally sustainable economy by 2050;⁸³ statutory authority for these mitigation and adaptation plans was subsequently provided for in the Climate Action and Low Carbon Development Act 2015. Under section 5 of the 2015 Act, the Minister for Communications, Climate Action and Environment must submit a *National Adaptation Framework* to Government for approval (not later than 10 December 2017) and the Framework must be reviewed not less than once in every five year period. Ireland's first statutory NAF was published in January 2018.

In line with the legislative requirement the NAF specifies the national strategy for the application of adaptation measures in different sectors and by local authorities in their administrative areas in order to reduce the vulnerability of the State to the negative effects of climate change and to avail of any positive impacts that may occur. The 2015 Act also provides that relevant Ministers will be required to develop sectoral adaptation plans which will specify the adaptation policy measures the Minister in question proposes to adopt.

The NAF provides for the preparation of 12 statutory sectoral adaptation plans by 7 Government Departments in a number of priority sectors. Work on these statutory plans will begin during 2018. In an effort to promote enhanced cooperation and co-ordination, the NAF also sets how the sectors that have been identified could be grouped under four key thematic areas as follows; Natural and Cultural Capital; Critical Infrastructure; Water Resource and Flood Risk Management; and Public Health.

The themed approach highlights the potential to work cross departmentally in terms of identifying synergies and efficiencies that can be achieved in bringing forward coherence between respective adaptation policies and measures. Such an approach would also enable issues to be identified across themes thus ensuring another level of coherence on cross cutting issues. In terms of governance and working through formal sectoral co-ordination arrangements, the themed approach and the potential for enhanced collaboration and thematic coherence is something the sectors will consider when developing their respective adaptation plans.

⁸³ Known as the "national transition objective" – see section 3(1) of the Climate Action and Low Carbon Development Act 2015.

In addition to specific sectoral plans covering key areas the NAF also strongly recognises the importance of mainstreaming of adaptation and the importance of a whole-of-Government approach to ensuring a coherent and coordinated approach to climate adaptation in Ireland. In addition to the preparation of sectoral plans the NAF also , identifies the importance of;

- Integrating climate adaptation within all relevant national policy and legislation (e.g. National Planning Framework, estimates and budgetary process, National Investment Plan) and Department and Agency decision making.
- Increasing awareness of the necessity for climate adaptation and building adaptive capacity where required.
- Encouraging the implementation of climate adaptation measures.
- Developing and exploiting the knowledge base.
- Addressing prioritised urgent and future climate risks.
- Monitoring the progress and effectiveness of adaptation at national level.

6.4 Progress to Date at Sectoral Level

A small scale study⁸⁴ prepared for the EPA in 2016 identified 51 separate adaptation actions that have been undertaken in Ireland. Of these 31% of the actions were in flood risk management, 18% were in water management, 8% in biodiversity, 8% in coastal impacts and 20% were mitigation actions with adaptation co-benefits.

Examples of some of these actions include Flood Relief Schemes undertaken by the Office of Public Works (OPW), changes to building regulations, national guidelines on sustainable drainage systems and integrated constructed wetlands and policy guidance documents on green roofs in Dublin.

Arising from the 2012 NCCAF, the National Adaptation Steering Committee was established in 2014 and meets regularly and representation includes government sectors, EPA, Climate Change Advisory Council Secretariat, County and City Management Association (CCMA) and regional government. The aim of the Committee is to provide assistance and guidance to the various sectors (including Local Authorities) in the development of their sectoral/local level adaptation plans. In March 2017 a Committee subgroup on governance issues was formed to consider how adaptation planning can be

⁸⁴ Adaptation Inspiration- Scoping Adaptation Case Studies in Ireland, EPA Small Scale Study Report 2016

effectively progressed in sectors where roles and responsibilities are fragmented across government departments, agencies, bodies and local authorities. In common with other jurisdictions, further integration and coordination is required and this is provided for in the draft National Adaptation Framework.

A number of sectors in Ireland have also already developed non-statutory sectoral plans in line with the non-statutory National Climate Change Adaptation Framework (DECLG, 2012). These plans are;

- Sectoral Adaptation Plan for Flood Risk Management (OPW, 2015)⁸⁵.
- Adaptation Planning - Developing Resilience to Climate Change in the Irish Agriculture and Forest Sector (Department of Agriculture, Food and the Marine, 2017)⁸⁶.
- Adaptation Planning - Developing Resilience to Climate Change in the Irish Transport Sector (Department of Transport, Tourism and Sport, 2017)⁸⁷.
- Draft Adaptation Plan for the Electricity and Gas Networks Sector (Department of Communications, Climate Action and Environment, 2017)⁸⁸.

The following chapter summarises each of these plans.

6.4.1 Flood Risk Management

The Office of Public Works' flood defence sectoral adaptation plan⁸⁹ outlines existing flood risk and flood risk management practice in Ireland and summarises existing science on climate change and the current state of knowledge for impacts on flooding and flood risk. It defines the policy for adaptation in the flood risk management sector and sets out a series of actions to enhance the understanding of the potential impacts of climate change on flooding and flood risk and to embed adaptation into flood risk management practice. The plan also identifies how changing flood risk should be taken into account in spatial planning and other sectors and sets out what is required for the monitoring, review and evaluation of the plan.

The cyclical implementation of the EU 'Floods' Directive, which has included the National Catchment based Flood Risk Assessment and Management (CFRAM) in the first cycle, is the principal mechanism for the assessment of the potential impacts of climate change on flood risk, and for planning,

⁸⁵ <http://www.opw.ie/en/climatechange/>

⁸⁶ <https://www.agriculture.gov.ie/media/migration/ruralenvironment/climatechange/ApprovedAdaptationPlanning040817.pdf>

⁸⁷ <http://www.dttas.ie/public-transport/english/climate-change>

⁸⁸ Currently the subject of a public consultation with a closing date of 16 October 2017 <http://dcaae.gov.ie/en-ie/energy/consultations/Pages/National-Adaptation-Plan-for-Energy-Networks.aspx>

⁸⁹ <http://www.opw.ie/en/climatechange/>

through the Flood Risk Management Plans (FRMP), for the sustainable flood risk management over the long-term in Ireland, including embedding the consideration of climate change in the development of capital flood relief projects. The future scenario flood maps produced under the CFRAM Programme will facilitate this approach, inform other sectors, and provide a valuable resource for local adaptation planning and sustainable land use management and planning.

Example: Climate-Rogerstown Estuary⁹⁰

This case study summarises the actions undertaken by Fingal County Council to begin to 'climate-proof' Rogerstown Estuary⁹¹, a key area of public amenity and biodiversity conservation. The project adopted a 'let it flood' approach, the first of its kind in Ireland and is a pioneering study for climate adaptation in estuarine environments.

The project undertaken at Rogerstown is a pioneer example of 'Climate Smart Conservation' in Ireland. The initiative was taken on by Fingal County Council in anticipation of the effects that future climate changes would have on the estuary, including rising sea levels, higher tides, and more frequent and intense storm events.

By allocating additional space for floodwater storage on this site, properties upstream are protected from future flooding. Rogerstown presented a unique opportunity to conduct an experiment to investigate the effects of a more natural tidal regime, as there was no risk to people or property as a result of the increased levels of flooding resulting from the removal of the embankment. Long term financial savings have also been secured, as the cost of removing the embankment is significantly less than continual upgrading and maintenance of the embankment structure.

In the long term, this action will restore the natural hydrology of Rogerstown estuary, and will help to protect sites further upstream of the site from the effects of sea level rise, storm surges and higher tides by allocating space for additional floodwater. As part of Fingal's biodiversity strategy, monitoring of biodiversity on the site had been ongoing for a number of years. The information gathered through this monitoring process has provided a baseline of environmental and ecological conditions on the site against which future changes can be measured.

The project, headed by Fingal's biodiversity officer, Hans Visser, aims to encourage the return of the broad ecosystem dynamics that created the landscape of the area and provide for increased floodwater storage. This was achieved by completely removing the existing embankment, allowing for tidal flooding at the site. This process allowed for complete inundation of the inner estuary in the event of a high tide or a storm surge and protects areas upstream of the site.

Areas of inland saltmarsh, created as a result of the breaching of the embankment, are now increasingly inundated and the environment is expected to continue to change as a result of the increased influence of more brackish water. The return of this natural interaction between fresh and brackish water has already seen the success of species that had been virtually non-existent in the area prior to the project.

A high level of stakeholder engagement was involved in the project. A key part of Fingal's biodiversity plan was targeted at opening up the estuary to a wide range of visitors. An extensive public consultation was carried out and significant volunteer efforts were put towards the project, with trees planted by local

⁹⁰ Adapted case study from Power, S, & O'Dwyer, B. (2016) 'Adaptation Inspiration – Scoping Adaptation Case Studies in Ireland', EPA Small Scale Study Report 2016

⁹¹ Project page is available at http://www.fingalbiodiversity.ie/proj_rogerstown.html

schoolchildren, volunteer built fences and paths and collaboration with the National Parks and Wildlife Service, and several other organisations and industries

6.4.2 Agriculture and Forestry

The primary objective of *Adaptation Planning - Developing Resilience to Climate Change in the Irish Agriculture and Forest Sector* published by the Department of Agriculture, Food and the Marine is to outline a joined up approach to adaptation planning within the agriculture and forest sector.

The objectives of the plan outline a first step for the sectors in terms of adaptation to climate change in Ireland. The objectives are as follows:

- To analyse the changes that have already occurred to Ireland's climate and the vulnerabilities which are currently in place in the sector.
- To identify the projected changes to Ireland's climate and analyse the potential impacts and vulnerabilities which could occur within the sector.
- Set out adaptation options which would build resilience and reduce the vulnerability of the sector.
- Establish steps to monitor the implementation of these options.

6.4.3 Transport

Climate Change Adaptation refers to how we plan for the negative effects of climate change and take suitable action to limit damage caused by climate change to our vital transport networks. The first Adaptation Plan for Transport, *Developing Resilience to Climate Change in the Transport Sector*, will be published in November 2017. Adaptation planning is an iterative process and this sectoral Plan is seen as an important step towards the preparation of future statutory Adaptation Plans. DTTAS has actively engaged with DCCA in the development of the *National Adaptation Framework* arising from the *Climate Action and Low Carbon Development Act, 2015*, which will place adaptation planning in Ireland on a statutory footing.

DTTAS established and undertook consultation with a team of key Transport stakeholders from key Transport stakeholders in Road; Rail; Aviation; Ports; and Bus Services in developing this first Adaptation Plan. This team identified current and potential climate change-related impacts, the consequences of these impacts for Transport services and infrastructure and the capacity of stakeholders to respond. The Plan has been developed with input both these key stakeholders and from the EPA in line with EU guidelines for adaptation planning. It outlines initial research and analysis on the likely effects of climate change on the Irish Transport Sector and proposes preparatory actions to develop climate resilience within the sector.

6.4.4 Energy

Ireland's draft Adaptation Plan for Electricity and Gas Networks Sector (Energy) examines the impacts of climate change and weather related events, both past and projected, on the energy networks (gas and electricity). The plan can be viewed as a first step towards reducing vulnerability and building resilience in the sector. Its aim is to stimulate thinking from the public and interested stakeholders on the very important area of climate change adaptation in the energy networks sector. The plan outlines areas of vulnerability now and sets out the steps that can be taken and measures put in place to avoid or minimise future adverse impacts within the sector and also outlines methods to exploit opportunities.

The sectoral plans above benefitted from the availability of climate information, expert opinion and high level guidance made available through the Centre for Marine and Renewable Energy (MaREI) climate change adaptation research group in University College Cork (UCC) and funded by the Department of Communications, Climate Action and Environment.

These plans can be seen as a step in advancing towards the statutory requirement to develop sectoral plans in accordance with the requirements of the Climate Action and Low Carbon Development Act 2015. The work carried out by the sectors to date, while helping to inform the statutory plan making process required under the NAF, has also identified a number of other benefits such as:

- creating awareness within sectors of the need to adapt;
- building capacity and confidence within sectors;
- engaging stakeholders on adaptation;
- identifying information sources and knowledge gaps

In order to further support key national sectors in planning for climate change adaptation under the NAF, sectoral adaptation guidelines⁹² have been developed as part of the Irish Climate Information Platform, Climate Ireland (ICIP)⁹³. The guidelines have been developed by drawing on international

⁹² Sectoral Guidelines for Planning for Climate Change Adaptation, O'Dwyer, Alexander and Gault, 2017

⁹³ Funded by the Environmental Protection Agency (EPA) and the Department of Communications, Climate Action and Environment (DCCA/E)

best practice and in close consultation with the Department of Transport, Tourism and Sport (DTTAS) and the Department of Agriculture, Food and the Marine (DAFM) based on work undertaken in line with the 2012 NCCAF. The guidelines aim to ensure that a coherent and consistent approach to adaptation planning is adopted at national and local scales and drawing on existing sources of climate and adaptation information (e.g. the web-based tool www.climateireland.ie). It is also hoped that these guidelines will have application beyond the sectors that have been identified to prepare sectoral plans.

6.5 Local Level Adaptation

Ireland's local government sector is already facing and responding to a range of weather and climate related impacts in respect of their key role in the national emergency management structures. The sector will also have key responsibilities in terms of dealing with other medium to long term climate impacts that are likely to emerge over the coming decades. These will likely put significant pressure on the sector's ability to deliver services at local level. These impacts could include an increased risk of damage to local infrastructure (e.g. parks, roads, social housing and healthcare facilities) and also increasing demand for the local authority's services (e.g. flood risk management, emergency accommodation). These impacts will require a strategic and planned response from the local authority sector.

Ireland's local authorities are often in a position to respond faster and more effectively to local climate events than other more centralised government organisations. Effective local and regional adaptation often requires unique solutions which can integrate with existing processes and also account for local variations and vulnerabilities. There is no uniform adaptation response that can be managed centrally that can account for the myriad of potential local variation and vulnerabilities.

A number of technical supports have also been produced to assist in the development of local level adaptation strategies such as Climate Ireland and *the Local Authority Adaptation Strategy Development Guidelines* (Gray, 2016)⁹⁴. The guidelines, which prepared under the EPA Research Programme, are designed to assist local authorities to develop their own adaptation strategies and to ensure that they are in line with policies outlined in NAF and other sectoral adaptation.

⁹⁴ Gray, S. (2016). Local Authority Adaptation Strategy Development Guidelines EPA Report no 164. 2016: EPA.

The guidelines recommend that a strategy, once approved, should be used by a local authority to assess the adaptation fitness of its spatial plans and the other plans and policies under its remit. The guidelines recommend that the work undertaken to develop a local adaptation strategy should inform and be mainstreamed into development plans and other statutory plans of the local authority.

Local authorities are actively working in consultation with DCCAIE to develop a proposal for a regional approach to climate action. Through the development of four Regional Climate Action Offices, the proposed approach harnesses the potential to group certain local authorities based on similar geographical/topographical characteristics and on the basis of existing synergies in addressing threats and impacts of severe weather events and ongoing climate change risks.

All local authorities are required in the NAF to prepare and adopt a local authority adaptation strategy or collaborate in the preparation and adoption of a regional adaptation strategy. Strategies should be developed in accordance with *the Local Authority Adaptation Strategy Development Guidelines*.

Ultimately, national policy will aim to ensure that the appropriate tools and guidance are provided to the local authority sector to enable them to plan effectively for the impacts of climate change and to ensure that climate change adaptation is a key issue that is considered by each local authority in the formulation of their own plans and programmes.

6.6 Awareness and Capacity Building

A number of tools resources are now also in place to assist with building adaptive capacity at an institutional level in Ireland. These include Climate Ireland, as well as Sectoral Guidelines for Planning for Climate Change Adaptation and Local Authority Climate Change Adaptation Strategy Guidelines, both of which are described earlier in this Chapter.

Climate Ireland, Ireland's Climate Information Platform (www.climateireland.ie), provides support to decision makers in the development of their adaptation plans, policies and strategies. This is achieved through the provision of:

- Tailored information to support awareness and understanding of climate adaptation;
- Essential climate information (observed and projected) to support impact and risk assessment;
- Decision-making frameworks and tools to support Local Authority and Sectoral plans

It is an objective of the National Adaptation Framework to operationalise Climate Ireland and to further develop it as a resource for civil society as well as policy makers.

6.7 Flood Risk

It is likely that climate change will have a significant impact on flood risk in Ireland.

- Sea level rise is already being observed and is projected to continue to rise into the future, increasing risk to our coastal communities and assets, and threatening coastal squeeze of inter-tidal habitats where hard defences exist;
- It is possible that the number of heavy rainfall days per year may increase, which could lead to an increase in both fluvial and pluvial (urban storm water) flood risk, although there is considerable uncertainty associated with projections of short duration, intense rainfall changes due to climate model scale and temporal and spatial down-scaling issues;
- The projected wetter winters, particularly in the West of the Country, could give rise to increased groundwater flood risk associated with turloughs.

While there is considerable uncertainty associated with most aspects of the potential impacts of climate change on flood risk, it is prudent to take the potential for change into account in the development of Flood Risk Management (FRM) policies and strategies, and the design of FRM measures.

6.7.1 CFRAM Programme

The cyclical implementation of the EU Floods Directive which has included the National Catchment-based Flood Risk Assessment and Management (CFRAM) in the first cycle, is the principal mechanism for the assessment of the potential impacts of climate change on flood risk, and for planning, through the Flood Risk Management Plans, for the sustainable flood risk management over the long-term in Ireland, including embedding the consideration of climate change in the development of capital flood relief projects.

The future scenario flood maps that have been produced under the CFRAM Programme will facilitate this approach, inform other sectors, and provide a valuable resource for local adaptation planning and sustainable land use management and planning.

The development of flood risk management measures under the CFRAM Programme is equally cognisant of the potential impacts of climate and other future changes. A National Flood Relief Capital Investment Programme has been published with the Plans, which indicates the planned programme for the implementation of the schemes set out in the Plans alongside the existing programme of flood relief schemes already in-hand.

The CFRAM Programme was central to the planning of future FRM activity in Ireland, and was designed as the vehicle through which potential climate change impacts on flood risk would be assessed and adaptation policies implemented with respect to flood risk management. It has formed the foundation on which climate change adaptation in the flood risk management sector is based.

The Government's medium term capital investment *plan Building on Recovery: Infrastructure and Capital Investment 2016 - 2021* includes a total allocation to the OPW of €430m for flood risk management and demonstrates the priority placed by the Government to addressing Ireland's flood risk. This commitment is also evident from the flooding policy priorities set out by Government in A Programme for a Partnership Government.

Information on and outputs from the pilot CFRAM studies, and on the ongoing National CFRAM Programme are available from the Programme website: <http://www.opw.ie/FloodPlans>.

In addition, it is important to note the establishment of an Interdepartmental Flood Policy Coordination Group to support the CFRAM Programme. Through this group the Office of Public Works is coordinating Ireland's whole of Government approach to flood risk management across three strategic and policy areas including prevention, protection and preparedness. The purpose of the Coordination Group is to help inform the ten-year implementation strategy of the FRMPs and to ensure that policies that can benefit communities and individuals directly are carefully considered. It will be critical that the work of this group also aligns with the on-going development of climate resilience being carried out by the relevant sectors under the *National Adaptation Framework*.

6.8 Spatial Planning and Adaptation

For Ireland, climate change mitigation and adaptation will continue to be key spatial planning objectives in both forward planning (the preparation of long term plans and strategies) and development management (the processing of planning applications). The spatial planning process, with full engagement of local communities and other key stakeholders, provides an established

means through which to implement and integrate climate change objectives, including adaptation, at local level.

The Government's non-statutory *Planning Policy Statement (2015)* notes that the planning process plays a very significant role in promoting patterns of development which help Ireland meet its international obligations by:

- tackling the sources of climate change by reducing Ireland's carbon footprint;
- securing less energy and travel intensive development patterns;
- facilitating the generation of energy from low carbon sources; and
- adapting to the effects of climate change.

The Planning and Development Act 2000, as amended, requires that local authority development plans and the forthcoming Regional Spatial and Economic Strategies address the promotion of sustainable settlement and transportation strategies in urban and rural areas, including the promotion of measures to reduce anthropogenic greenhouse gas emissions and address the necessity of adaptation to climate change. In addition, current statutory planning guidance for local authorities and An Bord Pleanála (planning appeals board which is also responsible for the strategic infrastructure development consent process) makes reference to climate change for example:

- Development Plan Guidelines, 2007;
- The Planning System and Flood Risk Management Guidelines, 2009;
- Local Area Plans Guidelines, 2013

National Planning Framework

The Irish Government launched a National Planning Framework (NPF), *Ireland 2040 – Our Plan*⁹⁵, in February 2018. The NPF is a new strategic planning and development framework for Ireland and all its regions for the period to 2040, setting a high-level strategy for the co-ordination of a range of national, regional and local policies and activities, planning and investment, for delivery through both the public and private sectors. This framework includes a €500 million Climate Action Fund and will be hugely influential in directing climate change adaptation actions at national, regional and local levels. The *National Planning Framework* includes an objective to support national targets for

⁹⁵ <http://npf.ie/>

emissions reduction and objectives for climate change mitigation and adaptation by ensuring that climate change considerations are further integrated into the planning system, and that they continue to be taken into account as a matter of course in planning-related decision making processes. Its investment priorities integrate climate considerations across the built environment, transport, power generation and adaptation sectors over the course of the Framework's lifetime.

6.9 EU Policy

The EU Adaptation Strategy which was adopted in June 2013 has three main aims:

- Promoting action by Member States,
- Better informed decision making, and
- Climate Proofing EU action.

As part of the process of implementing the EU's Adaptation Strategy, Ireland will report on progress, as required, under the EU's Monitoring Mechanism Regulation (MMR), as well as participating in the relevant working groups under the EU's Climate Change Committee.

The Strategy is currently subject to a review and Ireland welcomes the review and is committed to fully participating in the review process.

7. Financial Resources and Transfer of Technology

7.1 Introduction

The term “climate finance” is generally used to describe financial flows from developed countries to developing countries to help the latter respond to climate change through mitigation and/or adaptation.

Climate finance can be from a variety of sources, both public and private, and can include publicly funded (in whole or in part) grants, loans or other financial instruments, and the provision of programmes for capacity building/skills transfers for climate change response.

Ireland has a strong record of providing climate finance to developing countries and has made significant advances in delivery of climate finance in recent years.

Ireland’s public funding for climate action includes on-going support for mitigation and adaptation action in developing countries, mainly through bilateral assistance to Ireland’s key partner countries in sub-Saharan Africa. Ireland also provides contributions in respect of a number of multilateral funds established under the auspices of the UNFCCC, including the Least Developed Countries Fund, the Least Developed Countries Expert Group, the Global Environment Facility, the Adaptation Fund and the Green Climate Fund. These funds, in line with their respective mandates, provide support for mitigation and adaptation action in developing countries. Funding through these mechanisms is provided through the Department of Communications, Climate Action and Environment and through the Official Development Assistance budget managed by the Department of Foreign Affairs and Trade. A consistent approach to programming climate support, based on policy prioritisation on addressing climate finance, has improved the predictability of Irish climate finance.

Ireland also joined the NDC Partnership in 2017 and will seek to use this policy mechanism both to share international experience, particularly in the areas of adaptation and agriculture, and to inform its medium to long term policy development in these areas.

The Adaptation Finance Transparency Gap Report ⁹⁶published by ‘Adaptation Watch’ in October 2016, ranked Ireland second among developed countries for overall transparency in reporting Climate Finance, after Germany.

7.2 Climate Finance – Ireland and International Policy

Developed country Parties to the UNFCCC committed in 2009 to a goal of mobilizing jointly USD \$ 100 billion a year by 2020 from public and private sources to support climate action in developing countries. This was reiterated at COP 21 in 2015 when Parties agreed that developed countries should continue their existing collective mobilisation goal, and that prior to 2025 the UNFCCC would set a new collective quantified goal from a floor of USD 100 billion per annum, taking into account the needs and priorities of developing countries.

COP 21 also resolved to enhance the provision of pre-2020 support by developed country Parties for ambitious climate action, strongly urging the Parties to scale up their level of financial support, with a concrete roadmap, to achieve the goal of jointly providing USD 100 billion annually by 2020.

Against this backdrop, Ireland committed, at COP 21, to scale up its support for international climate change action. Ireland committed to maintaining public climate finance support of €175 million in public funding from 2016 to 2020, to increase its contributions to the Least Developed Countries Fund, to commence contributions to the Green Climate Fund and to explore avenues to mobilise private climate finance.

Ireland is on track to meet its commitments made at COP21 in Paris to scale up climate finance, with support for Least Developed Countries continuing to form the greatest share of international climate finance.

7.3 Bilateral Activities

Ireland’s public climate finance continues to be predominantly provided through bilateral grants to key partner countries through Irish Aid, Ireland’s official overseas development assistance programme. Some key features of the support provided by Ireland are highlighted below:

⁹⁶ <http://www.adaptationwatch.org/s/Adaptation-Watch-Report-2016-Digital-FIN.pdf>

- Ireland's reported contributions are entirely in grant-form, which is considered to be a significant advantage to its donor countries.
- Ireland's public climate finance will continue to prioritise Least-Developed Countries (LDCs) particularly those in sub-Saharan Africa

Irish Aid's multi-annual funding framework also increases the predictability of its support to long-term programmes such as the World Resources Institute, the International Institute for Environment and Development, the Least Developed Countries Fund and the UNFCCC-LEG, as well as the work of former Irish President Mary Robinson and her foundation, the Mary Robinson Foundation for Climate Justice.

Ireland's bilateral aid in 2016 illustrates the continued support for a number of Least Developed Countries in Sub-Saharan Africa and South East Asia, as well as international institutions, to decrease vulnerability and support adaptation and mitigation efforts to the adverse effects of climate change.

This aid focuses largely on achieving results in the areas of sustainable food and nutrition security, particularly in climate resilient agriculture, improved natural resource management, disaster risk reduction, improving efficient and sustainable energy at the household level, and gender equality.

The following gives a more detailed account of the aid provided in 2016:

In **Zambia**, Ireland recognises that poverty and vulnerability are driven by a number of interrelated factors including climate change, food insecurity, malnutrition, gender inequality, insecure livelihoods and ill-health. Ireland supports improving the livelihoods, health status, food and nutrition security of poor households with a particular focus on women and vulnerable groups in Zambia's Northern Province. This includes interventions to improve crop productivity, diversification and marketing, supporting more climate resilient agricultural practices, as well as enhancing nutrition and health education through sanitation, hygiene education and malaria prevention and control.

In **Malawi**, Ireland works with Concern Universal on achieving the target of 2 million low emission and energy efficient cook-stoves in use by 2020. As a result of the emissions saved from reduced burning of biomass in fuel efficient stoves, and consequent reduced emissions from deforestation and degradation, this project contributes towards climate change mitigation. Due to the reduced pressures on woodland and forests for biomass harvesting, this project also contributes towards maintaining biodiversity.

In **Ethiopia**, Ireland works with the Bureau of Agriculture in Tigray Region, to develop and implement climate smart agricultural interventions. Ethiopia is highly vulnerable to climate change, as most agricultural production is rain-fed. The introduction of new crops and varieties contributes to the diversification of the farming system, food security and builds climate resilience. This project also tackles the seed supply challenge by facilitating access to improved varieties of seed.

Ireland supports the work of the **International Institute for Environment and Development (IIED)**, providing both core support as well as support for the Climate and Development Learning Platform, established to provide a means of supporting the Department of Foreign Affairs and Trade and its partners to better integrate climate change into development programming. The Platform also supports a stronger understanding of local level adaptation to climate change and linkages with social protection, gender and agriculture, in key partner countries across Africa, to inform national and international policy and programming.

7.4 Multilateral Activities

In September 2017, Ireland officially reported funding provided to multilateral climate change funds in 2015 and 2016. Funding provided in 2016 amounted to €4 million, provided to the GCF, the LDC Fund, as well as to the UNFCCC and the United Nations International Strategy for Disaster Risk Reduction.

Further information of this support is illustrated below:

[Least Developed Countries Expert Group \(LEG\)](#)

Ireland has continued to support the work of the Least Developed Countries Expert Group in the period since submission of the 6th National Communication, and has increased financial support to the LEG during this reporting period. In particular, Ireland's support has been focused on capacity building to contribute to sustainable development through the Least Developed Countries Expert Group's two-year work programmes. Ireland was nominated by the European Union to become one of thirteen LEG members, which was approved at COP21. Ireland will hold this position until 2020, and continue to engage actively in the work of the LEG, in particular on enhancing capacities of developing countries to adapt to climate change.

[Least Developed Countries Fund \(LDCF\)](#)

Ireland has continued to provide annual funding to the Least Developed Countries Fund, which supports vulnerable countries in the preparation and implementation of National Adaptation Programmes of Action (NAPAs) and National Adaptation Plans (NAPs) in accordance with mandates of the COP and the Paris Agreement, to address their short, medium and long term climate adaptation needs. During this reporting period, Ireland has increased its contributions to the LDCF.

United Nations Office for Disaster Risk Reduction (UNISDR)

Ireland and UNISDR have been in partnership since 2011, with a continued focus on supporting integration of disaster risk reduction and climate change adaptation into development planning, supporting linkages among Irish supported development programmes, as well as globally through establishing greater synergies between the Sendai Framework and Paris Agreement.

Green Climate Fund

The GCF was established under the auspices of the UNFCCC in 2010 to support the efforts of developing countries to respond to the challenge of climate change. The GCF helps developing countries limit or reduce their greenhouse gas emissions and adapt to climate change. It seeks to promote a paradigm shift to low-emission and climate-resilient development, taking into account the needs of nations that are particularly vulnerable to climate change impacts. The GCF aims to deliver equal amounts of funding to mitigation and adaptation, while being guided by the Convention's principles and provisions. Ireland committed at COP 21 to support the Green Climate Fund and made an initial contribution of €2 million in 2016.

Global Environment Facility

The Global Environment Facility (GEF) was established in 1992 to help tackle environmental problems across the world. It has a wide remit of action and is supported by Ireland both in the context of its broader environmental scope as well as through its climate mechanism, the Least Developed Countries Fund.

Table 7.1 below provides an indication of contributions from the Department of Communications Climate Action and Environment and the Department of Foreign Affairs and Trade/Irish Aid to the Global Environment Facility and the Least Developed Countries Fund (GEF-LDCF) from 2013-2017:

Table 7.1: Contributions to GEF/LDCF 2013-2017

YEAR	CORE FUNDING – DCCAЕ € ,000	LDCF FUNDING – DFAT € m
2013	1,421	200
2014	1,470	900
2015	1,420	1,000
2016	1,420	1,000
2017	1,420	1,000

Funding for the Global Environment Facility – Least Developed Countries Fund (LDCF) has focused on Least Developed Countries, mainly in Sub-Saharan Africa, by providing funds to support activities related to biodiversity, climate change, international waters, land degradation, and chemicals and waste in the context of development projects and Programmes.

Ireland has collaborated with the LDCF since 2003, providing some \$17.5m in funding. The Department of Foreign Affairs and Trade has strengthened its partnership with the LDCF in recent years, signing a three year multiannual funding arrangement of €1 million per year from 2016 to 2018. The partnership between Ireland and the LDCF supports vulnerable developing countries, in particular Ireland’s Key Partner Countries, to address adaptation needs through the design and implementation of National Adaptation Plans (NAPs) and National Adaptation Programmes of Action (NAPAs), which also informs Ireland’s country strategies. Complementarity and coherence is also promoted with the Green Climate Fund.

Case Study: Ireland’s Multilateral Support to United Nations Office for Disaster Risk Reduction

(UNISDR): Ireland has been supporting UNISDR to strengthen linkages and policy coherence at the global level, between the Sendai Framework, Paris Agreement and Sustainable Development Goals, as well as at national and local levels, recognising the need to support further synergies between Disaster Risk Reduction Strategies, National Development Plans and National Adaptation Plans in country.

In 2015 and 2016, UNISDR have shown progress across Ireland's key partner countries, mainly in Sub-Saharan Africa, in the establishment of functioning disaster loss databases, risk information systems, as well as in building government capacity in the creation and implementation of Disaster Risk Management Policies and Strategies, aligned with National Development and Climate Adaptation Plans. For example, by 2016, 34 sub-Saharan African countries have established multi-stakeholder National Platforms for Disaster Risk Reduction. These are expected to play an important role to ensure coherent approaches to DRR and climate change adaptation across sectors, stakeholder groups and Government Ministries. UNISDR, with support from Ireland, have been providing regular technical and policy support for their effective functioning. With such support, Ethiopia adopted a National Policy and Strategy on Disaster Risk Management and associated regulation that facilitated the transition of the DRR portfolio from the Ministry of Agriculture to the Prime Minister's Office, to support effective coordination across departments. Furthermore, significant progress was achieved in linking the Sendai Framework with the SDGs reporting mechanisms. Moving forward Ireland intends to continue supporting this work at both the global, national and local level for the 2016-18 period.

Case Study: Ireland's continued commitment to the provision of climate finance in Mozambique: Supporting the Government to link Climate Adaptation and Social Protection efforts:

Mozambique is one of the most vulnerable countries in Africa to climate change, prone to multiple weather-related hazards, including floods, droughts and cyclones. Climate change will erode social protection (SP) effectiveness by increasing the frequency and severity of climate shocks on SP receiving households. Climate change will also exacerbate poverty drivers in gender inequitable ways. Ireland is supporting the linking of social protection and climate adaptation, to improve the resilience of poor, vulnerable households through strengthening capacity to absorb and transfer risks. Both Government strategies on Social Protection and Climate Adaptation focus on the poorest and most vulnerable, and therefore have the same target group. Both are government led, with large returns associated with good coordination, and cost of failure to link these areas too high.

Through supporting IIED, Ireland has been working with Ministry of Land, Environment and Rural Development (MITADER), and the Ministry of Gender, Children and Social Action (MGCAS) in Mozambique since 2015, on linking Local Adaptation Plans (LAPs) with Social Protection Delivery at the local level, ensuring LAPs reflect the adaptation needs of the poorest, in particular women. The

Government, through the Ministry of Gender, Children, and Social Action (MGCAS), have identified climate resilience links as critical in their new National Strategy on Social Protection. Support has been programmed for the 2016-18 period, from Ireland, to support the revision of LAP methodology to include Social Protection, and support the implementation of the SP and LAP strategies. The support will also fund locally planned and coordinated climate adaptation and social protection interventions to benefit 50,000 people. The lessons learned from district level are also expected to inform Social Protection stakeholders at national level.

7.5 Carbon Funds and Other Investments

Ireland made a number of financial commitments in the 2006-2007 period with a view to achieving compliance with its obligations under the first commitment period of the Kyoto Protocol. As previously outlined, the National Treasury Management Agency was appointed under the Carbon Fund Act 2007 to manage Ireland's actions in the carbon market. Ireland invested in three multilateral funds for the purpose of investing in projects aimed at achieving carbon emissions reductions, as follows:

- 1) The Multilateral Carbon Credit Fund (MCCF) under the management of the European Bank for Reconstruction and Development (EBRD) – total investment of €20m, paid in 2006. Launched in December 2006 by the EBRD and the European Investment Bank (EIB), and whose participants include the governments of Ireland, Finland, Belgium (Flanders), Luxembourg, Spain and Sweden, as well as five private sector participants, the MCCF is one of the few carbon funds dedicated specifically to countries from central Europe to central Asia;
- 2) The Carbon Fund for Europe (CEF) is under the management of the World Bank. The EIB and World Bank launched the CFE in 2007 as a trust fund. The fund purchases greenhouse gas emission reductions from climate-friendly investment projects through the Kyoto Protocol's Clean Development and Joint Implementation mechanisms. Initial investment of up to €10m was agreed in 2007 but in light of Ireland's economic circumstances was reduced in 2011 and 2012. Ireland's final contribution was €4.263m;
- 3) The BioCarbon Fund was introduced in 2007 as a public/private initiative administered under the management of the World Bank. The Fund purchases carbon credits accruing from a variety of land use and forestry projects; the portfolio includes afforestation, reforestation, and reducing emissions from deforestation and degradation. An investment of up to €10m was agreed in 2007 but was reduced in light of Ireland's economic situation in 2011 and

2012 to \$10,078m. Out of a commitment of €7.790m, to date Ireland has paid €6.465m.

Ireland expects to conclude transactions relating to the BioCarbon Fund in 2019.

As outlined in Chapter 4.4.2, Ireland also has committed under the European Union Effort Sharing Decision 406/2009/EC to reduce greenhouse gas emissions from the non-ETS sector by 20% by 2020, compared with 2005 levels. Recognising the projected shortfall to this target, Ireland will need to avail of the mechanisms provided in the framework of the Effort Sharing Decision in order to comply with its targets, which may result in a requirement to purchase additional allowances. While this purchasing requirement is not, at this stage, expected to be significant, further analysis will be required to quantify the likely costs involved, in light of the final amount and price of allowances required. This will result, in the coming years, in a requirement to make further purchases under the Carbon Fund Act.

7.6 Contributions to Multilateral Institutions and Programmes

The table below provides information on examples of Ireland's Contributions to Multilateral Institutions and Programmes, including Multilateral Climate Change Funds, Multilateral financial institutions, regional development banks and Specialised UN Agencies, with additional information provided on the programmes supported. The implementation period is from 2013 to 2016, which follows on from Ireland's Sixth National Communication, which listed contributions to Multilateral Institutions up to and including 2012. Further information on Ireland's contributions to Multilateral Institutions and Programmes is also provided in the Third Biennial Report attached to this Seventh National Communication.

Table 7.2: Ireland's Contributions to Multilateral Institutions and Programmes

Institution or Programme	Contributions over the Implementation Period 2013-2016 (million €)					Additional Information/ Short Description of Programme
	2013	2014	2015	2016	Total (2013-2016 period)	
<i>Multilateral Climate Change Funds</i>						
Least Developed Countries Fund (LDCF) of the Global Environment Facility.	0.2	0.9	1.0	1.0	3.1	Support is provided to assist Least Developed Countries to carry out preparation and implementation of NAPAs and NAPs.
Green Climate Fund				2.0	2.0	Supports developing countries' responses to climate change
UNFCCC Trust Fund for Supplementary Activities –Least Developed Countries Expert Group (LEG)	0.05	0.1	0.2	0.5	0.85	Support for the development and implementation of the LEG Work Programme.
Multilateral financial institutions, including regional development banks						
World Bank	1.0	1.0	1.0	1.0	4.0	Of the €4m provided, €2.4m was allocated to the Facility for Investment in Climate Advisory Services (FIAS), €1.2m to Conflict Affected States in Africa (CASA) and €400,000 to

						UNCTAD.
CGIAR (Consultative Group for International Agricultural Research)	4.2	4.2	3.5	3.2	15.2	Support channelled to a number of research programmes under CGIAR including Policies, Institutions and Markets, Agriculture, Nutrition and Food Security, Climate Change and Food Security.
<i>Specialized United Nations bodies</i>						
United Nations Development Programme	8.9	8.5	7.75	7.75	32.9	Core support provided to UNDP, as part of Ireland's Overseas Development Assistance (ODA), in the form of a grant.
International Fund For Agricultural Development	2.0	2.0	2.0	2.0	8.0	Core contributions provided to IFAD to support programmes on rural poverty reduction.
United Nations Office for Disaster Risk Reduction (UNISDR)	0.3	0.3	0.3	0.5	1.4	Climate Specific support provided for establishment of disaster risk reduction and climate change adaptation synergies, for resilience and sustainable development.
United Nations Environment Programme (UNEP) Global Environment Monitoring System (GEMS) Water		0.3	0.19	0.17	0.66	Support is provided for improving water quality monitoring capacity in developing countries.

Table 7.3 Ireland's Additional Support to Global Climate Partners

Institution or Programme	Contributions over the Implementation Period 2013-2016 (million €)					Additional Information/ Short Description of Programme
	2013	2014	2015	2016	Total (2013-2016 period)	
<i>Support Provided by DFAT to Independent Research Organisations and Civil Society Organisations engaged in Climate:</i>						
World Resources Institute (WRI)	0.2	0.5	0.6	0.6	1.9	Support provided in particular for NDC implementation in LDCs, to build capacity in tracking adaptation financing, and for integrated implementation of SDGs and NDCs.
International Institute for Environment and Development (IIED)	0.55	1.0	1.1	1.1	3.75	Support is provided, both core and non-core, to support implementation of IIEDs Strategic Plan and to support the Least Developed Countries Group in the UNFCCC Negotiations and for women delegates in particular.
Mary Robinson Foundation- Climate Justice		0.1	0.15	0.15	0.4	Core support is provided to the Foundation to support people centred approaches to climate and development, participation of grassroots women in climate policy development and promote rights protections in the context of human mobility associated with climate change.

7.7 Bilateral and Regional Financial Contributions to the Implementation of the Convention

The contributions listed in this table include examples of technology transfer and support in 2016.

Table 7.4: Ireland's Bilateral and Regional financial contributions to the implementation of the Convention

Beneficiary Country / Region	Thematic area	Programme or Project title	Implementation Period	Implementing Agency	Contribution by EU or MS (million€)	Type (grant / loan)	Additional information (short description of the action, co-financing arrangements, etc.)
Ethiopia	Mitigation	Enhancing integrated Watershed management with climate smart Agriculture in Gergera Watershed.	2014-2016	World Agro-Forestry Center (ICRAF)	0.45	grant	The CSA activities focus on adaptation and mitigation against climate change impacts, while the Integrated Watershed Management activities include the introduction of best-fit technologies, approaches and practices for improved agricultural productivity.
Ethiopia	Adaptation	Improving Food and Nutrition Security and Climate Resilience through Adoptive Research in Tigray.	2013-2016	Tigray Agricultural Research Institute (TARI)	0.69	grant	The overall goal of the programme is to contribute to food and nutrition security, gender equity and building a climate resilient economy through adaptation, evaluation and dissemination of improved agricultural technologies. The introduction of new crops and varieties contributes to the diversification of the farming system, food security and builds climate resilience. This project also tackles the seed supply challenge by facilitating access to improved varieties of seed.

Ethiopia	Mitigation	Support for rural livelihoods that are climate smart through promotion and dissemination of off-grid PV lighting in SNNP and Tigray region	2013-2016	GIZ	2.42	grant	Objective to contribute to regional energy sector development in Tigray and improvement of the livelihood of rural households by providing access to modern energy technologies.
Ethiopia	Adaptation	Improving smallholder livelihoods and resilience through climate smart agriculture and economic development	2014-2016	Consortium of NGOs (SOS Sahel Ethiopia, Farm Africa, VITA and Self Help Africa)	3.85	grant	Undertaking a landscapes level approach and incorporating ecosystems aspects; forestry, fisheries, crops and livestock systems, the project aims to respond to and mitigate against the impacts of climate change.
Ethiopia	Adaptation	Community Driven Climate Resilience Building (Civil Society Support Programme- (CSSP)	2014-2016	Christian Aid along with other two partners	1.05	grant	Building resilience capacity of vulnerable groups is conducted through the promotion of alternative livelihoods, maintenance of ecosystems, support to community innovations and promotion of learning.
Ethiopia	Cross-cutting	Innovative Approaches to Food Security	2014	Farm Africa	0.1	grant	Includes an objective to promote climate resilient green agricultural activities. As part of this objective, education in climate resilient agriculture is promoted for district or woreda stakeholders, communities and school youth, and tree planting campaigns for plantations on highly degraded lands encouraged.
Malawi	Mitigation	Concern Universal Accelerating Uptake of Improved Cook-stoves	2013-2016	Concern Universal	1.04	grant	The programme proposes to reach a target of 2 million low emission and energy efficient stoves by 2020. In addition, the project aims to provide technical support and carbon financing services to other organizations and both local and national stakeholders.

Malawi	Adaptation	Enhancing Community Resilience Programme (ECRP)	2013-2016	Consortium of NGOs including Christian Aid, Concern Universal, Action Aid Malawi and Care International.	1.31	grant	The programme reduces existing and future risks caused by natural hazards and climate change and strengthens the capacity of vulnerable communities to cope with current risks and adapt to new ones. Programme works with 600,000 people in 11 vulnerable districts in central and southern Malawi to build capacity to increase resilience to climatic risks.
Malawi	Adaptation	Strengthening Community Disaster Resilience - Balaka Social Cash Transfer (SCT)	2014-2016	Malawi Government	2.78	grant	The purpose of this programme is to build evidence on the potential of Social Cash Transfer Programming (SCTP) in building resilience and reducing chronic recurrent food insecurity in vulnerable districts.
Malawi	Adaptation	Agro-forestry Food Security Program (AFSP Phase II).	2013-2015	International Centre for Research in Agroforestry (ICRAF)	1.5	grant	This project was designed, with input from government departments, to be closely aligned with Malawi's National Adaptation Programme of Action (NAPA), Nationally Appropriate Mitigation Action (NAMA), and the Agriculture Sector Wide Approach Programme (ASWAP).
Malawi	Cross-cutting	Agriculture Sector Wide Approach Support Project (ASWAP SP MDTF).	2013-2016	World Bank	12.25	grant	The objectives of this Agriculture Sector Wide Approach Support Project (ASWAP) are to improve the effectiveness of investments in food security and sustainable agricultural growth and strengthen the natural resource base in agricultural lands.

Malawi	Mitigation	Adoption of Climate-Smart Agriculture principles and practices under smallholder farmer conditions in the context of climate change.	2013-2016	National Association of Smallholder Farmers in Malawi (NASFAM)	1	grant	The overall objective of this project is the promotion of principles and practices of conservation agriculture for smallholder farmer in the context of climate change and escalating fertilizer prices, in order to achieve sustainable agricultural production.
Malawi	Mitigation	Development of Thermal Electrical Generator (TEG) Stoves	2013-2015	Trinity College Dublin	0.3	grant	This project is for the development of a stove prototype and medium-scale deployment in rural Malawi with the ultimate aim of national roll-out. By providing low cost energy access with low or zero carbon emissions, this project supports climate change mitigation.
Mozambique	Adaptation	PROSAN - Programme on Food Security and Nutrition (2012-2017)	2013-16	CARE International, Inhambane Province	2.41	grant	Programme focuses on tackling household food and nutrition insecurity while strengthening resilience to natural disasters and climate change. Low agricultural production, the dependence on farm and natural resource based incomes and limited climate change adaptive capacity are addressed in an effort to reduce the poverty and vulnerability of targeted communities.
Mozambique	Adaptation	Preparedness and disaster risk reduction (2013-2015)	2013-2015	INGC	0.4	grant	Programme trained and equipped 30 Local Disaster Risk Management Committees in Niassa, Cabo Delgado and Sofala, which are often the first responders in the event of a disaster.

Mozambique	Cross-cutting	Improving vitamin A and energy intake of rural households in Niassa with drought tolerant Orange Flesh Sweet Potato	2014-2015	International Potato Centre (CIP)	0.5	grant	The project aims to improve vitamin A and energy intake through increasing more drought tolerant OFSP varieties, and strengthening the resilience and livelihoods of vulnerable households, particularly pregnant women, women of reproductive age and children less than 2 years old.
Mozambique	Cross-cutting	ARENA - Agriculture and Natural Resources- Sustainable and equitable land and natural resource management	2013-2016	ARENA, Niassa province	0.4	grant	The aim of this support is to improve outcomes in application of sustainable and climate adaptive agricultural techniques. ARENA promotes good natural resource and environmental management as a means to tackle poverty reduction and economic growth.
Mozambique	Adaptation	Multiannual provincial support to water and sanitation in Inhambane and Niassa province	2013-2016	Directorate of Public Works and Housing's (DPOPH), Inhambane and Niassa Province	0.75	grant	The programme's main objective is to increase the coverage of safe drinking water in rural districts, vulnerable to climate change and natural disasters. Activities specified under this priority include the construction of cisterns for rain water harvesting in drought prone communities and support to the construction and rehabilitation of boreholes for safe drinking water.
Mozambique	Adaptation	National Programme for decentralised planning and financing (PNPFD)	2014	Government (MPD/MAE/MOPH, MICOA/MFP)	0.15	grant	The programme aims at assisting decentralised planning processes at district level, with consideration of cross-cutting issues such as climate change. This will support the Government of Mozambique's National Adaptation Plan (NAP) and in their roll out of Local Adaptation Plans (LAPs) for every county.

Tanzania	Cross-cutting	Pastoralist programme: support to pastoral CSO and communities to improve livelihood and mitigate climate change	2014-2015	CARE International	0.75	grant	The programme provides capacity building and funding for community-based organisations (CBOs) on securing resource access through improved local land management, gender rights and climate change awareness training.
Tanzania	Cross-cutting	Agriculture Sector Development Programme (ASDP). National agriculture programme focusing on small holder farmer's productivity and increased incomes.	2013-2014	Ministry of Agriculture, Food Security and Cooperatives	2.23	grant	The programme promotes conservation agriculture practices, agro-forestry practices, thus supporting carbon sinks and promotes drought resistant crops, water conservation and improved irrigation and the use of indigenous crops and livestock species, thus supporting climate resilience.
Tanzania	Adaptation	MVIWATA; strengthen lobbying and farmers networks, capacity of farmers (farmers voice).	2013-2016	MVIWATA; small holder farmers and farmer's networks	0.61	grant	This programme supports the Network of Small-Scale Farmers' Groups in Tanzania. The focus of this programme is the strengthening of farmer groups and networks at all levels including through capacity building, economic empowerment and advocacy.
Tanzania	Cross-cutting	Cocoa value chain; developing a high quality cocoa value chain improving production and market access	2013-2016	Technoserve	1.9	grant	The programme aims to increase the incomes of 5,000 smallholder farmers by improving quality and linking farmers to markets in two regions, Mbeya and Morogoro. This project introduces technologies and practices to reduce environmental impact and adapt to climate change.

Tanzania	Adaptation	SNV Oil Seeds Value Chain project: Improving producer association and oil seed value chain and markets	2013-2016	SNV/Sesame and sunflower farmers and producer associations	0.75	grant	The programme promotes edible oilseeds such as sunflower and sesame seeds to support improved household nutrition and food security in poor communities. Sunflower and sesame seeds were chosen for their potential for increased processing capacity, income and employment, and for being climate smart crops.
Uganda	Adaptation	Programme to Strengthen household resilience	2014	WFP	0.12	grant	The main goal of the programme was to support the government in addressing protracted and acute food and nutrition insecurity among refugees and the extremely vulnerable households in Uganda's poorest region, through micro-finance as well as through agriculture and market development.
Uganda	Cross-cutting	Support to Skilling Uganda Project - Karamoja Component (skills development to labour market needs).	2016	Belgian Development Agency (BTC)	0.57	grant	One of the eight guiding principles is a focus on innovation, green skills and employment niches - through training in production of low environment impact bricks and energy efficient stoves, alternative construction techniques to lower the impact on deforestation, solar panel maintenance, installation and repair, water pump maintenance and solid waste management and treatment.
Uganda	Adaptation	Protect and promote resilient livelihoods to ensure adequate food availability and income access across rural and urban environments	2016	GOAL	0.26	grant	Support to communities in Abim and Agago to have improved access, availability and utilisation of food and reduced vulnerability to disasters, and increased and improved availability of and access to diversified income sources.

Uganda	Adaptation	Increased smallholder production and return from Enterprises.	2016	Self Help Africa	0.33	grant	Program focuses on increased smallholder skills and knowledge to benefit nutritionally and economically from intensified and diversified agricultural production.
Vietnam	Adaptation	Poverty Reduction Program 2012-2015 (Programme 135)	2014	Multi-sector involving State Treasury of Vietnam	2.21	grant	Irish Aid provides earmarked budget support to the most disadvantaged communities in improving their basic infrastructure and accessibility to services for poor ethnic minorities. The infrastructure and services also support the climate resilience of these communities.
Vietnam	Adaptation	Technical Assistance to Poverty reduction programmes and policies in Vietnam	2014-2015	UNDP, Government officials engaging in poverty reduction	1.0	grant	This support is for development of a thorough understanding of the situation of poverty relapse and vulnerability increase due to the impacts of economic shocks, diseases, natural disasters and climate change. Lessons learned from this project will be used to design, operate/implement poverty reduction policies and programmes.
Vietnam	Adaptation	Improvement of livelihood of the poor and ethnic minorities in the Central Highlands through the adoption of sustainable coffee production technologies and pro - poor market access (CPMA)	2015-2016	Centre for research on Initiatives of community Development (RIC)	0.1	grant	Programme aims to improve the livelihoods of the poor and ethnic minorities in the Central Highlands of Vietnam through sustainable coffee production and pro poor market access. Support is directed to coffee farmers who are vulnerable to 'life shocks' and loss of income due to effects such as crop losses from climate change.

Vietnam	Adaptation	Renovation of schools to make them safer during typhoon seasons in Quang Tri	2015-2016	Ministry of Education of Vietnam in disaster prone areas in Quang Tri province	0.06	grant	The purpose of the project is to renovate damaged school infrastructure components that pose significant risks to students' safety in the typhoon season in Quang Tri province. The major construction works include: storm-resistance roofing and replacement of old doors and windows hinges and glasses.
Vietnam	Adaptation	From university to community: preparing a generation of professionals in sustainable development	2015-2016	200 students in 10 participating universities	0.13	grant	The project seeks to i) prepare university students and recent graduates for careers or grassroots actions in sustainable development, ii) build a network among NGOs, universities, business and local government in research and training in sustainable development, and iii) To document a new model of transforming universities into development partners with cities/towns where they are based.
Zambia	Cross-cutting	Integrated Research in Development for improved Livelihoods in Northern Province	2013-2016	World Fish Centre, Small scale farmers in Northern Province	0.75	grant	This project builds capacity for the integration of biodiversity and ecosystem service concerns into local planning and development and supports the protection of carbon sinks.

Zambia	Cross-cutting	Local Development Programme in Northern Province (aimed at improving livelihoods, food and nutrition status of the targeted small holder farmers; including resilience to climate variabilities).	2014-2016	Self Help Africa and Small scale farmers in Northern Province	2.5	grant	Programme aims to increase household food and nutrition security while improving knowledge in integrated soil management practices. Training is provided in climate-smart crop, livestock and aquaculture production, and sustainable use of wetlands. The programme also aims to mainstream disaster risk reduction in all its activities including through capacity building, and establishment of disaster management committees.
Zambia	Adaptation	Increased smallholder skills and knowledge to benefit from intensified and diversified agricultural production.	2016	Self Help Africa	0.32	grant	The project contributes to improved livelihoods, food and nutrition security for small holder farmers, including resilience to climate variability and climate change. The project also focused on building capacity for the integration of biodiversity and ecosystem service concerns into local planning.
South Africa	Adaptation	Support to UN OCHA Southern Africa Regional Office	2016	UN OCHA Southern Africa	0.1	grant	Support is to address El Nino impacts in Southern Africa. The support focuses on strengthening coordination and building capacity of countries to respond to the prevailing drought situation in the region.
South Africa	Adaptation	Support for Climate Smart Agriculture	2016	Technoserve South Africa	0.15	grant	The objective is to improve emerging farmers' livelihoods and resilience through climate smart agriculture and access to finance and markets.

Zimbabwe	Cross-cutting	Protect and promote resilient livelihoods to ensure adequate food availability and income access across rural and urban environments.	2016	GOAL	0.23	grant	Support for improved access, availability and utilisation of food, and to reduce vulnerability to disasters in target communities in Buhera, Makoni and Nyanga districts of Manicaland Province. Programme also looks to increase and improve availability of and access to diversified income sources.
Zimbabwe	Adaptation	Women and men in targeted communities of Insiza, Matopo and Bikita districts have improved their livelihood diversity and resilience.	2016	Trocaire	0.53	grant	Work in Zimbabwe aims to develop sustainable and resilient livelihoods, as well as achieve stronger human rights protections and women's empowerment.
Kenya	Adaptation	Resilient and sustainable pastoral, agro-pastoral and marginal mixed farmer livelihoods in ASAL areas of Kenya.	2016	Trocaire	0.58	grant	Objectives focus on enabling households and communities in the targeted Adaptive Strategy for Sustainable Livelihoods (ASALs) districts of Kenya to better mitigate risk, prepare for and respond to crisis and shocks, to increase income, food and diversified livelihoods strategies, and to ensure access to natural resources, managed in a sustainable manner.
Kenya	Adaptation	Protect and promote resilient livelihoods to ensure adequate food availability and income access across rural and urban environment.	2016	GOAL	0.03	grant	Support for targeted communities in Mukuru and Korogocho, to increase and improve availability of and access to diversified income sources. Support also programmed to ensure institutions are strengthened to create conditions for implementation of programmes that lead to improved access, availability and utilisation of food, and diversification of income sources.

Kenya	Adaptation	Support for vulnerable groups in particular children and mothers.	2016	World Vision	0.05	grant	Support programmed for community groups, in particular children and mothers, promoting locally appropriate and sustainable approaches to improved nutrition.
Sierra Leone	Adaptation	Child Survival Freetown and Poverty Alleviation Tonkolili Programme	2016	Concern Worldwide	0.28	grant	Programs to reduce maternal and child mortality and morbidity in Freetown and poverty alleviation in Tonkolili District through a holistic and integrated approach to community development.
Liberia	Adaptation	Increased livelihood security and increased resilience to shocks for the extreme poor target groups.	2016	Concern Worldwide	0.21	grant	Support for the extreme poor target groups to increase livelihood security, increase resilience to shocks, and increase 'voice' in influencing more pro poor responsive state and CSO structures and service delivery at various levels (micro/ meso/ macro).
Sudan	Adaptation	Resilience and Recovery Capacity Programme for Extreme Poor	2016	Concern Worldwide	0.94	grant	To contribute to increasing the resilience and recovery capacity of the extreme poor in West Darfur by providing basic services and strengthening coping strategies of the communities in the Mornei area.

7.8 International Co-Operation on Adaptation

Ireland's policy for International Development, *One World, One Future*⁹⁷ and Ireland's Foreign Policy, *Global Island*⁹⁸ prioritise action against climate change for the poorest people in developing countries, in particular the least developed countries.

The majority of this work falls within the remit of the Department of Foreign Affairs and Trade, through Irish Aid. Their international programmes recognise the importance of community based adaptation to climate change programming, reflected in the Climate Change and Development Learning Platform (www.climatelearningplatform.org), developed in collaboration with the International Institute for Environment and Development (IIED), which supports Irish Aid Key Partner Countries and organisations in integrating climate change and climate risk management into development programmes and planning.

Adaptation is seen as a key priority by developing countries, and Ireland has a strong record of recognising and supporting this need. Ireland's international financial support for climate change action heavily prioritises adaptation programmes. Generally, over 90% of Irish finance in recent years has supported adaptation goals in developing countries, largely in sub-Saharan Africa. Ireland contributes to the Least Developed Countries – Expert Group and the Least Developed Countries Fund, for the design of National Adaptation Plans in these countries. Ireland has been an active partner in supporting climate diplomacy at EU and UN levels, and has supported the prioritisation of adaptation and the climate change needs of Developing Country Parties.

⁹⁷ <https://www.irishaid.ie/news-publications/publications/publicationsarchive/2013/may/one-world-one-future-irelands-policy/> <https://www.irishaid.ie/news-publications/publications/publicationsarchive/2013/may/one-world-one-future-irelands-policy/>

⁹⁸ <https://www.dfa.ie/our-role-policies/our-work/casestudiesarchive/2015/january/the-global-island/>
<https://www.dfa.ie/our-role-policies/our-work/casestudiesarchive/2015/january/the-global-island/>

8. Research and Systematic Observation

8.1 Introduction

Research and systematic observations are essential to understanding and responding to climate change. Ireland has advanced a series of initiatives to support, develop and co-ordinate, climate change research as part of a national programme. Systematic observation of Essential Climate Variables (ECVs) are being developed by building on existing observation systems in the atmospheric, ocean and terrestrial domains and through investment in new systems. An overview of these is provided here, in the context of the administrative and operational structures under which these take place.

Ireland has developed a well-structured climate change research programme which is primarily aimed at informing and supporting climate change policy implementation and development and informing actions by stakeholders.

Ireland carries out an extensive range of systematic observations of essential climate variables and also hosts a range of advanced observations which are part of regional and global networks.

Information and analysis from research and systematic observation systems are made available to key stakeholders and the public.

Ireland actively engages with process at the science to policy interface including contributing to the work of the IPCC and engagement with UNFCCC Subsidiary Body on Scientific and Technical Advice (SBSTA).

8.2 Public Funding of Climate Research and Systematic Observation

Research and systematic observations are essential to understanding and responding to climate change. Ireland's EPA is mandated under Section 71 of the EPA Act 1992 to advise the Minister for Communications, Climate Action and Environment of the need for environmental research and to prepare research programmes. Funding for environmental research is the responsibility of the Department of Communications, Climate Action and Environment. The EPA is mandated to manage and allocate this funding under the EPA Research Programme 2014-2020. Climate Change is one of the 3 pillars of this programme, together with Water and Sustainability.

Climate related research is also funded by a number of other state bodies including Teagasc, Met Éireann and the Sustainable Energy Authority of Ireland (SEAI), e.g. energy research funded by SEAI; agriculture research and soil carbon analysis funded through the Department of Agriculture, Food and the Marine and Teagasc (www.teagasc.ie); socio-economic and enterprise orientated research being advanced by the Economic and Social Research Institute (ESRI) (www.esri.ie) and Enterprise Ireland (www.enterprise-ireland.com).

Funding for specific climate change research is primarily provided by the Department of Communications, Climate Action and Environment, largely through the Environmental Protection Agency and the Sustainable Energy Authority of Ireland. A number of other Departments also provide significant funding for climate change research. The Department of Agriculture, Food and Marine and the Department of Housing, Planning and Local Government have important roles in this area, the latter owing to its responsibility for Met Éireann, Ireland's meteorological service and the systematic observations it carries out within the climate change area.

Research by national research institutions is also funded through Horizon 2020, the EU's Research and Innovation programme 2014 to 2020, and international research programmes.

There has also been a growing engagement with pan European research work through the Joint Programming Initiatives (JPIs) and the development of wider international links. For example, the JPI Climate ERA NET for climate services (ERA4CS)⁹⁹ is currently supporting 6 Irish research projects. Engagement with such initiatives provides unique international collaborative opportunities for Irish researchers.

Environmental Protection Agency

Since 2007, the Environmental Protection Agency has acted to provide a national co-ordination structure and process. Climate change research has been developed along four thematic areas as shown in **Figure 8.1**. This thematic focus has enabled cross departmental and cross agency issues to be addressed in a positive manner and avoids strong focus on sectoral issues. Each of the thematic areas has its own objective and integrating framework e.g. Theme 1 is focused on increasing understanding of greenhouse gas emissions and removals and the annual National Inventory Report

⁹⁹ <http://www.jpi-climate.eu/publications>

provides the integrating framework. Key achievements include moving from default Tier 1 analysis to Tier 2 and Tier 3 national science based analysis and reporting.

The role of the EPA in coordination and development of research has been further enhanced in the 2017 National Mitigation Plan, which highlighted the importance of ensuring ongoing coherence between different national and EU funding streams of climate research both to exploit synergies and to avoid duplication and to ensure that publicly-funded research is accessible and broadly disseminated and that it is relevant to inform the future development of policy, through alignment with the objectives of the National Mitigation Plan and the National Adaptation Framework. The National Mitigation Plan required that the EPA provides an annual report on climate change research activities and an assessment report on key findings from research activities every five years. It is expected that these processes will be initiated in 2018.

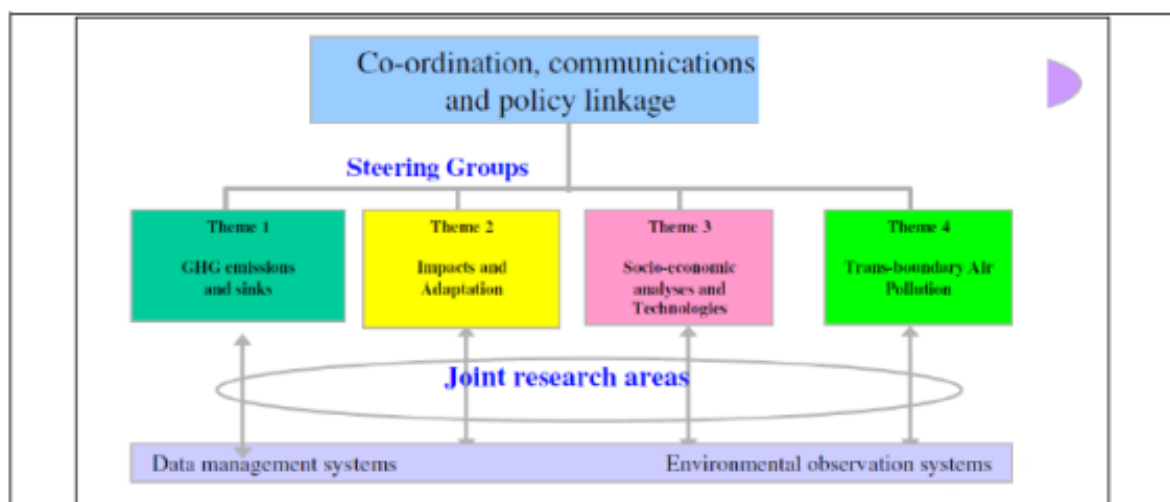


FIGURE 8.1 A schematic of the organisational structure of Climate Change Research in Ireland based on thematic research in four areas; (1) Greenhouse gas emissions and sinks, (2), climate change impacts and adaptation, (3) socio-economic analysis and technologies focused mitigation and adaptation solutions and (4) trans-boundary air pollution/ short life climate forcers. Cross cutting activities include observation systems and data /information.

Sustainable Energy Authority Ireland (SEAI)

The SEAI coordinates and funds a range of research, development, demonstration & innovation (RDDI) activities relating to the production, supply and use of energy. The work programme includes

an objective to support solutions that enable technical and other barriers to market uptake of energy related products, processes and systems to be overcome. SEAI also aims to provide timely guidance and support to policy makers and public bodies through results, outcomes and learning from supported projects. While the overarching goals of these activities have a specific energy-related remit, they provide an essential contribution to research activities in support of the transition to a low-carbon economy.

SEAI's RDDI funding is delivered through three primary mechanisms:

- The SEAI research, development & demonstration funding programme
- The SEAI ocean energy prototype development fund
- Supporting participation of Ireland-based researchers in Horizon 2020 activities.

SEAI supports the successful participation of Irish industry, academia & public sector bodies in Horizon 2020 by fulfilling the role of National Delegate for Societal Challenge 3 (Secure, Clean and Efficient Energy). The National Delegate (ND) has an influential role in relation to development of Societal Challenge 3 Work Programmes and leads Ireland's input into the associated Programme Committee. Enterprise Ireland support the role of National Contact Point for Societal Challenge 3. The National Contact Point (NCP) provides advice on funding opportunities, contractual & IPR issues, supports proposal preparation, submission & follow up on grant applications, and provides ongoing advice on next steps for successful & unsuccessful applicants. Ireland-based researchers in companies and academic institutions have secured in excess of €40M in energy-related Horizon 2020 funding to-date.

Agricultural Research

Research is critical in identifying state of the art technologies to improve both the carbon efficiency and climate resilience of Irish agriculture and also to help develop a circular bioeconomy. Ireland has significant expertise that can help the agri-food sector become a world leader in low carbon production systems. Research also has an important role in optimising the mitigation potential within Ireland's forest sector.

Irish agricultural greenhouse gas research is focused on developing an improved understanding of the key processes involved in the production of methane and N₂O emissions such as identifying promising mitigation options (such as dietary strategies, manure management, fertiliser technologies as well as future technologies; quantifying the carbon sequestration potential of

agricultural soils) and improving the national greenhouse gas inventories regarding forestry and agriculture.

In addition, the Department of Agriculture, Food and the Marine, together with Teagasc, is active in EU and international research groups on greenhouse gases such as the EU Joint Programming Initiative on Agriculture, Food Security and Climate Change (JPI-FACCE) and the Global Research Alliance (GRA) on mitigating agricultural greenhouse gases. DAFM hosts and chairs a national steering group which provides a forum to help guide Ireland's involvement on both initiatives.

DAFM research funding (which underpins both national and international research) is informed by two Strategic Research Agendas which identify sector research priorities and include relevant climate change mitigation related research areas. These are the Sustainable, Healthy Agri-food Research Plan (SHARP), developed by a cross-funded working group hosted by DAFM and published in June 2015, and Forest Research Ireland (FOI) developed by a working group of the Competitive Forest Research for Development Council and published by DAFM in October 2014. Informed by the two research agendas, DAFM funds competitive calls for 'public good' research through its three research programmes – the Food Institutional Research Measure (FIRM), the Research Stimulus Fund (RSF) for primary agriculture production, and the Programme of Competitive Forest Research for Development (COFORD).

Some €17.1 million in funding has been committed under the three DAFM programmes in the sustainable land management, bioeconomy and greenhouse gas related areas arising from its research calls in the 2010-2015 period.

DAFM also promotes and supports the activities of Irish researchers in the Horizon 2020 Societal Challenge 2 programme on 'Food Security, Sustainable Agriculture and Forestry, Marine, Maritime and Inland Water Research and the Bioeconomy' and in the 'Biobased Industries Joint Technology Initiative (BBI).

Met Éireann

Met Éireann, Ireland's meteorological service, maintains atmospheric observations networks and carries out analysis, research and modelling activities funded by the State. It is also involved in funding research and participates in research partnerships with institutions in Ireland and abroad, such as the EC-Earth and ERA4CS consortia.

Met Éireann and the EPA have joined an ERA-NET consortium and are now part of the ERA4CS (European Research Area for Climate Service) community. The consortium has been designed to boost the development of efficient Climate Services in Europe, by supporting research for developing better tools, methods and standards on how to produce, transfer, communicate and use reliable climate information to cope with current and future climate variability. Met Éireann has been successful in partnering on projects with three different research consortia in 2017. These are:

- Indecis: Integrated approach for the development across Europe of user oriented climate indicators for GFCS high-priority sectors: agriculture, disaster risk reduction, energy, health, water and tourism
- Eupheme: European Prototype demonstrator for the Harmonisation and Evaluation of Methodologies for attribution of extreme weather Events (UK)
- Windsurfer: WIND and wave Scenarios, Uncertainty and climate Risk assessments for Forestry, Energy and Reinsurance

Through the ERA4CS joint call, the Environmental Protection Agency is also supporting three major projects with Irish and international participants that will run from 2017 to 2020.

- Clim2Power will develop a climate service that integrates seasonal weather forecasts into decision making in the electricity sector.
- WatexR will integrate state-of-the-art climate seasonal prediction and water quality simulation in an advanced solution to ensure efficient decision making and adaptation of water resources management to an increased frequency of climate extreme events.
- ERA4CS CoClima will produce a set of regionally focused climate services to address key impact areas including human health, aquaculture, fisheries and tourism across the regional seas of Europe.

Through the additional activities of the ERA4CS, the Environmental Protection Agency has co-authored the paper [‘Research and Innovation for Climate Services Report on the synergy and mismatch analysis’](#). This report forms the basis for assessing and further developing JPI Climate activities contributing to research and innovation supporting climate services towards developing a joint vision between its partners and the Member States to forge a common implementation strategy up to 2020.

Met Éireann, along with the EPA and ICHEC is contributing to the scientific development of the new version of global climate model (EC-Earth), performing test runs and tuning. Centennial-scale

simulations with the model are in the pipeline as part of the CMIP6 project for assessment by the IPCC in AR6.

8.3 Significant Research Outcomes

In terms of impacts, risk and vulnerability Ireland has been making progress in attempting to identify the key climate impacts for the country nationally and within individual sectors. This work is ongoing and will be hugely influential in informing further progress in this complex area. The following should be particularly noted:

- A National Climate Change Vulnerability Scoping study (Sweeney, et al., 2013a)¹⁰⁰ was undertaken to identify first generation vulnerabilities for Ireland. The priority sectors identified for further investigation are: biodiversity and fisheries; water resources and the built coastal environment; forestry and agriculture.
- An overarching study, (COCOADAPT, Sweeney et al., 2013b)¹⁰¹ provided recommendations on how key sectors and vulnerable areas could increase their resilience to climate change through adaptation. These include the water sector, biodiversity, construction and tourism.
- The Coastal Climate Adaptation in Ireland (CLAD) study (Falaleeva et al., 2013)¹⁰² developed a tool for climate adaptation in response to the need for capacity building at the coastal zone.
- The Urban Adapt¹⁰³ project is focusing on the Greater Dublin area and will develop an innovative regional approach that allows for the integrated assessment and management of current and future climate vulnerabilities within the context of existing climate and non-climate pressures and spatial planning practices.
- A National Risk Assessment of Impacts of Climate Change has commenced¹⁰⁴ (EPA) the aim of which is to establish a national risk and impacts assessment of the effect upon Ireland of the current and future patterns in the 21st Century of climate warming.

¹⁰⁰ Sweeney, J., & Coll, J. (2013a). Current and future vulnerabilities to Climate Change in Ireland CCRP Report Series No. 29. Wexford: EPA

¹⁰¹ Sweeney, J., Bourke, D., Coll, J., Flood, S., Gormally, M., Hall, J., Smyth, D. (2013b). Co-Ordination, Communication and Adaptation in Ireland: An Integrated Approach (COCOADAPT). Wexford: EPA.

¹⁰² Falaleeva, M., Gray, S., O'Mahony, C., Gault, J. (2013). Coastal Climate Adaptation in Ireland: Assessing current conditions and enhancing the capacity for climate resilience in local coastal management CCRP Report. Wexford: EPA.

¹⁰³ <https://urbadapt.com/about/>

¹⁰⁴ www.marei.ie/national-risk-assessment-impacts-climate-change/

- The CIVic study at National University of Ireland Galway (NUIG), will assess the vulnerability of elements (water, energy, transport and communications) of Ireland’s critical infrastructure to climate change. The overall aim is to inform critical asset management decisions in the context of climate change.
- The VAPOR¹⁰⁵ project at University College Dublin (UCD) is assessing the vulnerability of peatlands to climate change and extremes.
- The Acclimatize¹⁰⁶ project will identify and quantify pollution streams and determine the impact on at risk urban and rural bathing waters in Ireland and Wales through a dynamic period of climate change.
- Climate Ireland, Ireland’s Climate Information Platform, discussed further below.

Future Climate Research

Moving more towards the implementation of climate change adaptation across all levels and spheres will require substantial changes in how we live, work and play. In order to understand the changes required, new research will be needed on topics such as:

- Vulnerability of key sectors and the identification of critical thresholds. This should build on the earlier work in this area utilising new methods and approaches.
- Adaptation decision making frameworks.
- Adaptation option selection (especially green options).
- Policy integration: levels of policy integration, coherence between policy objectives (especially mitigation and adaptation).
- Adaptation pathways: more information is required on how the approach can be used for short, medium and long term resilience goals.
- Costing impacts and adaptation and societal transitions.

¹⁰⁵ www.ucd.ie/vapor

¹⁰⁶ www.acclimatize.eu

8.4 International Cooperation on Climate Research and Data Exchange

All meteorological data and products that are produced by WMO Members (national meteorological services) to the WMO are available under the terms of WMO Resolution 40. Such data are freely available without charge, i.e. at no other cost than the cost of reproduction and delivery, without charge for the data and products themselves and with no condition on their use. Other meteorological or climatological data for climate change related research are provided either through a web portal or by request from Met Éireann. All such data are provided free under an open data creative commons license.

Ireland recognises the international nature of climate change and the need to participate in global efforts. Research groups have strong links to research groups in Europe and beyond. Irish international Participation in this regard includes the provision of a focal point to the Intergovernmental Panel on Climate Change (IPCC) by the Department of Communications, Climate Action and Environment,, and participation managed by the Environmental Protection Agency.

EPA

The Environmental Protection Agency is a member of the Joint Programming Initiative "Connecting Climate Knowledge for Europe" (JPI Climate). It is a pan-European intergovernmental initiative gathering European countries to jointly coordinate climate research and fund new transnational research initiatives that provide useful climate knowledge and services for post-COP21 Climate Action.

Specifically, the Environmental Protection Agency is supporting:

- The ERA-NET-Cofund: AXIS: Assessment of Cross(X)-sectoral climate Impacts and pathways for Sustainable transformation. The three anticipated research areas (topics) are:
- Cross-sectoral and cross-scale climate change impact assessments.
- Integration of biophysical climate change impacts estimates with economic models.
- Developing pathways to achieve the long-term objectives of the Paris Agreement, considering interactions with SDGs closely linked to SDG 13 ("climate action").

Close partnership of the AXIS consortium and JPI Climate with other key international initiatives (Belmont Forum, GFCS, Future Earth, UN PROVIA, Copernicus) will be sought to continue to work against fragmentation of disciplines and geographies in climate science. The call and projects will run from 2018 to 2022.

IPCC

The development of national climate research capacity has enabled greater national participation in IPCC activities. At least six Irish scientists contributed the IPCC reports published in the 5th Assessment Cycle. Ireland also assists the IPCC in carrying out its work programme through the hosting of its meetings. In 2012, Ireland hosted an IPCC Lead Authors meeting on the IPCC supplement to the 2006 Good Practice Guidelines on Wetlands. Ireland also hosted an IPCC expert meeting on Agriculture and Climate Change in 2016. This process continued in 2017 with the hosting of a preparatory meeting on the scope of the IPCC Special Report on Land. Irish scientists are also contributing to the preparation of this Report.

Ireland also supports the EU European Space Agency (ESA) Copernicus programme which aims to provide global to local information on for environmental management and Civil Security and is part of the ESA Earth Observation research programme. Ireland is a member of the GEO and supports its development. These contribute to the development of sustained observations systems as required and in support of Global Atmospheric Observing Systems (GCOS).

[The Coordination and support action \(CSA\) proposal SINCERE: Strengthening International Cooperation on climate change Research.](#)

The CSA will strengthen and open international climate change research and innovation cooperation, involving European partners in support of the implementation of the Paris Climate Agreement. It will include in the broader context the work of the Sendai Framework for Disaster reduction and the UN Sustainable Development Goals. There will be two Flagship Actions, focused on the design of research and innovation collaborations in Africa and Latin America, to expand and deepen knowledge to support the uptake of climate change adaptation and mitigation policies, climate services and resilience to disasters linked to climate change. Targeted

The call and projects for both AXIS and SINCERE will run from 2018 to 2022.

8.5 Themes of Irish Climate Change Research

8.5.1 Greenhouse Gas Emissions and Sinks

The main objective of this thematic research area is to support improvement of the national emissions inventory, projections of future emissions and inform management options. A key aim is to ensure that the national inventory is based on the best possible science and, where feasible, subject to independent scientific verification. The topics of projects in this area include:

- Emissions from livestock through enteric fermentation;
- Emissions from other agriculture sources e.g. fertilizer use, manure storage and land application technologies and practices;
- Land fill gas management and utilisation;
- LULUCF; and
- Top down analysis of greenhouse gas emissions and sinks based on observations and modelling.

Due to Ireland's greenhouse gas emissions profile there is a significant focus on the agricultural sector and land- use land-use change issues including work on enteric fermentation and options to reduce these emissions e.g. dietary supplements. This work has been initiated through Environmental Protection Agency funding and progressed under the DAFM stimulus projects.

Several research initiatives have been undertaken to help quantify carbon stock changes in response to land use management such as;

- Surveying of greenhouse gas emission and sink potential of active and degraded blanket peatlands in Ireland.
- Analysis of grasslands and associated management practices and potential impact on greenhouse gas emissions and removals.
- Review national emission factors for methane emissions from livestock.
- National Forest Inventory Support - Developing Methods to Track Forestry Related Land Use Change.

8.5.2 Peatlands

Approximately 17%-20% of lands in Ireland are peatlands, or have peat as a substrate. It is estimated that these lands contain between 53-62% of the total soil carbon stock. Recent studies, funded by EPA, are focusing specifically on the impact of management on drained and restored wetlands;

- Greenhouse gas emissions and sink potential of Irish peatlands.
- AUGER: peAtland properties influencing greenhouse Gas Emissions and Removals.
- Network Monitoring Rewetted and Restored Peatlands/Organic Soils for Climate and Biodiversity Benefits (NEROS).

Greenhouse gas emissions and sinks associated with human intervention of peatlands are reported under the UNFCCC under three IPCC land use categories: Wetlands, Forest land and Grassland, and identified through analysis of land cover and the specific land use declared by land managers.

Peatland under forest and grass are assumed to be subject to artificial drainage and carbon losses are estimated using country specific emission factors and methodologies. Ireland presently accounts for mitigation action associated with wetlands falling within currently-reported land types. Research is currently being carried out which will support the understanding of carbon stock changes associated with peatlands and agricultural soils. This will feed into the development of a more robust inventory and underpin future accounting for mitigation action associated with wetlands.

8.5.3 Top down analysis of Greenhouse Gas emissions and sinks

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 a national greenhouse gas measurement network at three sites, in the North (Malin Head), the South East (Carnsore Point), and the West (Mace Head). This effectively triangulates Ireland and is a part of the Irish contribution to EU ICOS. ICOS is a large-scale European infrastructure development and sites are being developed in order to run in ICOS compliant fashion. ICOS aims to:

- Quantify and understand the greenhouse gas balances of Europe and neighbouring regions;
- Provide long-term observations of atmospheric concentrations;
- Produce continuous measurement of fluxes between the atmosphere and both land and ocean surfaces;
- Predict future behaviour of the global carbon cycle as well as greenhouse gas emissions and concentrations; and
- Support the knowledge transfer from science to societal innovation.

An existing EPA funded project (MapEire) has recently completed 1km x 1km emissions maps for all greenhouse gases under UNFCCC. This data is now being used in conjunction with another EPA funded project (IMPLiCit), which is looking to improve the inversion model capability in Ireland. This offers the opportunity to reconcile the bottom up and top down approach in order to better understand our national greenhouse gas emissions.

8.6 Modelling and Prediction, Impacts and Adaptation

8.6.1 Observations and Indicators of Climate Change

Analysis of climate change indicators is ongoing. An updated report on analysis of climate change indicators was produced in 2007. This report provided a detailed analysis of signals of climate change from meteorological records. The status of Ireland's climate 2012¹⁰⁷, updated and expanded the range of ECVs analysed. This report is being reviewed and updated in the period 2018 - 2020 to include new sources of information and variables.

8.6.2 Future Climate Projections

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 a regional scale. A comprehensive report¹⁰⁸ was released in 2008, describing the expected changes in a 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 and new global model simulations carried out in Ireland by Met Éireann (2013) provide an update on the expected changes in the Earth's climate over the 21st Century. It was a partner in the EU-funded ENSEMBLES project and has run centennial climate simulations for the European area. Together with University College Dublin (UCD) and the Irish Centre for High-End Computing (ICHEC), it has contributed to the scientific development of a new global climate model (EC-Earth), performing centennial-scale simulations with the model and contributing to the coupled model inter-comparison project (CMIP5) for assessment by the IPCC in the AR5 report. This Multi Model Ensemble approach provides the basic data to assess

¹⁰⁷ Dwyer, N, 2013, The Status of Ireland's Climate, 2012, Climate Change Research Programme Report 26, Environmental protection Agency, Johnstown Castle, <http://www.epa.ie/pubs/reports/research/climate/ccrpreport26.html>

¹⁰⁸ <http://edepositireland.ie/handle/2262/19699>

the impacts of climate change on Ireland. Wave climate projections and surface winds in the context of climate change¹⁰⁹ were studied at Met Éireann in association with UCD.

Currently, development work on the new version of the EC-Earth model is underway at Met Éireann with tuning and long-term simulations planned for the period 2017-2018. This work is part of the CMIP6 project and will contribute to the IPCC AR6 report.

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 the development of river modelling tools and climate impacts modelling have also been advanced.

8.6.3 Climate Re-Analysis

Met Éireann has recently completed a 35-year very high resolution climate reanalysis for Ireland, called MÉRA, using the HARMONIE-AROME numerical weather prediction model¹¹⁰. The hourly dataset has been produced on a spatial resolution of 2.5 km for the period 1981 - 2015 for the region covering Ireland, the United Kingdom and a small area of north-west France. It is the highest resolution reanalysis dataset available today for the Irish-UK region.

8.6.4 Paleoclimatology

¹⁰⁹ **Gallagher, S., E. Gleeson, R. Tiron, R. McGrath, and F. Dias.** "Twenty-First Century Wave Climate Projections for Ireland and Surface Winds in the North Atlantic Ocean." *Advances in Science and Research* 13 (2016): 75–80. doi:10.5194/asr-13-75-2016. (Full Text) **Gallagher, S., E. Gleeson, R. Tiron, R. McGrath, and F. Dias.** "Wave Climate Projections for Ireland for the End of the 21st Century Including Analysis of EC-Earth Winds over the North Atlantic Ocean." *International Journal of Climatology* Early View (2016). doi:10.1002/joc.4656.

¹¹⁰ **Gleeson, E., Whelan, E., and Hanley, J.:** "Met Éireann high resolution reanalysis for Ireland", *Adv. Sci. Res.*, 14, 49-61, <https://doi.org/10.5194/asr-14-49-2017>, 2017.

Ireland is supporting a range of paleo climate research. Regional climate instabilities and abrupt hemispheric change is an area of interest and specifically, the response of the North Atlantic to climate forcing mechanisms during the Holocene (10,000 years). Studies of atmosphere-ocean circulation systems show their potential role in controlling, propagating, and amplifying climate instabilities into abrupt climate change. This changes of the strength of the Atlantic Meridional Overturning Circulation (AMOC) on multi-decadal to centennial timescales.¹¹¹

Irish peatland and lake systems provide a rich source of information on long-term climate change. The NUI Galway based Paleoenvironmental Research Unit¹¹² has a very active research programme on the late-glacial period c. 15,000 to 11,500 years Before Present and Holocene environments in Ireland¹¹³.

Studies in TCD have advanced the application of statistical methods to the reconstruction of past climate, based on pollen analysis¹¹⁴. 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 Ireland¹¹⁵. More recent research within this group has explored the signal of changing precipitation in peat accumulation in Ireland and the contrasting conditions associated with the Medieval Warm Period and the Little Ice Age¹¹⁶.

University College Dublin has established a state-of-the-art plant growth room facility with full monitoring and control of climatic and atmospheric conditions. The chambers are used to explore plant responses to a range of atmospheric CO₂ (380 to 2000 ppmV), O₂ (9 to 21%) and SO₂ (200 to 2000 ppbV) levels that occurred in pre-Holocene eras. This enables research on plant paleoecology including morphological and anatomical responses, to simulated past or future climatic atmospheric scenario.

¹¹¹ www.nuigalway.ie/our-research/people/geography-and-archaeology/audreymorley/

¹¹² www.nuigalway.ie/pru/

¹¹³ Ghilardi, B. and O'Connell, M. 2013. Early Holocene vegetation and climate dynamics with particular reference to the 8.2 ka event: pollen and macrofossil evidence from a small lake in western Ireland. *Vegetation History and Archaeobotany*, 22, 99–114

¹¹⁴ www.tcd.ie/Statistics/

¹¹⁵ Implications of the EU climate protection target for Ireland McElwain and Sweeney, 2007 ERC Report Series No. 5

¹¹⁶ Charman, D.J., et.al., A 1000-year reconstruction of summer precipitation from Ireland: Calibration of a peat-based palaeoclimate record, *Quaternary International* (2011), doi:

The recently completed national sea-bed survey by 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 studies¹¹⁷.

A recent EPA study of extreme events provided an opportunity to review synthesis and information on such events from a range of proxy sources including paleo and tree ring data, and unique monastic archives. This study showed a link between pre-instrumental written records of extremely adverse weather conditions in Ireland and regional volcanic events¹¹⁸.

8.6.5 Information Systems and Supports for Policy and Decision Making

The Environmental Protection Agency funded the development of the Irish Climate Information Platform under its Climate Research programme. The Climate Ireland website provides information, support and advice to help organisations, sectors and Government to adapt to the consequences of climate change. Climate Ireland is designed and developed by the Centre for Marine and Renewable Energy at University College Cork and the Irish Centre for High End Computer at the National University of Ireland, Galway

Climate Ireland aims to deliver climatic and adaptation information that is of direct relevance to climate adaptation planning in Ireland and as such, our work revolves around three key areas:

1. Raising awareness and increasing understanding of climate change and climate adaptation;
2. Providing the information and data required for climate adaptation planning in Ireland;
3. Facilitating decision-makers in developing their adaptation plans.

Access to Climate Ireland has been limited to local authorities and sectoral stakeholders during the development phase, with 406 registered unique users.

The information platform has been progressed from development to operational phase with secured funding from the DCCA. Climate Ireland will be launched for public access in early 2018.

The report published in 2017 '[A Summary of the State of Knowledge on Climate Change Impacts for Ireland](#)' presents a summary of the state of knowledge on ongoing climate change and projected

¹¹⁷ www.gsi.ie

¹¹⁸ Francis Ludlow, et al, 2013, *Medieval Irish chronicles reveal persistent volcanic forcing of severe winter cold events, 431–1649 CE*, Environ. Res. Lett. 8 024035

impacts for Ireland. It updates and enhances the information provided in the 2009 Summary of the State of Knowledge Report (Desmond et al., 2009). A further report, currently under review is due on *'National Preparedness to adapt to climate change: analysis of state of play'* and this builds on previously reported work (National Adaptive Capacity Assessment, [Desmond and Shine, 2012](#)). It will be published in 2018.

The information provided in both reports takes account of new data, analyses and knowledge that have been published since then. The purpose of this report is to provide an accessible summary of the available information in a format that will be of use to policymakers, sectoral and local decision-makers and other stakeholders interested in or working on adaptation to climate change in Ireland.

The national information is largely based on Environmental Protection Agency funded research and linked research funded by other national bodies, including Met Éireann, the Office of Public Works (OPW) and the Marine Institute, and research carried out by third-level institutes.

8.6.6 Aerosol Radiative Impacts

Ireland supports research on aerosol which is at the interface between air pollution and climate issues. Historically Irish scientists have made important contributions to the development of aerosol science. National research has maintained a focus on aerosol science and aerosol cloud interactions. As is illustrated in the IPCC 5th Assessment Report Working Group I, Summary for Policymakers, Figure SPM.5, aerosol radiative forcing remains a major source of uncertainty in relation to anthropogenic forcing of climate. An extensive range of aerosol measurements and atmospheric composition studies are carried out at the Mace Head Atmospheric Research Station, operated by the National University of Ireland, Galway. Aerosol climate studies at Mace Head have focused on air sea exchange processes and medium and long range transport of aerosols, and their impacts on direct and indirect radiative forcing. The goal is to improve parameterisation of these in regional and global climate models.

Mace Head is a key Global Atmospheric Watch site in the North Atlantic Marine Boundary layer. Measurements are carried out of all the greenhouse gases as well as the industrial gases covered under the Montreal Protocol. Activities at Mace Head are funded through national and international sources. National funding is focused on aerosol studies, e.g. organic and inorganic aerosols, and other short climate forcers such as ozone. The data collected are provided to a range of Global and Regional data centres.

8.7 Socio-Economic Analysis and Technologies

Research on socio-economic analysis and technologies is advanced under Theme 3 of the Climate Change Research Programme (CCRP). Work in this area is solution focussed. It aims to analyse and identify new approaches to mitigation and adaptation. A key aim is to identify pathways for achievement of a carbon/greenhouse gas 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.

8.7.1 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. In addition a number of studies are looking at the social pathways during the transformation.

The project 'Catalysing and Characterising Transition' seeks to develop an analytical framework for directing and integrating research on the low carbon transition in Ireland. To benchmark Ireland's transition compared to other international examples and a synthesis of the research into an overall analytical framework for catalysing and characterising transition in Ireland.

The project 'Enabling Transition' is using a range of methodologies from the behavioural sciences to aid our understanding of behaviour in relation to the environment and utilise this information to aid the design of environmental policy measures to stimulate change

The project 'Developing the Potential of Community Energy Action Groups Towards Transition to a Low Carbon Society' is looking at the significant role of rural communities in transition. 38% of the Irish population live in rural areas and represent a significant contribution to greenhouse gas/CO₂ emissions. Community energy projects addressing greenhouse gas emissions are instrumental in bringing positive change in environmental and socio-economic sustainability. Many community

groups, nationally and internationally, have successfully come together improving their immediate environment. The means to scale up these successes will assist the national transition.

8.7.2 Model Development

Modelling and developing an Irish modelling capacity has been a key element of the Climate Research. An Irish TIMES energy systems model has been developed in collaboration with the Economic and Social Research Institute (ESRI), Teagasc, University College Cork and University College Dublin over the period 2009 – 2013. The most recent phase of development for Irish TIMES included improvements in the model capability in several key areas, with focus on

- better representation of demand side technologies to more explicitly quantify energy efficiency;
- improved understanding of land-use implications of mitigation and better integration of agriculture, bioenergy and forestry;
- providing feedback between Irish TIMES and the ESRI's macro-economic model of Ireland's economy to gain insights into the effects of climate mitigation on the macro-economy; and
- interfacing with other modelling activity at EU level (PET) and national level (GAINS).

Cross cutting studies aim to address synergies and trade-offs between policy objectives and sectors. This work is undertaken at Government level, under the auspices of the Department of Communications, Climate Action and Environment, through the Technical Research and Modelling (TRAM) to inform policy development.

8.8 Research and Development on Mitigation and Adaptation Technologies

Improved information and analysis is needed to manage the transition to a climate resilient Ireland. The Environmental Protection Agency supports these developments of Ireland's adaptation and mitigation pathways by providing through research, analysis on the risks, vulnerability and adaptation actions for Ireland.

Several research initiatives have been undertaken to assist this process:

- CIViC- Critical Infrastructure Vulnerability to Climate Change
- Developing the Potential of Community Energy Action Groups Towards Transition to a Low Carbon Society
- Large Urban Area Adaptation
- National Risk Assessment of Impacts of Climate Change.

8.9 Systematic Observation

Several national bodies/organisations are engaged in systematic observations including contributions to the 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.

Following publication of the GCOS 2016 Implementation plan, a GCOS national coordinator has been nominated and a National GCOS committee established. Under the coordination of this group, work is on-going on the implementation of the observations action plan for Ireland¹¹⁹. A comprehensive review of Ireland's climate observation system and a report on the trends observed in time-series analysis of all the ECVs of relevance to Ireland was completed in 2012 and will be regularly updated¹²⁰. Table 8.1 summarises the current monitoring status for these ECVs. It shows the length of the observation period, the key organisations carrying out the measurements, the level of analysis to date and the security of the measurement programme. The report concludes that many elements of a climate observation, analysis and reporting system are in place, but that there are a number of issues that need to be addressed in order to make it more robust and capable of addressing the country's long-term needs with regard to climate monitoring and understanding. A number of recommendations to address these issues are made in the report.

Work has also progressed on re-enforcing elements of the climate observation system across the atmospheric, oceanic and terrestrial domains and these are described in the relevant sections below.

¹¹⁹ Dwyer, N., 2009, Current Status and Required Actions for National Climate Observing Systems, Environmental Research Centre Report 14, Environmental Protection Agency, Johnstown Castle, <http://www.epa.ie/pubs/reports/research/climate/ercreport14.html>

¹²⁰ Dwyer, N., 2013, The Status of Ireland's Climate, 2012, Climate Change Research Programme Report 26, Environmental protection Agency, Johnstown Castle, <http://www.epa.ie/pubs/reports/research/climate/ccrpreport26.html>

8.9.1 Atmospheric Climate Observation System

Ireland has three main groupings of meteorological observing stations:

- 25 Synoptic stations
- 60 Climate stations
- 475 Rainfall stations

The synoptic station network consists of one Observatory (Valentia), five airport stations, four of which are manned 24 hours, one manned part time but with an Automatic Weather Station (AWS), and nineteen unmanned AWS. The airport synoptic stations operated by Met Éireann provide hourly observations of the standard meteorological parameters; a project to modernise and automate observations at the airports is underway. Automatic Weather Stations provide observations of most of the standard meteorological parameters by the minute. Measured parameters include:

- Wind speed and direction (23 locations)
- Atmospheric pressure
- Precipitation
- Air temperature
- Water Vapour
- A range of soil and earth temperatures
- Radiation (22 locations)

The climate station network currently consists of 60 stations which return daily values of Dry-bulb, Wet-bulb, Max and Min temperatures and rainfall; 14 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 UTC. Readings are taken by private individuals, Government bodies, local authorities, schools and colleges, etc. A climate network modernisation project is underway, which will automate the climate network and provide readings at one minute resolution.

The rainfall station network consists of 450 stations which report daily rainfall at 0900 UTC and 25 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 27 daily and 2 weekly Dines Tilting Syphon Rain Recorders in operation at various locations.

There are also 6 evaporation stations using Class A pan evaporimeters.

Data from all the above networks are archived by Met Éireann. These data are quality controlled and quality assured 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 adhere to GCOS monitoring principles. Records from some stations span more than 100 years. Much of the data since 1941 from the above stations are held in electronic form.

Valentia Observatory is also an upper air station which measures upper air temperature, water vapour and wind speed twice a day. Total column ozone (O₃) has been measured at Valentia Observatory since 1993 using ground-based optical equipment. Since 1994 vertical ozone profiles are routinely measured using equipment carried on weather balloons. Air quality measurements are undertaken daily at the Observatory; a comprehensive analysis of air (SO₄, NO₃, NH₄, Cl, Mg, Na, Ca, K) and precipitation (SO₄, SO₂, NH₄, NO₃, Na, Ca, Mg, K – including pH and conductivity) is performed by Met Éireann in Dublin for Valentia and a number of other sites on behalf of the EPA and NUIG (air quality); daily and monthly values are provided. A ground-based O₃ observational network has been established with 11 sites around the country.

Ireland contributes to space-based observations through membership of the European Space Agency, ESA and the European meteorological satellite organisation EUMETSAT. The Copernicus Climate Change service (Copernicus C3S) is tasked to provide information to increase the knowledge base to support adaptation and mitigation policies. It will in particular contribute to the provision of Essential Climate Variables (ECVs).

8.9.2 Oceanic Climate Observation Systems

Ocean surface variables

A number of ocean surface variables are measured by the Irish National Weather Buoy Network. The first buoy was installed in 2000 and the network now comprises 5 offshore buoys including M6 deployed in deep water to the west of Ireland. The weather buoys return hourly information on:

- Wind speed and direction
- Maximum gust
- Atmospheric pressure and tendency

- Air temperature
- Relative humidity
- Sea surface temperature and salinity
- Significant wave height and period
- Maximum wave height and period
- Mean direction of waves

Sea level

The Marine Institute, in collaboration with the Office of Public Works, are leading the ongoing development of the National Irish Tide Gauge Network. The network will ultimately be comprised of 20-25 permanent stations with GSM enabled real time data logging and dissemination capacity. Two stations are being upgraded during 2017 to recommence reporting at international GLOSS standard; Castletownbere and Malin Head.

Subsurface ocean variables

A number of ocean variables are measured continuously by the two national research vessels. These are typically temperature, salinity, dissolved oxygen, chlorophyll fluorescence, turbidity and pCO₂. In addition, the annual Southern Rockall Trough Ocean Climate survey collects: Dissolved Inorganic Carbon/Total Alkalinity, Dissolved Inorganic nutrients (phosphate, total oxidised nitrogen, nitrite, silicate), and water current velocities and direction. During April-May 2017 Ireland led the GO-SHIP A02 (St John's to Galway) decadal transect successfully collecting all Level 1 variables and this data will be delivered to the relevant international data centres by November.

During 2017/2018 a full depth water column mooring will be installed close to the M6 buoy to build upon the full depth time series collected between mid-2008 to end of 2012.

A total of 30 Irish Argo floats have been deployed since 2003, with 11 currently active, to complement the around 3,800 floats in use at a global scale. As part of the Euro-Argo European Research Infrastructure Consortium, Ireland is committed to deploying 3 standard temperature and salinity floats per annum and will be deploying a biogeochemical Argo float during 2018.

Table 8.2: Participation in the Global Oceanographic Observing Systems

	Argo	DBCP	Ocean SITES	GO-SHIP	GLOSS/Tide Gauges	SOT
For how many platforms is the Party responsible?	30	5	0	1 (A02 - 2017)	19	9
How many are providing data to international	11	5	0	1 (A02 - 2017)	2 (upgrading during 2017 to meet GLOSS standard)	9

datacentres?						
How many are expected to be operating in 2017?	11	5	0	1 (A02 - 2017)	16 (plus 3 to come online during 2017)	9

Ocean acidification

In a series of projects since 2008, the Marine Institute and National University of Ireland, Galway have collaborated on repeat hydrographic surveys along a section of the southern Rockall Trough including collection of physical and biogeochemical Essential Ocean Variables. Increasing acidification has been observed in surface and, to a lesser extent, in deeper water masses in the Rockall Trough¹²¹. Additional biogeochemical studies have been undertaken to investigate the carbonate system baseline for Irish inshore and coastal waters.

Irish EOY Analyses

A detailed analysis of much of the data collected was carried out, and a significant report on the status of the Irish ocean climate and ecosystem was published in 2010¹²². An updated analysis of Essential Ocean Variables for Ireland is expected during 2019 as part of a wider programme.

8.9.3 Terrestrial Climate Observation Systems

Phenology

Met Éireann have managed the International Phenological Garden (IPG) Network in Ireland since their planting in the early 1960's. In 2010 the six existing IPG gardens was expanded to thirteen under a project funded by the EPA¹²³. Observations from these Irish IPG gardens are shared through the Pan European Phenology Project¹²⁴. In addition, during the EPA project, ten native species

¹²¹ McGrath T., Kivimäe C., Tanhua T., Cave R. R. & McGovern E., (2012) [Inorganic carbon and pH levels in the Rockall Trough 1991–2010](#). *Deep Sea Research Part I: Oceanographic Research Papers*.

¹²² Nolan, G., Gillooly, M., Whelan, K. (eds), [Irish Ocean Climate and Ecosystem Status Report Summary 2009](#), Marine Institute, 2010

¹²³ Donnelly, A., Proctor, H., & O' Connor, B., 2013, Ireland's national Phenology Network, CCRP Report 23, Environmental protection Agency, Johnstown Castle, <http://www.epa.ie/pubs/reports/research/climate/climatechangeresearchprogrammereportnumber23.html>

¹²⁴ Pan European Phenology Project <http://www.pep725.eu/>

gardens have been established for the monitoring of a number of nationally important native tree species.

Fire Disturbance

The Forest Service maintains a record of forest areas reported as burned in Ireland since 1930. They calculate Fire Disturbance burn area from a combination of damage reports from forest owners, ground observations, and more recently remote sensing imagery¹²⁵. Records are updated by the Forest Service annually and reported to the European Commission and other reporting agencies.

Soil Moisture

Met Éireann calculate Soil Moisture Deficit (SMD) at 23 synoptic weather stations on a daily basis. SMD is the amount of rain needed to bring the soil moisture content back to field capacity.

A hybrid SMD Model¹²⁶ has been developed which accounts for differences in drainage regimes between different soil types in Ireland. Three soil drainage classes are modelled; (a) well drained, where soil never saturates, (b) moderately drained, where soil may saturate on wet days and (c) poorly drained, where soil saturates on wet days. Soil moisture surpluses are assumed to be removed by drainage and surface run-off over time.

8.9.4 Support for Developing Countries to Establish and Maintain Observing Systems and Related Data and Monitoring Systems

Support to the National Meteorological Agency in Ethiopia to improve access to climate and weather information for rural farmers

Ireland has provided €400,000 to the World Meteorological Organisation (WMO) to support Food Security initiatives under the Global Framework for Climate Services (GFCS) initiative, which aims to enhance the quality, quantity and application of climate services. Under this programme, support has been provided to the National Meteorological Agency in Ethiopia to strengthen the operational

¹²⁵ MODIS Active Fire and Burned Area Products <http://modis-fire.umd.edu/>

¹²⁶ R.P.O.Schulte, J.Diamond, K.Finkele, N.M.Holden and A.J.Brereton 2005. Predicting the Soil Moisture Conditions of Irish Grasslands. Irish Journal of Agricultural Research 44: 95-110

resources of National Meteorological Services in country, to provide weather and climate information and services to rural farmers in the agricultural sector. The project has strengthened the capacity of regional Meteorology Service Centres in Tigray and SNNP Regions in Ethiopia, on the production of localized weather information at regional level, providing tailored weather forecasts in local language, agriculture advisory services, and ten day and monthly weather forecast updates.

Through access to weather information, farmers in Ethiopia have been able to improve their decision making with regard crop planting times. Farmers have also been provided with equipment to support monitoring, including rain gauges, and trained on taking daily recordings, which informs the network of the National Meteorological Agency and improves coverage. The project has also improved institutional linkages between the Regional Met Service Centres, Bureau of Agriculture and Natural Resources, Agricultural Research Institutions and Universities in Ethiopia. This ensures that farmers in the region benefit from not only access to improved weather and climate information, but also access to better farming methods, and research on improved crop varieties under a changing climate.

9. Education, Training and Public Awareness

9.1 Introduction

The importance of education, training and the raising of public awareness on environmental issues is recognised in Ireland's framework for sustainable development – '*Our Sustainable Future*'. This framework takes a whole of Government approach to sustainable development and aims to embed sustainable development in the policy making process across Departments, in order to reap benefits, not only in terms of protecting the environment but also in terms of the Green Economy, Jobs and Growth. Overall, the objective of '*Our Sustainable Future*' is to identify and prioritise policy areas and mechanisms where a sustainable development approach will add value and will enable continuous improvement of quality of life for current and future generations.

The framework makes it clear that education and awareness play a crucial role in moving towards a more sustainable society. Education strengthens the capacity of individuals, communities, businesses and governments to make judgements and decisions that take proper account of environmental protection. '*Our Sustainable Future*' recognises that education for sustainable development needs to be embedded at every level of the formal and informal education system, and that public awareness measures are vital for sustainable development to be better understood and appreciated. Public authorities need to actively engage with citizens and stakeholders in the development and implementation of policy if we are to effect behaviour change and the transition to a more sustainable society and economy.

A wide range of environmental awareness raising programmes and initiatives are supported by various Government agencies, building on the awareness raising achievements of earlier awareness campaigns, including the *An Taisce Green-Schools (ECO-Schools) Climate Action and Awareness Programme*.

9.2 Education

National Strategy on Education for Sustainable Development

The Department of Education and Skills published Ireland's the National Strategy on Education for sustainable development in June 2014. This Strategy sets out Ireland's commitment to further promote education for sustainable development across the formal and non-formal education sectors. Eight 'priority action areas' have been identified. They include leadership and coordination, data collection and baseline measurement, and promoting participation by young people in decisions that affect them. Each of the eight priority areas has a series of recommendations. These recommendations encompass all areas of the education system, from pre-school through to further and higher education, as well as non-formal and community education, and the Youth sector. The Education for Sustainable Development plan promotes greater participation by children and young people in decisions that affect them within the education sector.

The Department of Education and Skills published 'Education for Sustainability' the National Strategy on Education for Sustainable Development (ESD), 2014-2020; this fosters and strengthens the capacity of individuals to make judgements and choices in favour of sustainable development. The Strategy aims to ensure that learners are equipped with the relevant knowledge, and the key dispositions, skills and values to motivate and empower them to become informed citizens acting for a more sustainable future. Ireland continues to provide funding to environmental NGOs, to build their capacity and facilitate participation, and to support awareness-raising.

9.2.1 Primary, Secondary and Higher Education

The Green-Schools Programme

The Green Schools Programme (www.greenschoolsireland.org) is the pre-eminent environmental education programme in Ireland with a participation rate of more than 93% of all Irish Schools – over 3,800 schools are registered with the programme and 3,139 schools have been awarded at least one Green Flag. Green Schools is part of the Eco-Schools programme which is coordinated internationally by the Foundation for Environmental Education. The programme is run in Ireland by the environmental NGO, An Taisce, in partnership with local authorities. The majority of funding for Green School is provided by the Irish Government and State Agencies.

The Green-Schools programme promotes whole school action for the environment and aims to instil a strong sense of environmental responsibility in students that also spreads beyond the classroom into students' homes and the wider community. Schools are visited throughout the year by representatives of An Taisce and local authority Environmental Awareness Officers from local

authorities, who advise them on successful implementation of the Green-Schools Programme. Each year An Taisce runs a series of seminars for teachers involved in the programme.

Ireland's Smarter Travel Workplaces (STW) and Smarter Travel Campus (STC) programmes are national, voluntary programmes that work with large employers and third level institutions to implement workplace travel plans. The Smarter Travel Workplaces (STW) programme was established in 2009, and is now engaged with 138 large employers, with a potential reach of over 100,000 employees. The STW programme engages with smaller employers on a cluster basis. The Smarter Travel Campus (STC) programme was established in 2012, and is engaged with 24 third levels, including all of the Irish universities and the majority of the Institutes of Technology – a potential reach of over 25,000 employees and over 200,000 students.

Ireland's Green-Schools Travel programme has been operating at a national level since 2008. The theme is funded by the Department of Transport, Tourism and Sport and supported by the National Transport Authority. The aim of the Travel theme is to raise awareness of active and sustainable travel as well as promoting modal shift within a two year period.

1,686 schools have been awarded the travel flag since 2008. This equates to the 361,755 students and 25,593 teachers. Additionally, there are approximately 230 schools working on the theme this year who will be awarded in May 2018.

Building on the success of the Green-Schools Programme, a programme was introduced at third-level to encourage a partnership approach to environmental management in third level institutions. The Green-Campus Programme aims to make environmental awareness and action an intrinsic part of the life and ethos of third-level institutions and other large campuses. The Green-Campus initiative mirrors the principles of Green-Schools and endeavours to extend learning beyond the lecture theatre to develop responsible attitudes and commitment to the environment, both at home and in the wider community.

The Green-Campus Programme is an enhancement of traditional environmental management systems which tend to be management driven. The Green-Campus Programme identifies the campus as a community and places significant importance on the inclusion of all sectors of the campus community in its environmental management and enhancement. The Green-Campus Programme has been in operation in Ireland since 2007 with University College Cork being the first university in the world to be awarded the status of a Green Campus in 2010. At present 28 Campuses are participating in the Programme with 9 having been awarded the Green Flag. The Programme encourages a partnership approach to environmental education, management and

action in third level institutions. The Programme primarily aims to ensure that members of a campus community can engage in a meaningful way to enhance sustainability on campus. It must be noted that the Green-Campus Programme does not reward specific environmental projects or implementation of a new technology. Rather it rewards long term commitment to continuous improvement from the campus community.

An Taisce has also recently commenced a Green Flag for Parks award.

A new Green-Schools National Climate Action and Awareness Programme was launched in March 2017. Implementation of the programme is managed by the An Taisce Education Unit under the oversight of the Department of Communications, Climate Action and Environment. Under this programme a series of regional teacher-training seminars are providing teachers with key information to strengthen their own knowledge on climate change and practical guidance and ideas on how to introduce the topic into the classroom. The programme also included a National Climate Action Week in October 2017 which involved schools made 'climate pledges' and showcase their actions. A Climate Action themed Green-Schools Expo will be held in February 2018. The Expo will bring together over 5,000 students, teachers, parents and community groups.

SEAI Schools Programme

The SEAI schools programme¹²⁷ aims to excite and inspire teachers and students about sustainable energy and the role they can play in creating a clean energy future¹²⁸. The programme helps teachers to inform attitudes and beliefs on energy and climate change through three strands: curriculum based teaching resources, interactive student workshops and the SEAI One Good Idea energy awareness competition.

By integrating the three strands of the education programme and collaborating with the Department of Education and Skills, SEAI can encourage a whole school approach to energy.

Teaching resources

¹²⁷ <https://www.seai.ie/teaching-sustainability/>

¹²⁸ <https://www.seai.ie/teaching-sustainability/>

SEAI provides rich, curriculum aligned teaching resources for primary and post primary schools. Dublin City University were commissioned to develop the resources for SEAI.

[Exploring our Energy](#) provides primary school teachers with resources for teaching energy to pupils from 5 to 12 years, using interactive white board lessons, experiments and investigations.

[Energy in Action](#) is a teaching resource for post primary students on energy and sustainability and is aligned with Junior Cycle subjects: Science, Home Economics, Geography and CSPE. The resources are available for teachers to download from SEAI's website.

Workshops

Every year SEAI reach over 20,000 primary and post primary students with its workshops. All workshops are hands on, interactive and encourage debate on the topics of energy efficiency and climate change.

SEAI, in partnership with Department for Education and Skills, provide workshops for teachers on integrating SEAI's resources into the various curricula. SEAI, working with Science Foundation Ireland, also run summer courses for teachers in various locations throughout Ireland.

One Good Idea competition

SEAI's One Good Idea competition¹²⁹ encourages students to inspire lifestyle changes to save energy and help tackle climate change. It is open to both primary and post primary students and challenges them to develop awareness campaigns on energy efficiency and climate action. Their campaigns target their peers, other schools in the area or the wider community. In a typical year the competition engages with 580 schools and over 1,500 students, with an additional reach of 500,000 via their campaigns. The enthusiasm and dedication from the students is always inspiring and their understanding of the issues around energy and climate change is very impressive. Some of the campaigns that the students have run have had a lasting impact on the school and in some cases the wider community.

¹²⁹ <https://www.seai.ie/teaching-sustainability/one-good-idea/>

SEAI also works in collaboration with Department for Education and Skills and offers a range of supports to help schools to improve energy management, reduce school operating costs and protect the environment through a dedicated website¹³⁰. Over 600 schools have availed of energy management training and technical advice. Other resources include step by step guides and workbooks, a dedicated website with factsheets, videos, on-line energy management tools and case studies.

EPA education activities

The EPA provides a range of environmentally focused educational resources for all levels.

<http://www.epa.ie/researchandeducation/education/>

The EPA contributes an annual lesson to the [Science and Technology in Action](#) secondary school pack, distributed to all second level schools.

The EPA BeGreen programme supports resource efficiency activities for the hospitality sector in Ireland and includes the development of educational modules for example in the catering colleges in Ireland in food, water, and energy efficiency¹³¹.

The major EPA funded research project CONSENSUS: A cross-border household analysis of CONsumption, ENvironment and SUstainability in Ireland yielded valuable educational resources for primary, secondary and tertiary education. CONSENSUS lifestyle survey factsheets were circulated as an educational resource to all schoolteachers and students through the AGTI¹³² website, with a growing number of students taking a sustainable consumption module based on the project's findings.

The EPA worked with An Taisce to develop a Green Home module of the Green Schools Programme. This module involves householders and has widened its reach to include community groups through the Tidy Towns competition. The programme currently focuses on four key household themes of waste prevention, water conservation, energy conservation and sustainable transportation.

¹³⁰ <http://www.energyineducation.ie/>

¹³¹ <http://www.epa.ie/begreen/>

¹³² [Association of Geography Teachers of Ireland](#)

The EPA continues to implement the National Waste Prevention Programme and as part of the programme it launched a Stop Food Waste Programme to promote food waste prevention and home composting.

In November 2016 the EPA published its sixth State of the Environment Report titled 'Ireland's Environment - An Assessment 2016'. The report provides a key evidence base and acts as a resource for education, training and public awareness

9.3 Public Awareness

National Dialogue on Climate Action

The National Dialogue for Climate Action (NDCA) was set up under the Programme for a Partnership Government and being funded by DCCA. The NDCA will inform Ireland's national objective to transition to a low carbon and climate resilient economy and society.

The objectives of the National Dialogue on Climate Action are to:

- Create awareness, engagement and motivation to act (locally, regionally and nationally) in relation to the challenges presented by climate change;
- Create structures and information flows to facilitate people gathering to discuss, deliberate and maximise consensus on appropriate responses to these challenges, and to enable and empower appropriate action;
- Establish, on a long-term basis, appropriate networks for people to meet periodically to consider evidence-based inputs on the economic, social, behavioural, environmental and public aspects of climate and energy policy; and
- Provide regular input, through the National Dialogue on Climate Action, into the prioritisation and implementation of climate and energy policy which can be reported and monitored at local, regional and national levels.

In terms of climate resilience (i.e. adapting to climate change impacts), the publication of the approved National Adaptation Framework will play a key role in informing the dialogue process and how it addresses the issue of climate change impacts.

An advisory group on the National Dialogue has been established to provide advice in relation to the overall strategy, structure and operation of the National Dialogue.

Engagement with the public through the NDCA may include Regional gatherings, local moderated meetings, a series of expert lectures and moderated debates; An Taisce Green–Schools National Climate Change Action and Awareness Programme; An Taisce Climate Ambassador Programme;

Citizen’s Assembly

Ireland’s Oireachtas established a Citizens Assembly¹³³ in 2017, a panel representing public opinion charged with examining a range of complex issues requiring cross-sectoral action. The Citizens Assembly has a mandate to look at a limited number of key issues over an extended time period. The Citizens' Assembly is an exercise in deliberative democracy, placing the citizen at the heart of important legal and policy issues facing Irish society today. One of the issues the Citizens’ Assembly is tasked with considering is “How the State can make Ireland a leader in tackling climate change” and deliberations on the topic took place in September and November 2017.

The Assembly’s report on this topic is expected to be submitted to the Oireachtas early in 2018 for further consideration.

Climate Change Advisory Council

The Climate Change Advisory Council (CCAC) was established under the Climate Action and Low Carbon Development Act 2015. It is an independent advisory body tasked with assessing and advising on how Ireland can achieve the transition to a low carbon, climate resilient and environmentally sustainable economy. The CCAC conducts evidence-based analyses on how best to respond to the impact of climate change and provide timely advice on the most effective policies to assist with Ireland’s transition to a low carbon and climate resilient economy. As part of this work, the CCAC provides regular reports regarding Ireland’s progress in achieving its national policy goals and greenhouse gas emissions targets agreed by the European Union.

¹³³<https://www.citizensassembly.ie/en/How-the-State-can-make-Ireland-a-leader-in-tackling-climate-change/How-the-State-can-make-Ireland-a-leader-in-tackling-climate-change.html>

The Council has published three reports to date, along with a number of specific recommendations.¹³⁴

Environmental Protection Agency

The EPA is at the front-line of environmental protection and policing in Ireland. The EPA has a wide range of functions including environmental licensing; enforcement of environmental law; environmental planning, education and guidance; monitoring, analysing and reporting on the environment; regulating Ireland's greenhouse gas emissions; environmental research development; Strategic Environmental Assessment and Waste Management.

The Climate Action and Low Carbon Development Act 2015 requires sectors that are required to prepare sectoral adaptation plans consult with the EPA and with the Climate Change Advisory Council in the preparation of their sectoral adaptation plans. The CCAC Secretariat, which is based in the EPA, provides corporate and secretarial services to the CCAC to assist them to carry out their statutory functions under the Climate Action and Low Carbon Development Act 2015.

- [Climate Change Website](#)

A climate change section on the EPA's website¹³⁵ provides a range of information for the public, including the latest research findings from EPA funded climate projects, information from international climate negotiations, links to international and national organisations working on climate change, carbon calculator tools for personal and business use, and answers to frequently asked questions about climate change. The EPA website includes a number of Carbon Calculator tools. The Carbon / CO₂ Calculator allows an individual to calculate the amount of carbon dioxide emitted as a result of their daily actions. The Carbon Management Tool allows businesses to calculate carbon emissions and which shows how those emissions can be reduced. The EPA also manages a Twitter account which highlights climate issues, the account has 3901 followers.

- [Eco Eye](#)

¹³⁴ <http://www.climatecouncil.ie/>

¹³⁵ www.epa.ie/climate

The EPA, with the support of the Department of Communications, Climate Action and Environment, has provided funding for the popular environmental television series, Eco Eye, which has aired over 100 episodes on the national television broadcaster, RTE, and attracts an audience of approximately 500,000 per episode. Past episodes for seasons 2012 to 2017 are available to the public on the Eco Eye production website.¹³⁶

- Climate Change Research Report

The EPA has publicised the findings of its various research projects through the media and sectoral workshops. Research supported under the Climate Change Research Report Programme has focused on investigating priority issues related to Ireland's response to climate change and has produced valuable insights on a range of issues including adaptation and options for mitigation in various sectors. More detail on this research programme is provided in the previous Chapter.

- State of Environment reporting

In November 2016 the Environmental Protection Agency published its sixth state of the environment report Ireland's Environment - An Assessment 2016. The 2016 State of the Environment report draws from data and assessments by the EPA and many other public bodies. It provides the public, policy makers, non-governmental organisations, community groups, businesses, teachers and students with the national evidence base about the condition of our environment. The report acts as a key resource for education, training and public awareness. It is a landmark evidence-based document that examines the environment in its totality and offers us the opportunity to reflect and plan for a better future.

The report acts as a key public awareness resource to highlight climate change and the integrated actions needed in Ireland to meet national, European and global targets. The report highlights community engagement as an important part of environmental protection, and advocates for the continued need to inform, engage and support communities in the protection and improvement of the environment.

- EPA Climate Ambassadors

¹³⁶ <http://www.earthhorizon.ie/television/eco-eye>

In 2015 the EPA provided funding for nine climate leaders in Ireland to undertake climate communications training under the Climate Reality Project¹³⁷. Following the training, these Climate Leaders returned to Ireland and created strong impact in improving climate change awareness in their local communities, the table below provides a summary of engagements in first 12 months since training.

Table 9.1 Activities of EPA funded Climate Ambassadors over first 12 month period

Type of Engagement	Total
Talks/Seminars	82
Attendance	3,707
On-line views	23,000
Radio and television interviews	16
Media articles and quotes	17
Other	9

Building on this capacity, and positive feedback, in 2017, the EPA with Cool Planet Experience initiated a Climate Ambassador programme, and has recruited 26 members of the public to become climate champions in their local areas and counties.

- Climate Lecture Series

The EPA's *Climate Change Lecture Series* has been running since 2007, as part of its programme of increasing public awareness of climate change issues. The early evening events are free and open to the general public, and hosted by a popular current affairs media personality. The series has included a wide range of international and Irish speakers, who have discussed key aspects of climate change. A total of twenty four events have been promoted by end 2017. Recent speakers have included Jos Delbeke, EU Commission, Director General Climate Action, Thomas Stocker, IPCC WG1 2013 Assessment Report, Ottmar Edenhofer, IPCC WGIII 2014 Assessment Report and Myles Allen, University of Oxford.

An average of 340 people have attended the events in person. The lectures are available for viewing on the EPA's website¹³⁸ and on the EPA YouTube¹³⁹ channel).

- EPA / IFA Smart Farming Programme

¹³⁷ <https://www.youtube.com/watch?v=Gpww0ASiWWk&feature=youtu.be>

¹³⁸ www.epa.ie

¹³⁹ www.youtube.com/epaireland

Smart Farming is an EPA led collaboration with key agriculture stakeholders including the Irish Farming Organisation, Department of Agriculture, Food and Marine, Teagasc, SEAI and third level institutions, to raise environmental awareness in the agriculture sector. The aim of initiative to enable farmers to adopt sustainable farming practices, including greenhouse gas mitigation measures, through knowledge transfer whilst also achieving significant cost co-benefits, and thus improve farm environmental and economic sustainability. Smart Farming¹⁴⁰ provides access to a range of tools and detailed case studies that demonstrate the adoption of scientifically robust management options which can be implemented at farm scale. A variety of communication platforms are used as out-reach to the farming community including on-line tools and social media, regular print media and advertorials, showcases and seminars are key farming events (including the annual National Ploughing Championship which has attendances in excess of 250,000 people).

- National Waste Prevention Programme

The National Waste Prevention Programme (NWPP) aims to effect changes towards a vision of ‘living well, using less’ as articulated in the current strategy Towards a Resource Efficient Ireland. The programme is one of EPA’s flagship initiatives and combines direct interventions such as greenbusiness.ie; with support funding to organisations working in the area – such as Community ReUse Network Ireland. The NWPP provides some incentives for technological improvements, but the major emphasis is on prompting behavioural changes. The portfolio of projects within the NWPP is funded by the Irish government and the direction of the programme is overseen by a National Waste Prevention Committee. In recent years, the NWPP has seen an increased focus on areas such as social enterprises and community-based activities. This is due to strategic nudges from national and EU policy (such as the Circular Economy package). Future directions for the programme will continue to be informed through policy drivers and also through the UN Sustainable Development Goals.

In order to get the message to as many people as possible and avoid duplication of effort, NWPP actively pursues opportunities for collaboration with other organisations targeting similar audiences or having mutually beneficial goals, such as trade associations, enterprise agencies and community champions. Programmes developed as part of the NWPP such as **Green Business, Smart Farming**

¹⁴⁰ <http://smartfarming.ie/>

and **Green Healthcare** aim to increase resource efficiency in businesses and public sector organisations, including reduction in energy and water consumption and preventing waste generation.

Through the Local Authority Prevention Network, the NWPP also collaborates with local authorities to promote sustainability in local businesses and communities, encouraging reduction of energy and water consumption and preventing waste generation.

Consumers are becoming increasingly aware of food waste and its link to climate change. The EPA's **Stop Food Waste** campaign aims to prevent food waste by empowering consumers to rethink how they shop, store cook and eat. In 2017, EPA launched a national charter on food waste which declares the significance of food waste as a pressing environmental and social issue, and commits signatories to taking a strong approach to preventing food waste

Sustainable Energy Authority of Ireland

SEAI's vision is for Ireland's energy to be sustainable, secure, affordable, and clean. Its role is to help homes, businesses, communities, and industry to be more energy efficient and to support the development of environmentally friendly clean energy technologies.

The Department of Communications, Climate Action and Environment funds a wide range of programmes operated by the SEAI, which reach all sections of society, raising awareness and guiding behavioural change towards more sustainable energy. Among SEAI's most significant programmes are:

- The Large Industry Energy Network¹⁴¹ with over 190 members accounting for more than €1 billion energy spend, many of whom are certified to the international ISO50001 Energy management standard
- 80 public bodies are members of SEAI's Public Sector Partnership Programme¹⁴² covering €480 million energy spend, committed to the highest levels of energy management, with an ultimate target of 33% reduction

¹⁴¹ <https://www.seai.ie/energy-in-business/lien/>

¹⁴² <https://www.seai.ie/energy-in-business/public-sector/>

- SEAI has developed a growing national network of over 110 Sustainable Energy Communities ¹⁴³ with diverse interests and skills all working together to transition to sustainable energy practices and systems.
- The Energy in Education ¹⁴⁴ web portal has an extensive range of support materials, guides, advice and best-practice videos for teachers, principals, boards of management, and contractors. Over 530 schools completed the more intensive support activities on offer, including training combined with energy assessment specifically designed for schools.
- The annual SEAI Sustainable Energy Awards ¹⁴⁵ recognise and reward excellence in all aspects of energy efficiency and renewable energy. On average €100 million energy savings are achieved across the more than entrants each year.
- The Triple E Products Register ¹⁴⁶ is a searchable listing of best in class energy efficient products with only the top 10 - 15% most energy efficient products in any technology listed. This is an important support for purchasing capital equipment in the private and public sectors and underpins tax supports from the Irish revenue services.
- SEAI's consumer information programme ¹⁴⁷, engages and motivate consumers to play an active role in energy sustainability. It gives consumers practical steps to becoming more energy-efficient in the home. The consumer information activities typically complement the aims of specific schemes administered by SEAI such as home and electric vehicle energy grants, building energy rating, community programmes, as well as SEAI's market surveillance responsibilities. A range of tools are used including advertising, public relations and public events, with a large amount of supporting advice materials on our website.
- SEAI is makes extensive use of social media as a means to reach motivated and engaged energy users, with 19,000 followers and connections currently across LinkedIn, Twitter Facebook.
- Since 2011, SEAI has participated with the Commission for Energy Regulation and other key Stakeholders in the National Smart Meter Project. Work to date included the design of the national smart meter programme, which is due to commence in 2018.

¹⁴³ <https://www.seai.ie/sustainable-solutions/community-projects/community-network/>

¹⁴⁴ <http://www.energyineducation.ie/>

¹⁴⁵ <https://www.seai.ie/events/sustainable-energy-awards/>

¹⁴⁶ <https://www.seai.ie/energy-ratings/triple-e-register-for-business/>

¹⁴⁷ <https://www.seai.ie/sustainable-solutions/energy-saving-tips/>

- SEAI provides expertise in the area of citizen engagement and has recently established a unit dedicated to the area of behavioural economics and behavioural science (<https://www.seai.ie/sustainable-solutions/behavioural-insights/>).
- In 2017, SEAI commenced the review of the 2011 Smart Grid Roadmap to 2050.
- SEAI also maintains an online energy research (RD+D) portal for Ireland (<https://www.seai.ie/sustainable-solutions/research-development-demonstration-and-innovation/>) as well as annually publishing a national energy research inventory.

Local Agenda 21 Environmental Partnership Fund

The objective of the Local Agenda 21 Environmental Partnership Fund is to promote sustainable development by assisting environmental projects, including awareness projects at local level. The funding scheme is open to non-profit local and community groups, and is co-financed by local authorities and DCCA. A wide variety of projects and schemes have been supported under the Fund in previous years including, for example, community gardens, allotments and compost schemes, rainwater conservation schemes, educational initiatives and environmental exhibitions. In 2017 over 770 small local projects in every corner of the country received funding under his scheme. Funding was increased for this initiative in 2017.

Tidy Towns

The TidyTowns competition is a long-running awards scheme which encourages community involvement in improving towns and villages, and which incorporates natural environment elements, including biodiversity. The competition is run by the Department of Rural and Community Development with sponsorship from a national retailer. The TidyTowns initiative has been very successful in encouraging voluntary effort throughout the country and it promotes a sense of pride in communities and the local environment. The competition includes a specific Climate Change award and an Air Quality Award, funded by the Department of Communications, Climate Action and Environment.

Environmental Awareness Officers

Local Authority Environmental Awareness Officers promote positive Environmental Action at local level. The Awareness Officers raise awareness of environmental issues with schools, community

groups and the public in general. DCCAE facilitates the Environmental Awareness Officers' Network, which provides opportunities for exchange of best practice.

9.3.1 Involvement of Public and Non-Governmental Organisations

Support for Environmental NGOs

The Department of Communications, Climate Action & Environment (DCCAE) continues to engage with and provide funding to the environmental NGO Sector in order to support them in the role they play in protecting the environment, raising awareness, promoting sustainability and participating in environmental policy development. DCCAE funds the Irish Environmental Network (IEN) an umbrella organisation of environmental NGOs in Ireland and core funding provided by DCCAE is distributed to the IEN's 30 member organisations.

ECO-UNESCO

ECO-UNESCO is an environmental NGO which is affiliated to the World Federation of UNESCO Clubs, Centres and Associations. ECO-UNESCO raises environmental awareness, promotes environmental protection and encourages active citizenship in children and young people across Ireland. Its programmes receive support from various Government Departments and Agencies. ECO-UNESCO has an extensive network and works with young people, teachers, local authorities, business and community leaders as well as participants from the environmental, youth, community and international NGOs.

ECO-UNESCO provides a range of youth and education programmes including training programmes, environmental workshops and peer education programmes. It also supports teachers and youth leaders by providing various educational resources. Along with its youth programmes, ECO-UNESCO also provides accredited and non-accredited adult training in areas such as sustainable development, community gardening and environmental education.

ECO-UNESCO also runs the Young Environmentalist Awards which is aimed at promoting environmental responsibility among young people aged 10 to 18. The programme culminates in an annual National showcase and awards ceremony which is partly funded by the Department of Communications, Climate Action & Environment.

Annex A.1 Summary tables on Emission Tables

A.1.1 CO₂ equivalent Emission Trends 1990-2015

A.1.2 CO₂ Emission Trends 1990-2015

A.1.3 CH₄ Emission Trends 1990-2015

A.1.4 N₂O Emission Trends 1990-2015

A.1.5 HFCs, PFCs, SF₆ and NF₃ Emission Trends 1990-2015

A.1.6 All greenhouse gas Summary Emission Trends 1990-2015

A1.1 CO₂ equivalent Emission Trends 1990, 1995, 2000, 2005-

A1.4 N2O Emission Trends 1990, 1995, 2000, 2005-2015

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Change from base to latest reported year
															%
1. Energy	0.85	1.28	1.31	1.40	1.40	1.37	1.37	1.26	1.24	1.16	1.15	1.11	1.10	1.09	27.64
A. Fuel combustion (sectoral approach)	0.85	1.28	1.31	1.40	1.40	1.37	1.37	1.26	1.24	1.16	1.15	1.11	1.10	1.09	27.64
1. Energy industries	0.24	0.25	0.26	0.34	0.36	0.39	0.48	0.46	0.48	0.44	0.45	0.42	0.42	0.41	70.78
2. Manufacturing industries and construction	0.04	0.04	0.05	0.07	0.07	0.06	0.06	0.05	0.05	0.05	0.04	0.04	0.05	0.05	19.76
3. Transport	0.22	0.58	0.63	0.61	0.60	0.57	0.44	0.40	0.38	0.37	0.37	0.38	0.40	0.40	79.80
4. Other sectors	0.35	0.41	0.37	0.39	0.37	0.36	0.39	0.34	0.32	0.31	0.29	0.26	0.24	0.23	-33.82
5. Other	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	0.00
B. Fugitive emissions from fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
1. Solid fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
2. Oil and natural gas and other emissions from energy production	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
C. CO ₂ transport and storage															
2. Industrial processes	3.45	2.73	2.73	0.12	0.13	0.13	0.13	0.14	0.14	0.14	0.14	0.14	0.14	0.14	-95.96
A. Mineral industry															
B. Chemical industry	3.34	2.62	2.62	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
C. Metal industry															
D. Non-energy products from fuels and solvent use	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
E. Electronic industry															
F. Product uses as ODS substitutes															
G. Other product manufacture and use	0.11	0.11	0.11	0.12	0.13	0.13	0.13	0.14	0.14	0.14	0.14	0.14	0.14	0.14	32.22
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
3. Agriculture	23.64	24.87	24.58	22.98	22.18	21.55	21.53	21.33	21.91	20.58	20.92	22.19	21.98	22.10	-6.54
A. Enteric fermentation	1.61	1.69	1.71	1.74	1.71	1.68	1.69	1.67	1.62	1.60	1.68	1.69	1.68	1.70	5.43
B. Manure management															
C. Rice cultivation															
D. Agricultural soils	22.03	23.17	22.87	21.24	20.47	19.87	19.84	19.67	20.29	18.98	19.25	20.50	20.30	20.40	-7.41
E. Prescribed burning of savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
F. Field burning of agricultural residues	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
G. Liming															
H. Urea application															
I. Other carbon containing fertilizers															
J. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
4. Land use, land-use change and forestry	0.43	0.56	0.65	0.82	0.82	0.86	0.92	0.91	1.02	0.92	0.90	0.93	0.93	0.92	114.77
A. Forest land	0.31	0.40	0.46	0.51	0.52	0.53	0.54	0.55	0.57	0.57	0.57	0.58	0.58	0.59	88.14
B. Cropland	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-72.02
C. Grassland	0.00	0.01	0.05	0.05	0.05	0.05	0.05	0.05	0.04	0.05	0.06	0.05	0.05	0.05	1558.02
D. Wetlands	0.10	0.12	0.09	0.07	0.07	0.07	0.06	0.05	0.13	0.07	0.05	0.07	0.07	0.06	-43.12
E. Settlements	0.02	0.03	0.06	0.19	0.18	0.21	0.26	0.26	0.27	0.23	0.23	0.23	0.23	0.23	1120.86
F. Other land	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	69486.07
G. Harvested wood products															
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
5. Waste	0.32	0.32	0.36	0.41	0.41	0.41	0.42	0.43	0.43	0.43	0.43	0.43	0.43	0.43	32.67
A. Solid waste disposal															
B. Biological treatment of solid waste	NO	NO	NO	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	100.00
C. Incineration and open burning of waste	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-60.06
D. Waste water treatment and discharge	0.32	0.31	0.35	0.38	0.39	0.39	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	25.26
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
6. Other (as specified in summary 1.A)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Total direct N₂O emissions without N₂O from LULUCF	28.27	29.19	28.98	24.91	24.11	23.47	23.46	23.16	23.72	22.31	22.64	23.87	23.65	23.76	-15.96
Total direct N₂O emissions with N₂O from LULUCF	28.70	29.74	29.63	25.73	24.94	24.33	24.38	24.07	24.74	23.24	23.55	24.80	24.58	24.68	-14.00
Memo items:															
International bunkers	0.04	0.05	0.07	0.09	0.10	0.11	0.10	0.08	0.09	0.08	0.07	0.08	0.08	0.10	156.45
Aviation	0.04	0.04	0.06	0.08	0.09	0.10	0.09	0.07	0.08	0.07	0.06	0.07	0.07	0.08	130.08
Navigation	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	778.21
Multilateral operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
CO ₂ emissions from biomass															
CO ₂ captured															
Long-term storage of C in waste disposal sites															
Indirect N₂O	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NO,NE	NE,NO	0.00
Indirect CO₂ ⁽³⁾															

A1.5 HFCs, PFCs, SF₆ Emission Trends 1990, 1995, 2000, 2005-2015

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Change from base to latest reported year
															%
Emissions of HFCs and PFCs - (kt CO₂ equivalent)	1.35	200.80	854.42	894.79	1089.77	1074.01	981.90	998.72	978.60	971.04	958.16	1078.34	1156.13	1097.29	80949.20
Emissions of HFCs - (kt CO₂ equivalent)	1.23	103.19	456.66	678.41	898.82	905.91	845.77	915.09	932.02	955.16	948.61	1070.01	1152.57	1076.80	87154.19
HFC-23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	605.95
HFC-32	NO	NO	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.04	100.00
HFC-41	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-43-10mee	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-125	NO	NO	0.02	0.04	0.07	0.07	0.06	0.07	0.07	0.07	0.07	0.09	0.10	0.10	100.00
HFC-134	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-134a	0.00	0.07	0.20	0.22	0.24	0.24	0.26	0.27	0.28	0.28	0.28	0.29	0.30	0.29	64164.22
HFC-143	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-143a	NO	NO	0.01	0.04	0.06	0.06	0.05	0.05	0.05	0.06	0.06	0.07	0.07	0.06	100.00
HFC-152	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-152a	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	12433.97
HFC-161	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-227ea	NO	NO	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	100.00
HFC-236cb	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-236ea	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-236fa	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-245ca	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-245fa	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-365mfc	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Unspecified mix of HFCs ⁽⁴⁾ - (kt CO ₂ equivalent)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Emissions of PFCs - (kt CO₂ equivalent)	0.12	97.61	397.76	216.39	190.96	168.10	136.14	83.63	46.58	15.88	9.56	8.32	3.56	20.50	17013.94
CF ₄	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	67081.82
C ₂ F ₆	0.00	0.01	0.03	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	5125.00
C ₃ F ₈	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
C ₄ F ₁₀	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
c-C ₄ F ₈	NO	NO	NO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
C ₅ F ₁₂	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
C ₆ F ₁₄	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
C ₁₀ F ₁₈	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
c-C ₃ F ₆	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Unspecified mix of PFCs ⁽⁴⁾ - (kt CO ₂ equivalent)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Unspecified mix of HFCs and PFCs - (kt CO₂ equivalent)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Emissions of SF₆ - (kt CO₂ equivalent)	33.88	79.11	51.76	96.78	60.21	62.94	54.69	39.18	33.09	45.45	37.39	43.53	37.40	44.49	31.32
SF ₆	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	31.32
Emissions of NF₃ - (kt CO₂ equivalent)	NO	4.37	49.17	28.38	28.21	37.67	NO	NO	NO	NO	0.78	0.90	0.96	0.96	100.00
NF ₃	NO	0.00	0.00	0.00	0.00	0.00	NO	NO	NO	NO	0.00	0.00	0.00	0.00	100.00

A1.6 All Greenhouse Gas Summary Emission Trends 1990, 1995, 2000, 2005-2015

GREENHOUSE GAS EMISSIONS	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Change from base to latest reported year (%)
															(%)
CO ₂ emissions without net CO ₂ from LULUCF	32840.70	35793.19	45192.87	48027.69	47485.33	47576.06	47251.61	42068.72	41630.06	37964.95	38144.11	37122.84	36633.05	38392.84	16.91
CO ₂ emissions with net CO ₂ from LULUCF	38282.71	42028.68	50653.38	52682.33	52991.31	51786.65	50307.22	44578.72	45007.95	41444.76	42116.19	40795.22	40618.58	42060.01	9.87
CH ₄ emissions without CH ₄ from LULUCF	14803.41	14996.77	14292.22	13511.18	13461.84	12801.90	12604.12	12232.19	11980.58	11936.38	12235.71	12564.38	12881.41	13263.43	-10.40
CH ₄ emissions with CH ₄ from LULUCF	15029.97	15305.32	14576.59	13816.29	13785.81	13134.58	12947.89	12556.79	12470.17	12329.37	12569.97	12956.01	13260.76	13634.24	-9.29
N ₂ O emissions without N ₂ O from LULUCF	8423.42	8698.32	8635.21	7422.80	7185.86	6993.07	6990.47	6901.15	7069.57	6649.62	6747.88	7112.48	7048.96	7079.20	-15.96
N ₂ O emissions with N ₂ O from LULUCF	8551.76	8863.89	8828.94	7666.25	7430.88	7249.68	7265.63	7173.66	7372.05	6925.16	7016.60	7389.29	7324.65	7354.82	-14.00
HFCs	1.23	103.19	456.66	678.41	898.82	905.91	845.77	915.09	932.02	955.16	948.61	1070.01	1152.57	1076.80	87154.19
PFCs	0.12	97.61	397.76	216.39	190.96	168.10	136.14	83.63	46.58	15.88	9.56	8.32	3.56	20.50	17013.94
Unspecified mix of HFCs and PFCs	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
SF ₆	33.88	79.11	51.76	96.78	60.21	62.94	54.69	39.18	33.09	45.45	37.39	43.53	37.40	44.49	31.32
NF ₃	NO	4.37	49.17	28.38	28.21	37.67	NO	NO	NO	NO	0.78	0.90	0.96	0.96	100.00
Total (without LULUCF)	56102.77	59772.57	69075.66	69981.63	69311.22	68545.65	67882.79	62239.95	61691.90	57567.45	58124.04	57922.47	57757.92	59878.21	6.73
Total (with LULUCF)	61899.68	66482.17	75014.25	75184.82	75386.18	73345.53	71557.34	65347.07	65861.86	61715.79	62699.10	62263.30	62398.47	64191.82	3.70
Total (without LULUCF, with indirect)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
Total (with LULUCF, with indirect)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Change from base to latest reported year (%)
															(%)
1. Energy	31118.48	33893.13	42526.11	45648.81	45151.83	45115.23	45209.88	40742.36	40359.59	36871.72	36953.58	35724.96	34994.70	36541.63	17.43
2. Industrial processes and product use	3272.17	3273.64	4742.75	3769.00	3875.26	3927.37	3495.36	2678.21	2458.49	2332.39	2535.56	2576.73	3001.92	3135.31	-4.18
3. Agriculture	20144.82	20762.83	20295.16	19248.76	18932.99	18629.40	18464.63	18278.60	18349.23	17748.11	18094.93	18923.95	18882.49	19227.11	-4.56
4. Land use, land-use change and forestry ⁽⁵⁾	5796.91	6709.61	5938.59	5203.19	6074.96	4799.88	3674.55	3107.12	4169.96	4148.35	4575.06	4340.82	4640.56	4313.61	-25.59
5. Waste	1567.29	1842.96	1511.63	1315.05	1351.14	873.64	712.91	540.78	524.59	615.22	539.97	696.84	878.81	974.16	-37.84
6. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Total (including LULUCF)⁽⁵⁾	61899.68	66482.17	75014.25	75184.82	75386.18	73345.53	71557.34	65347.07	65861.86	61715.79	62699.10	62263.30	62398.47	64191.82	3.70

Annex A.2 Quality Assurance/Quality Control Plan

Version: 1.1

QA/QC Activities

Paul Duffy has overall responsibility for the coordination of the activities below.

The tables below provides details of the QA/QC activities 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.

QA/QC Activity Name	QA/QC Activity Description	Deadline	Note	Date completed	Trigger	Activity Type	Responsibility	Guidance, records and templates	Output & Link to output
General Inventory QA/QC Management Activities									
Review and update roles and responsibilities.	Definition and Maintenance of Terms of Reference for Responsibilities for inventory planning, preparation and management.	31 December	Has this been reviewed for 2013 submission?	30/12/2012	Beginning of inventory compilation cycle	Documentation	Paul Duffy	see Responsibilities	see "Responsibilities"
Review management practices	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 December	Update	30/12/2012	Update as necessary to track progress. Use as reference for consistent working practice	Procedure to follow	All, Paul Duffy, Emilia Hanley, Bernard Hyde	see Archiving & Data Management	See DataManagement
Implement and check implementation of QA/QC template for calculation sheets	Use of QA/QC forms for inventory spreadsheet tools and outputs & transparent documentation of inventory methodologies. Check that all spreadsheets have an up-to-date QA/QC sheet	31 December	Some calculation sheets need QA/QC updating.	30/12/2012	Creation of a new spreadsheet or update of methodology	Documentation	All, Paul Duffy, Emilia Hanley, Bernard Hyde	See QA/QC TemplateSheet	
Maintain master list of calculation sheets	List of calculation spreadsheets/tools & status monitor	31 December	Update	30/12/2012	Update as necessary to track progress	Documentation	All, Paul Duffy, Emilia Hanley, Bernard Hyde	See CalculationSheetsList	
Maintain Improvement Log/Plan	Development and maintenance of Inventory Improvement log & co-ordinate annual improvements	ongoing (amend/review as necessary)	Update	Ongoing	update as improvement needs or possibilities are identified	Documentation	Paul Duffy	See ImprovementPlan	
Training activities for staff	Development and maintenance of Training and Induction procedures and material	ongoing (amend/review as necessary)	Update, if possible	Ongoing	New Staff or new activities	Procedure to follow	All, Paul Duffy, Emilia Hanley, Bernard Hyde	see Training	
Periodic Peer Review	Periodic Peer Review	As needed	Update, if possible	Ongoing	New Methods developed or as needed.	Review	Paul Duffy	See log of planned and completed Peer reviews. See QA/QC sheets of calculation sheets.	
Verification Activities	Verification Activities	ongoing (amend/review as necessary)	Update, if possible	Ongoing	Identification of new data, inventories, measurements.	Review	Paul Duffy	See Verification	

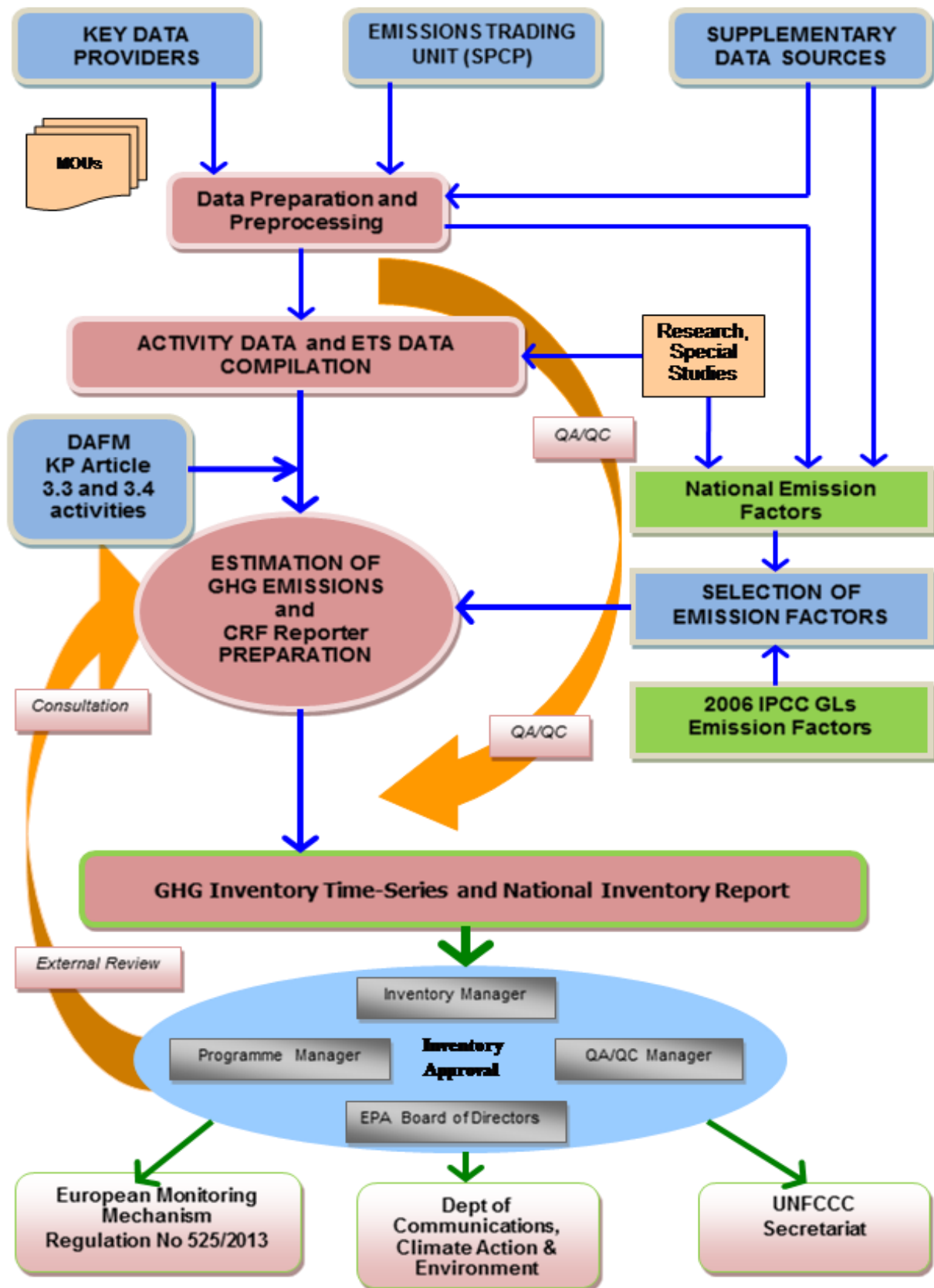
Annual QA/QC Activities: Lists the annual activities in order of appearance (Planning and Preparation Activities)									
General QA/QC									
Inventory planning, preparation and management review. Are procedures and guidelines in place for data quality review and checking on the inventory. Review the data quality objectives in the "DataQualityObjectives" sheet	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. Review data quality objectives and any issues with errors or lack of transparency in previous submission.	April		30/04/2013	Completion of previous inventory	Review	Paul Duffy	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	Review the data supplied last year and the data compilation needs this year. Check any new methods and/or plans for new/revised methods needing new data.	April		30/04/2013	Planning the annual inventory update	Review/Check	Paul Duffy	See ImprovementPlan	
Review the data supplied last year and the data compilation needs this year	Review the data supplied last year and the data compilation needs this year. Check for updates to reference sources of emission factors – IPCC, EMEP-CORINAIR, USEPA AP-42, National organisations / EFS	April		30/04/2013	Planning the annual inventory update	Review	Paul Duffy	See ImprovementPlan	
Planning review and agree on inventory improvements to be undertaken including timings and resources necessary	Planning review and agree on inventory improvements to be undertaken including timings and resources necessary.	April		30/04/2013	Planning the annual inventory update	Review	Paul Duffy	See ImprovementPlan	
Check all requests have been made.	Check all requests have been made. Review of previous year's raw data & key data suppliers and check that all requests for data have been made.	July		30/07/2013	Request annual data	Check	All, Paul Duffy, Emilia Hanley, Bernard Hyde	See Stakeholder List	Acceptance that all foreseen data sources are included
Archive source data.	Archive source data. As data arrives archive and reference for use in estimates. Update Stakeholder list with any updates to data received.	July/August		30/07/2013	Receipt of source data	Documentation	All, Paul Duffy, Emilia Hanley, Bernard Hyde		List of source data in this file
Check & Document Final Inventory;- transparent methods, data sources and assumptions	5) Check that transparent information is provided in the National Inventory Report (NIR) on methods, data sources & significant trends, completeness, accuracy and uncertainty and changes to the inventory and that notation keys, as indicated in UNFCCC guidelines, and appropriate source sector breakdowns are used for reporting data in the CRF.	November			Finished all Sector Calculations	Check	Paul Duffy		Checking cells & Checking summary in spreadsheets
Check & Document Final Inventory;- consistency	6) Check that there is consistency between the CRF and NIR (on completion of the NIR)	November			Finished all Sector Calculations	Check	Paul Duffy		Checking cells & Checking summary in spreadsheets
Official review of the Final Inventory;- Review	Review by stakeholders co-ordinated by OCLR prior to submission.	November			Finished all Sector Calculations	Review	Paul Duffy	See Stakeholder List	Checking cells & Checking summary in spreadsheets
Official review of the Final Inventory;- documentation of changes	Document Changes in the NIR Sectoral chapters: Compile a concise list of changes and overview of the reasons/justification and the impacts on National totals for chapter 10 of the NIR.	December			Annual inventory finalised	Documentation	Paul Duffy	Sector by Sector report for significant inventory changes + description in NIR	Checking cells & Checking summary in spreadsheets
Official review of the Final Inventory;- Checking reporting tables	Check Reporting tables	January +1			Compiled reporting tables	Check	All, Paul Duffy, Emilia Hanley, Bernard Hyde	Include annotated checking cells in reported sheets or in checking sheets linked to reporting sheets	Checking cells & Checking summary in spreadsheets
Review and update QA/QC Plan & procedures	QA/QC Coordinator annually compiles and updates an overview of QA/QC procedures	March +1			Annual inventory finalised	Documentation	Paul Duffy	see QA-QC overview	Year-specific overview document
Archiving	Archiving inventory material	March +1			Inventory Reported	Documentation/ Archiving	All, Paul Duffy, Emilia Hanley, Bernard Hyde	see Archiving & Data Management	

Sector Specific QA/QC: Documentation to be included in individual calculation and data source checking sheets of the current inventory.									
Check source data received:- vs Last year	Are the numbers similar to last year:- If not, Look for reasons as to why they should be different. Check with data supplier	August			Receipt of annual data update	Check	Paul Duffy-Energy, Bernard Hyde-Agriculture	See individual calculation sheets	Checking cells & Checking summary in spreadsheets
Check source data received:- Units	Are the activity consistent with last years or the EFs used:- If not, Convert units	August			Receipt of annual data update	Check	Paul Duffy-Energy, Bernard Hyde-Agriculture	See individual calculation sheets	Checking cells & Checking summary in spreadsheets
Check source data received:- Geographic Coverage	Does the data represent the National activity:- If not, Need additional data or data to aggregate up	August			Receipt of annual data update	Check	Paul Duffy-Energy, Bernard Hyde-Agriculture	See individual calculation sheets	Checking cells & Checking summary in spreadsheets
Check source data received:- Sector Coverage	Are all the required sectors included (Do the numbers include the same sectors as last year):- If not, Discuss with data source getting the same sectors included or consider revising the methodology (this will need to be done for the full timeseries)	August			Receipt of annual data update	Check	Paul Duffy-Energy, Bernard Hyde-Agriculture	See individual calculation sheets	Checking cells & Checking summary in spreadsheets
Check source data received:- Sector Detail	Is the necessary sector detail included (Is there the same detail as last year):- If not, Ask the data source for the required detail or consider revising the methodology (This will need to be done for the full timeseries)	August			Receipt of annual data update	Check	Paul Duffy-Energy, Bernard Hyde-Agriculture	See individual calculation sheets	Checking cells & Checking summary in spreadsheets
Check source data received:- Data Source Reliability	Check about bias in the data. Is the data likely to have a deliberate or incidental bias (e.g. is survey/EF data representative of national average):- If not, Discuss with data source methods to estimate a national average.	August			Receipt of annual data update	Check	Paul Duffy-Energy, Bernard Hyde-Agriculture	See individual calculation sheets	Checking cells & Checking summary in spreadsheets
Check source data received:- Reality Checking	Do the numbers make sense when compared with other data or common sense (i.e. do they look realistic, do energy values compare with published data for the same group of sectors or fuels):- If not, Ask the data source to confirm or clarify the numbers	August			Receipt of annual data update	Check	Paul Duffy-Energy, Bernard Hyde-Agriculture	See individual calculation sheets	Checking cells & Checking summary in spreadsheets
Check source data received:- Transparency	Is sufficient documentation (enabling a full understanding of the source and assumptions associated with the data) available and archived in the inventory archive:- If not, Ask the data supplier for further clarification	August			Receipt of annual data update	Check	Paul Duffy-Energy, Bernard Hyde-Agriculture	See individual calculation sheets	Checking cells & Checking summary in spreadsheets
Check source data received:- Timeseries	are numbers for previous years in any timeseries of data supplied the same as was used in last years inventory:- If not, revise the timeseries data were revised by the data source	August			Receipt of annual data update	Check	Paul Duffy-Energy, Bernard Hyde-Agriculture	See individual calculation sheets	Checking cells & Checking summary in spreadsheets
Check source data received:- Tier 3 fuel combustion categories	Cross check sum of site based fuel use is consistent with energy statistics by fuel type :- If not, Are there sites missing or a sector miss match between the point source based definition and the national statistics	August			Receipt of annual data update	Check	Paul Duffy-Energy, Bernard Hyde-Agriculture	See individual calculation sheets	Checking cells & Checking summary in spreadsheets
Check source data received:- Tier 3 timeseries consistency	Check reported emissions against last year are broadly consistent:- If not, check emission units and reported data for both years for errors or inconsistencies	August			Receipt of annual data update	Check	Paul Duffy-Energy, Bernard Hyde-Agriculture	See individual calculation sheets	Checking cells & Checking summary in spreadsheets
Check source data received:- Check against independent AD	e.g. for road vehicles cross check vehicle KM derived fuel consumption vs Energy consumption data are broadly consistent:- If not, Ensure road transport energy consumption data does not include off road fuel use. Check assumptions on fuel consumption per vehkm.	August			Receipt of annual data update	Check	Paul Duffy-Energy, Bernard Hyde-Agriculture	See individual calculation sheets	Checking cells & Checking summary in spreadsheets
Check Calculations:- Formulae & Sensible results	Are formulae working correctly, calculations producing sensible & logical results. Can a sample of the calculations be reproduced:- If not, Query with compiler & fix or document further	November			Finished Sector Calculations	Check	P.Duffy check B.Hyde, Bernard Hyde check E.Hanley, E.Hanley check Paul Duffy	See individual calculation sheets	Checking cells & Checking summary in spreadsheets
Check Calculations:- Units	Are emission units correct. Have activity and emission factor units been used correctly. Are units labeled in calculation sheets:- If not, Get further clarification from the compiler and amend calculations and annotations.	November			Finished Sector Calculations	Check	P.Duffy check B.Hyde, Bernard Hyde check E.Hanley, E.Hanley check Paul Duffy	See individual calculation sheets	Checking cells & Checking summary in spreadsheets
Check Calculations:- Assumptions and Transparency	Are all assumptions sensible and the transparency of calculations clear (e.g. use of formulas, no paste values, referencing of data sources). Check bibliographical references are correct and up-to-date:- If not, Get further clarification from the compiler	November			Finished Sector Calculations	Check	P.Duffy check B.Hyde, Bernard Hyde check E.Hanley, E.Hanley check Paul Duffy	See individual calculation sheets	Checking cells & Checking summary in spreadsheets
Check Calculations:- Coverage	Have all sectors been included for which there is input data. Is the inventory complete?:- If not, Get all sectors included	November			Finished Sector Calculations	Check	P.Duffy check B.Hyde, Bernard Hyde check E.Hanley, E.Hanley check Paul Duffy	See individual calculation sheets	Checking cells & Checking summary in spreadsheets

Check & Document Final Inventory;- completeness	3) Check that all sources are included (compare totals with last year's totals)	November			Finished all Sector Calculations	Check	Paul Duffy	See individual calculation sheets	Checking cells & Checking summary in spreadsheets
Check & Document Final Inventory;- categorisation	4) Check that the detailed sectors are aggregated to the right aggregation sectors.	November			Finished all Sector Calculations	Check	Paul Duffy	See individual calculation sheets	Checking cells & Checking summary in spreadsheets
Check Calculations:- Consistency	Are all emission factors used up-to-date and consistent across the timeseries:- If not, Update with more recent emission factors	November			Finished Sector Calculations	Check	P.Duffy check B.Hyde, Bernard Hyde check E.Hanley, E.Hanley check Paul Duffy	See individual calculation sheets	Checking cells & Checking summary in spreadsheets
Check & Document Final Inventory;- timeseries	2) Check for significant dips and jumps in the timeseries and document the reasons in chapter 2 of the NIR.	November			Finished all Sector Calculations	Check	Paul Duffy	See individual calculation sheets	Chapter 2 of the NIR and checking cells & Checking summary in spreadsheets
See individual calculation sheets for additional sector specific QA/QC.								See individual calculation sheets	
Document calculations, assumptions, data used and checks made.	Documentation of methods, data sources, assumptions and QA/QC for calculations in individual calculation spreadsheets.	September/October			Make Calculations: (Update or compile new estimates)	Documentation	All, Paul Duffy, Emilia Hanley, Bernard Hyde	QA-QC Template Sheet	Spreadsheet annotations and documentation

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		Annual activity Complete for 2009 Inventory	New /Un-peer reviewed Key Category methodology or new source estimate	Review of new Road Transport Model COPERT 4 for 1990-2006.	Eimear Cotter	see PeriodicPeerReview	
Inform data users, issue revision, make note to prevent error next year	Special		QA/QC Under Development	Errors found in published data	Procedure to follow	Paul Duffy	Keep records of errors, and inform users	
Institutional QA/QC audits (e.g. ISO 9001 2000)	Periodically		Not Started	Organisation audit	Review	Paul Duffy	Keep records of audits, dates, personnel and findings	
Government Audits	Periodically		Not Started	National Audits	Review	Paul Duffy	Keep records of audits, dates, personnel and findings	

Annex A.3 Institutional Arrangements for Compilation of Emissions Inventories



Annex A.4 Greenhouse Gas Inventory Key Category Analysis 2015

A.4.1 Key Category Analysis Level Assessment 1990 (excluding LULUCF)

A.4.2 Key Category Analysis Level Assessment 2015 (excluding LULUCF)

A.4.3 Key Category Analysis Level Assessment 1990 (including LULUCF)

A.4.4 Key Category Analysis Level Assessment 2015 (including LULUCF)

A.4.5 Key Category Analysis Trend Assessment 1990-2015 (excluding LULUCF)

A.4.6 Key Category Analysis Trend Assessment 1990-2015 (including LULUCF)

A.4.1 Key Category Analysis Level Assessment 1990 (excluding LULUCF)

Ranking	IPCC Sub-category	Emission Source / Activity	Direct GHG	1990 Emissions exclud. LULUCF (kt CO ₂ eq)	1990 Level assessment exclud. LULUCF (%)	Cumulative Total (%)
1	3.A.1	Enteric Fermentation - Non-Dairy Cattle	CH ₄	6,702.59	11.95	11.95
2	3.D.1	Agricultural Soils - Direct Soil Emissions	N ₂ O	6,027.77	10.78	22.72
3	1.A.1	Energy Industries - Solid Fuels	CO ₂	4,844.66	8.64	31.36
4	1.A.3.b	Road Transport - Liquid Fuels	CO ₂	4,690.42	8.36	39.72
5	3.A.1	Enteric Fermentation - Dairy Cattle	CH ₄	3,398.80	6.06	45.78
6	1.A.1	Energy Industries - Peat Fuel	CO ₂	3,164.78	5.64	51.42
7	1.A.4.b	Residential - Peat Fuel	CO ₂	3,123.37	5.57	56.98
8	1.A.4.b	Residential - Solid Fuels	CO ₂	2,483.42	4.43	61.41
9	1.A.2	Manufacturing Industries & Construction - Liquid Fuels	CO ₂	2,198.38	3.92	65.33
10	1.A.1	Energy Industries - Gaseous Fuels	CO ₂	1,880.66	3.35	68.68
11	1.A.4.a	Commercial/Institutional - Liquid Fuels	CO ₂	1,870.07	3.33	72.02
12	5.A	Solid Waste Disposal	CH ₄	1,396.49	2.35	74.36
13	1.A.1	Energy Industries - Liquid Fuels	CO ₂	1,254.90	2.24	76.60
14	3.A.2	Enteric Fermentation - Sheep	CH ₄	1,176.34	2.10	78.70
15	1.A.4.b	Residential - Liquid Fuels	CO ₂	1,175.35	2.09	80.79
16	2.B.2	Chemical Industry - Nitric Acid Production	N ₂ O	995.32	1.77	82.57
17	2.B.1	Chemical Industry - Ammonia Production	CO ₂	990.23	1.77	84.33
18	2.A.1	Cement Production	CO ₂	884.00	1.58	85.91
19	1.A.2	Manufacturing Industries & Construction - Gaseous Fuels	CO ₂	873.02	1.56	87.46
20	1.A.2	Manufacturing Industries & Construction - Solid Fuels	CO ₂	871.24	1.55	89.02
21	1.A.4.c	Agriculture/Fishing - Liquid Fuels	CO ₂	747.23	1.33	90.35
22	3.B.1.1	Manure Management - Non-Dairy Cattle	CH ₄	684.58	1.22	91.57

23	3.D.2	Agricultural Soils - Indirect Soil Emissions	N ₂ O	519.52	0.93	92.50
24	3.G.1	Liming - Limestone CaCO ₃	CO ₂	355.04	0.63	93.13
25	3.B.1.1	Manure Management - Dairy Cattle	CH ₄	354.22	0.63	93.76
26	1.A.4.b	Residential - Gaseous Fuels	CO ₂	269.73	0.48	94.24
27	1.A.4.b	Residential - Peat Fuel	CH ₄	227.65	0.41	94.65
28	1.A.4.a	Commercial/Institutional - Gaseous Fuels	CO ₂	223.49	0.40	95.05

A.4.2 Key Category Analysis Level Assessment 2015 (excluding LULUCF)

Ranking	IPCC Sub-category	Emission Source / Activity	Direct GHG	2015 Emissions excl. LULUCF (kt CO ₂ eq)	2015 Level assessment excl. LULUCF (%)	Cumulative Total (%)
1	1.A.3.b	Road Transport - Liquid Fuels	CO ₂	11,211.61	18.72	18.72
2	3.A.1	Enteric Fermentation - Non-Dairy Cattle	CH ₄	6,562.02	10.96	29.68
3	3.D.1	Agricultural Soils - Direct Soil Emissions	N ₂ O	5,595.69	9.35	39.03
4	1.A.1	Energy Industries - Solid Fuels	CO ₂	4,359.07	7.28	46.31
5	1.A.1	Energy Industries - Gaseous Fuels	CO ₂	3,888.85	6.49	52.80
6	3.A.1	Enteric Fermentation - Dairy Cattle	CH ₄	3,594.58	6.00	58.81
7	1.A.4.b	Residential - Liquid Fuels	CO ₂	2,862.94	4.78	63.59
8	1.A.1	Energy Industries - Peat Fuel	CO ₂	2,708.33	4.52	68.11
9	1.A.2	Manufacturing Industries & Construction - Gaseous Fuels	CO ₂	2,462.16	4.11	72.22
10	2.A.1	Cement Production	CO ₂	1,652.01	2.76	74.98
11	1.A.2	Manufacturing Industries & Construction - Liquid Fuels	CO ₂	1,491.12	2.49	77.47
12	1.A.4.b	Refrigeration and air-con (incl. MAC)	CO ₂	1,322.71	2.21	79.68
13	1.A.4.a	Commercial/Institutional - Gaseous Fuels	CO ₂	982.94	1.64	81.32
14	2.F.1	Product Uses as Substitutes for ODS -Refrigeration and air-con (incl. MAC)	HFC	909.62	1.52	82.84
15	1.A.4.b	Residential - Peat Fuel	CO ₂	857.79	1.43	84.27
16	1.A.4.b	Residential - Solid Fuels	CO ₂	830.63	1.39	85.66
17	1.A.4.a	Commercial/Institutional - Liquid Fuels	CO ₂	744.79	1.24	86.90
18	5.A	Solid Waste Disposal	CH ₄	741.41	1.24	88.14
19	3.A.2	Enteric Fermentation - Sheep	CH ₄	683.11	1.14	89.28

20	3.B.1.1	Manure Management - Non-Dairy Cattle	CH ₄	626.21	1.05	90.33
21	1.A.1	Energy Industries - Liquid Fuels	CO ₂	588.39	0.98	91.31
22	1.A.4.c	Agriculture/Fishing - Liquid Fuels	CO ₂	529.84	0.88	92.20
23	3.D.2	Agricultural Soils - Indirect Soil Emissions	N ₂ O	483.83	0.81	93.00
24	1.A.2	Manufacturing Industries & Construction - Solid Fuels	CO ₂	420.72	0.70	93.71
25	3.G.1	Liming - Limestone CaCO ₃	CO ₂	392.51	0.66	94.36
26	3.B.1.1	Manure Management - Dairy Cattle	CH ₄	326.45	0.55	94.91
27	1.A.3.d	Navigation - Liquid Fuels	CO ₂	219.43	0.37	95.27

A.4.3 Key Category Analysis Level Assessment 1990 (including LULUCF)

Ranking	IPCC Sub-category	Emission Source / Activity	Direct GHG	1990 Emissions excl. LULUCF (kt CO ₂ eq)	1990 Emissions for LULUCF (kt CO ₂ eq)	Absolute Values (kt CO ₂ eq)	1990 Level assessment incl. LULUCF (%)	Cumulative Total (%)
1	3.A.1	Enteric Fermentation - Non-Dairy Cattle	CH ₄	6,702.59	0.00	6,702.59	9.83	9.83
2	4.C.1	LULUCF - Grassland Remaining Grassland	CO ₂	0.00	6,666.38	6,666.38	9.78	19.61
3	3.D.1	Agricultural Soils - Direct Soil Emissions	N ₂ O	6,045.30	0.00	6,045.30	8.87	28.48
4	1.A.1	Energy Industries - Solid Fuels	CO ₂	4,844.66	0.00	4,844.66	7.11	35.59
5	1.A.3.b	Road Transport - Liquid Fuels	CO ₂	4,690.42	0.00	4,690.42	6.88	42.47
6	3.A.1	Enteric Fermentation - Dairy Cattle	CH ₄	3,398.80	0.00	3,398.80	4.99	47.45
7	1.A.1	Energy Industries - Peat Fuel	CO ₂	3,164.78	0.00	3,164.78	4.64	52.10
8	1.A.4.b	Residential - Peat Fuel	CO ₂	3,123.37	0.00	3,123.37	4.58	56.68
9	4.A.1	LULUCF - Forest land Remaining Forest Land	CO ₂	0.00	-2,719.66	2,719.66	3.99	60.67
10	1.A.4.b	Residential - Solid Fuels	CO ₂	2,483.42	0.00	2,483.42	3.64	64.31
11	1.A.2	Manufacturing Industries & Construction - Liquid Fuels	CO ₂	2,198.38	0.00	2,198.38	3.23	67.54
12	1.A.1	Energy Industries - Gaseous Fuels	CO ₂	1,880.66	0.00	1,880.66	2.76	70.30
13	1.A.4.a	Commercial/Institutional - Liquid Fuels	CO ₂	1,870.07	0.00	1,870.07	2.74	73.04
14	4.D.1	LULUCF - Wetlands Remaining wetlands	CO ₂	0.00	1,355.83	1,355.83	1.99	75.03
15	5.A	Solid Waste Disposal	CH ₄	1,318.08	0.00	1,318.08	1.93	76.96
16	1.A.1	Energy Industries - Liquid Fuels	CO ₂	1,254.90	0.00	1,254.90	1.84	78.80
17	3.A.2	Enteric Fermentation - Sheep	CH ₄	1,176.34	0.00	1,176.34	1.73	80.53
18	1.A.4.b	Residential - Liquid Fuels	CO ₂	1,175.34	0.00	1,175.34	1.72	82.25
19	2.B.2	Chemical Industry - Nitric Acid Production	N ₂ O	995.32	0.00	995.32	1.46	83.71
20	2.B.1	Chemical Industry - Ammonia Production	CO ₂	990.23	0.00	990.23	1.45	85.17
21	2.A.1	Cement Production	CO ₂	884.00	0.00	884.00	1.30	86.46

22	1.A.2	Manufacturing Industries & Construction - Gaseous Fuels	CO ₂	873.02	0.00	873.02	1.28	87.74
23	1.A.2	Manufacturing Industries & Construction - Solid Fuels	CO ₂	871.24	0.00	871.24	1.28	89.02
24	1.A.4.c	Agriculture/Fishing - Liquid Fuels	CO ₂	747.23	0.00	747.23	1.10	90.12
25	3.B.1.1	Manure Management - Non-Dairy Cattle	CH ₄	684.58	0.00	684.58	1.00	91.12
26	3.D.2	Agricultural Soils - Indirect Soil Emissions	N ₂ O	521.06	0.00	521.06	0.76	91.89
27	4.G	LULUCF - Harvested wood products	CO ₂	0.00	-413.54	413.54	0.61	92.49
28	4.C	LULUCF - Drained organic soils from other grasslands	CO ₂	0.00	382.68	382.68	0.56	93.05
29	3.G.1	Liming - Limestone CaCO ₃	CO ₂	355.04	0.00	355.04	0.52	93.58
30	3.B.1.1	Manure Management - Dairy Cattle	CH ₄	354.22	0.00	354.22	0.52	94.10
31	1.A.4.b	Residential - Gaseous Fuels	CO ₂	269.73	0.00	269.73	0.40	94.49
32	1.A.4.b	Residential - Peat Fuel	CH ₄	227.65	0.00	227.65	0.33	94.83
33	1.A.4.a	Commercial/Institutional - Gaseous Fuels	CO ₂	223.49	0.00	223.49	0.33	95.15

A.4.4 Key Category Analysis Level Assessment 2015 (including LULUCF)

Ranking	IPCC Sub-category	Emission Source / Activity	Direct GHG	2015 Emissions excl. LULUCF (kt CO ₂ eq)	2015 Emissions for LULUCF (kt CO ₂ eq)	Absolute Values (kt CO ₂ eq)	2015 Level assessment incl. LULUCF (%)	Cumulative Total (%)
1	1.A.3.b	Road Transport - Liquid Fuels	CO ₂	11,211.61	0.00	11,211.61	15.27	15.27
2	3.A.1	Enteric Fermentation - Non-Dairy Cattle	CH ₄	6,562.02	0.00	6,562.02	8.94	24.21
3	3.D.1	Agricultural Soils - Direct Soil Emissions	N ₂ O	5,595.69	0.00	5,595.69	7.62	31.84
4	4.C.1	LULUCF - Grassland Remaining Grassland	CO ₂	0.00	5,309.83	5,309.83	7.23	39.07
5	1.A.1	Energy Industries - Solid Fuels	CO ₂	4,359.07	0.00	4,359.07	5.94	45.01
6	1.A.1	Energy Industries - Gaseous Fuels	CO ₂	3,888.85	0.00	3,888.85	5.30	50.31
7	4.A.2	LULUCF - Land Converted to Forest Land	CO ₂	0.00	-3,685.59	3,685.59	5.02	55.33
8	3.A.1	Enteric Fermentation - Dairy Cattle	CH ₄	3,594.58	0.00	3,594.58	4.90	60.23
9	1.A.4.b	Residential - Liquid Fuels	CO ₂	2,862.94	0.00	2,862.94	3.90	64.13
10	1.A.1	Energy Industries - Peat Fuel	CO ₂	2,708.33	0.00	2,708.33	3.69	67.82
11	1.A.2	Manufacturing Industries & Construction - Gaseous Fuels	CO ₂	2,462.16	0.00	2,462.16	3.35	71.17
12	4.D.1	LULUCF - Wetlands Remaining wetlands	CO ₂	0.00	2,394.18	2,394.18	3.26	74.43
13	2.A.1	Cement Production	CO ₂	1,652.01	0.00	1,652.01	2.25	76.68
14	1.A.2	Refrigeration and air-con (incl. MAC)	CO ₂	1,491.12	0.00	1,491.12	2.03	78.71
15	1.A.4.b	Residential - Gaseous Fuels	CO ₂	1,322.71	0.00	1,322.71	1.80	80.52
16	1.A.4.a	Commercial/Institutional - Gaseous Fuels	CO ₂	982.94	0.00	982.94	1.34	81.86
17	2.F.1	Product Uses as Substitutes for ODS -Refrigeration and air-con (incl. MAC)	HFC	909.62	0.00	909.62	1.24	83.09
18	1.A.4.b	Residential - Peat Fuel	CO ₂	857.79	0.00	857.79	1.17	84.26
19	1.A.4.b	Residential - Solid Fuels	CO ₂	830.63	0.00	830.63	1.13	85.39
20	1.A.4.a	Commercial/Institutional - Liquid Fuels	CO ₂	744.79	0.00	744.79	1.01	86.41
21	5.A	Solid Waste Disposal	CH ₄	741.41	0.00	741.41	1.01	87.42
22	4.G	LULUCF - Harvested wood products	CO ₂	0.00	-731.46	731.46	1.00	88.42
23	3.A.2	Enteric Fermentation - Sheep	CH ₄	683.11	0.00	683.11	0.93	89.35

24	3.B.1.1	Manure Management - Non-Dairy Cattle	CH ₄	626.21	0.00	626.21	0.85	90.20
25	1.A.1	Energy Industries - Liquid Fuels	CO ₂	588.39	0.00	588.39	0.80	91.00
26	1.A.4.c	Agriculture/Fishing - Liquid Fuels	CO ₂	529.84	0.00	529.84	0.72	91.72
27	3.D.2	Agricultural Soils - Indirect Soil Emissions	N ₂ O	483.83	0.00	483.83	0.66	92.38
28	1.A.2	Manufacturing Industries & Construction - Solid Fuels	CO ₂	420.72	0.00	420.72	0.57	92.96
29	3.G.1	Liming - Limestone CaCO ₃	CO ₂	392.51	0.00	392.51	0.53	93.49
30	3.B.1.1	Manure Management - Dairy Cattle	CH ₄	326.45	0.00	326.45	0.44	93.94
31	4.C	LULUCF - Drained organic soils from other grasslands	CO ₂	0.00	317.70	317.70	0.43	94.37
32	1.A.3.d	Navigation - Liquid Fuels	CO ₂	219.43	0.00	219.43	0.30	94.67
33	3.B.2.5	Manure Management - Indirect N ₂ O emissions	N ₂ O	213.23	0.00	213.23	0.29	94.96
34	3.B.2.1	Manure Management - Non-Dairy Cattle	N ₂ O	212.22	0.00	212.22	0.29	95.25

A.4.5 Key Category Analysis Trend Assessment 1990-2015 (excluding LULUCF)

Ranking	IPCC Sub-category	Emission Source / Activity	Direct GHG	1990 Emissions excl. LULUCF (kt CO ₂ eq)	2015 Emissions excl. LULUCF (kt CO ₂ eq)	2015 Level assessment excl. LULUCF (%)	2015 Trend assessment excl. LULUCF (%)	Contribution to Trend (%)	Cumulative Total (%)
1	1.A.3.b	Road Transport - Liquid Fuels	CO ₂	4690.42	11211.61	18.73	9.71	21.50	21.50
2	1.A.4.b	Residential - Peat Fuel	CO ₂	3123.37	857.79	1.43	3.87	8.58	30.08
3	1.A.1	Energy Industries - Gaseous Fuels	CO ₂	1880.66	3888.85	6.49	2.94	6.52	36.60
4	1.A.4.b	Residential - Solid Fuels	CO ₂	2483.42	830.63	1.39	2.85	6.31	42.91
5	1.A.4.b	Residential - Liquid Fuels	CO ₂	1175.34	2862.94	4.78	2.52	5.57	48.48
6	1.A.2	Manufacturing Industries & Construction - Gaseous Fuels	CO ₂	873.02	2462.16	4.11	2.39	5.30	53.78
7	1.A.4.a	Commercial/Institutional - Liquid Fuels	CO ₂	1870.07	744.79	1.24	1.96	4.34	58.12
8	1.A.4.b	Residential - Gaseous Fuels	CO ₂	269.73	1322.71	2.21	1.62	3.59	61.70
9	2.F.1	Refrigeration and air-con (incl. MAC)	HFC	0.00	909.62	1.52	1.42	3.15	64.86
10	3.D.1	Agricultural Soils - Direct Soil Emissions	N ₂ O	6045.30	5595.69	9.35	1.34	2.97	67.82
11	1.A.2	Manufacturing Industries & Construction - Liquid Fuels	CO ₂	2198.38	1491.12	2.49	1.34	2.96	70.79
12	1.A.1	Energy Industries - Solid Fuels	CO ₂	4844.66	4359.07	7.28	1.27	2.81	73.60
13	1.A.1	Energy Industries - Liquid Fuels	CO ₂	1254.90	588.39	0.98	1.18	2.60	76.20
14	1.A.4.a	Commercial/Institutional - Gaseous Fuels	CO ₂	223.49	982.94	1.64	1.16	2.58	78.78

15	2.A.1	Cement Production	CO ₂	884.00	1652.01	2.76	1.11	2.46	81.23
16	1.A.1	Energy Industries - Peat Fuel	CO ₂	3164.78	2708.33	4.52	1.05	2.32	83.55
17	5.A	Solid Waste Disposal	CH ₄	1318.08	741.41	1.24	1.04	2.31	85.86
18	3.A.1	Enteric Fermentation - Non-Dairy Cattle	CH ₄	6702.59	6562.02	10.96	0.93	2.05	87.91
19	3.A.2	Enteric Fermentation - Sheep	CH ₄	1176.34	683.11	1.14	0.90	1.98	89.89
20	1.A.2	Manufacturing Industries & Construction - Solid Fuels	CO ₂	871.24	420.72	0.70	0.80	1.76	91.66
21	1.A.4.c	Agriculture/Fishing - Liquid Fuels	CO ₂	747.23	529.84	0.88	0.42	0.93	92.58
22	1.A.4.b	Residential - Peat Fuel	CH ₄	227.65	62.99	0.11	0.28	0.62	93.21
23	1.A.2	Manufacturing Industries & Construction - Non-Renewable waste	CO ₂	0.00	147.66	0.25	0.23	0.51	93.72
24	1.A.4.b	Residential - Solid Fuels	CH ₄	196.51	64.75	0.11	0.23	0.50	94.22
25	1.B.2.b	Fugitive emissions - Natural gas	CH ₄	156.05	22.82	0.04	0.22	0.50	94.72
26	2.F.4	Product Uses as Substitutes for ODS -Aerosols (incl. MDIs)	HFC	0.64	130.91	0.22	0.20	0.45	95.17

A.4.6 Key Category Analysis Trend Assessment 1990-2015 (including LULUCF)

Ranking	IPCC Sub-category	Emission Source / Activity	Direct GHG	1990 Emissions incl. LULUCF (kt CO ₂ eq)	2015 Emissions incl. LULUCF (kt CO ₂ eq)	2015 Level assessment incl. LULUCF (%)	2015 Trend assessment incl. LULUCF (%)	Contribution to Trend (%)	Cumulative Total (%)
1	1.A.3.b	Road Transport - Liquid Fuels	CO ₂	4690.42	11211.61	15.27	7.79	15.62	15.62
2	4.A.2	LULUCF - Land Converted to Forest Land	CO ₂	27.26	3685.59	5.02	4.63	9.27	24.89
3	4.A.1	LULUCF - Forest land Remaining Forest Land	CO ₂	2719.66	134.68	0.18	3.53	7.08	31.97
4	1.A.4.b	Residential - Peat Fuel	CO ₂	3123.37	857.79	1.17	3.17	6.35	38.33
5	4.C.1	LULUCF - Grassland Remaining Grassland	CO ₂	6666.38	5309.83	7.23	2.36	4.74	43.06
6	1.A.1	Energy Industries - Gaseous Fuels	CO ₂	1880.66	3888.85	5.30	2.36	4.73	47.79
7	1.A.4.b	Residential - Solid Fuels	CO ₂	2483.42	830.63	1.13	2.33	4.67	52.46
8	1.A.4.b	Residential - Liquid Fuels	CO ₂	1175.34	2862.94	3.90	2.02	4.05	56.51
9	1.A.2	Manufacturing Industries & Construction - Gaseous Fuels	CO ₂	873.02	2462.16	3.35	1.93	3.86	60.37
10	1.A.4.a	Commercial/Institutional - Liquid Fuels	CO ₂	1870.07	744.79	1.01	1.61	3.22	63.59
11	1.A.4.b	Residential - Gaseous Fuels	CO ₂	269.73	1322.71	1.80	1.31	2.62	66.21
12	4.D.1	LULUCF - Wetlands Remaining wetlands	CO ₂	1355.83	2394.18	3.26	1.18	2.37	68.57
13	3.D.1	Refrigeration and air-con (incl. MAC)	N ₂ O	6045.30	5595.69	7.62	1.16	2.32	70.89
14	2.F.1	Product Uses as Substitutes for ODS -Refrigeration and air-con (incl. MAC)	HFC	0.00	909.62	1.24	1.15	2.31	73.20
15	1.A.2	Manufacturing Industries & Construction - Liquid Fuels	CO ₂	2198.38	1491.12	2.03	1.11	2.22	75.42
16	1.A.1	Energy Industries - Solid Fuels	CO ₂	4844.66	4359.07	5.94	1.09	2.17	77.59

17	1.A.1	Energy Industries - Liquid Fuels	CO ₂	1254.90	588.39	0.80	0.97	1.93	79.53
18	1.A.4.a	Commercial/Institutional - Gaseous Fuels	CO ₂	223.49	982.94	1.34	0.94	1.88	81.41
19	2.A.1	Cement Production	CO ₂	884.00	1652.01	2.25	0.89	1.78	83.18
20	1.A.1	Energy Industries - Peat Fuel	CO ₂	3164.78	2708.33	3.69	0.89	1.77	84.96
21	5.A	Solid Waste Disposal	CH ₄	1318.08	741.41	1.01	0.86	1.72	86.68
22	3.A.1	Enteric Fermentation - Non-Dairy Cattle	CH ₄	6702.59	6562.02	8.94	0.83	1.66	88.34
23	3.A.2	Enteric Fermentation - Sheep	CH ₄	1176.34	683.11	0.93	0.74	1.48	89.82
24	1.A.2	Manufacturing Industries & Construction - Solid Fuels	CO ₂	871.24	420.72	0.57	0.65	1.31	91.13
25	4.G	LULUCF - Harvested wood products	CO ₂	413.54	731.46	1.00	0.36	0.73	91.86
26	1.A.4.c	Agriculture/Fishing - Liquid Fuels	CO ₂	747.23	529.84	0.72	0.35	0.70	92.55
27	4.C	LULUCF - Drained organic soils from rewetted organic soils	CH ₄	0.00	196.64	0.27	0.25	0.50	93.05
28	1.A.4.b	Residential - Peat Fuel	CH ₄	227.65	62.99	0.09	0.23	0.46	93.51
29	1.A.2	Manufacturing Industries & Construction - Non-Renewable waste	CO ₂	0.00	147.66	0.20	0.19	0.37	93.89
30	1.A.4.b	Residential - Solid Fuels	CH ₄	196.51	64.75	0.09	0.19	0.37	94.26
31	1.B.2.b	Fugitive emissions - Natural gas	CH ₄	156.05	22.82	0.03	0.18	0.37	94.63
32	2.F.4	Product Uses as Substitutes for ODS -Aerosols (incl. MDIs)	HFC	0.64	130.91	0.18	0.16	0.33	94.96
33	1.A.3.d	Navigation - Liquid Fuels	CO ₂	84.90	219.43	0.30	0.16	0.32	95.28

Annex A.5 Greenhouse Gas Inventory Uncertainty Analysis 2015

A.5.1 Tier 1 Uncertainty Estimates 2015 (excluding LULUCF)

A.5.2 Tier 1 Uncertainty Estimates 2015 (including LULUCF)

A.5.1 Tier 1 Uncertainty Estimates 2015 (excluding LULUCF)

		KEY CATEGORIES OF EMISSIONS AND REMOVALS	Gas	Emissions in 1990 (kt CO ₂ eq)	Emissions in 2015 (kt CO ₂ eq)	Activity Data (AD) Uncertainty (%)	Emission Factor (EF) Uncertainty (%)	Combined Uncertainty (%)	Contribution to Variance by Category in 2015	Combined Emissions Uncertainty Squared	Uncertainty in Trend in Total Emissions due to AD (%)	Uncertainty in Trend in Total Emissions due to EF (%)	Combined Uncertainty in Trend in Total Emissions (%)	Combined Trend Uncertainty Squared
1	1.A.1 Fuel combustion - Energy Industries - Gaseous Fuels	1.A.1	CO ₂	1880.660	3888.852	1.000	2.500	2.693	0.031	0.001	0.034	0.069	0.098	0.084
2	1.A.1 Fuel combustion - Energy Industries - Liquid Fuels	1.A.1	CO ₂	1254.902	588.388	1.000	2.500	2.693	0.001	0.000	-0.013	0.010	0.015	-0.033
3	1.A.1 Fuel combustion - Energy Industries - Other Fossil Fuels	1.A.1	CO ₂	-	86.724	1.000	5.000	5.099	0.000	0.000	0.002	0.002	0.002	0.008
4	1.A.1 Fuel combustion - Energy Industries - Peat	1.A.1	CO ₂	3164.784	2708.334	1.000	5.000	5.099	0.053	0.003	-0.012	0.048	0.068	-0.060
5	1.A.1 Fuel combustion - Energy Industries - Solid Fuels	1.A.1	CO ₂	4844.660	4359.075	1.000	5.000	5.099	0.138	0.019	-0.014	0.078	0.110	-0.072
6	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	1.A.2	CO ₂	873.019	2462.163	7.000	3.000	7.616	0.098	0.010	0.027	0.044	0.434	0.082
7	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	1.A.2	CO ₂	2198.375	1491.121	10.000	2.500	10.308	0.066	0.004	-0.015	0.027	0.376	-0.038
8	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Other Fossil Fuels	1.A.2	CO ₂	-	147.656	1.000	5.000	5.099	0.000	0.000	0.003	0.003	0.004	0.013
9	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Peat	1.A.2	CO ₂	-	3.335	2.000	5.000	5.385	0.000	0.000	0.000	0.000	0.000	0.000
10	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	1.A.2	CO ₂	871.235	420.718	2.000	5.000	5.385	0.001	0.000	-0.009	0.007	0.021	-0.045
11	1.A.3.a Domestic Aviation	1.A.3.a	CO ₂	51.132	10.373	1.000	2.500	2.693	0.000	0.000	-0.001	0.000	0.000	-0.002
12	1.A.3.b Road Transportation	1.A.3.b	CO ₂	4690.424	11211.611	1.250	3.000	3.250	0.370	0.137	0.111	0.200	0.353	0.332
13	1.A.3.c Railways	1.A.3.c	CO ₂	133.191	109.899	1.000	1.000	1.414	0.000	0.000	-0.001	0.002	0.003	-0.001
14	1.A.3.d Domestic Navigation - Liquid Fuels	1.A.3.d	CO ₂	84.900	219.427	1.000	2.000	2.236	0.000	0.000	0.002	0.004	0.006	0.005
15	1.A.3.e Other Transportation	1.A.3.e	CO ₂	62.043	141.548	1.000	2.500	2.693	0.000	0.000	0.001	0.003	0.004	0.003
16	1.A.4 Other Sectors - Gaseous Fuels	1.A.4	CO ₂	493.222	2305.656	2.500	2.500	3.536	0.019	0.000	0.032	0.041	0.145	0.079
17	1.A.4 Other Sectors - Liquid Fuels	1.A.4	CO ₂	3792.642	4137.568	10.000	5.000	11.180	0.597	0.356	0.002	0.074	1.043	0.008
18	1.A.4 Other Sectors - Peat	1.A.4	CO ₂	3259.106	857.787	10.000	20.000	22.361	0.103	0.011	-0.047	0.015	0.216	-0.934
19	1.A.4 Other Sectors - Solid Fuels	1.A.4	CO ₂	2485.971	830.625	5.000	10.000	11.180	0.024	0.001	-0.032	0.015	0.105	-0.325
20	2.A.1 Cement Production	2.A.1	CO ₂	884.000	1652.014	1.500	1.500	2.121	0.003	0.000	0.013	0.029	0.062	0.019
21	2.A.2 Lime Production	2.A.2	CO ₂	214.077	177.347	5.000	5.000	7.071	0.000	0.000	-0.001	0.003	0.022	-0.005
22	2.A.3 Glass Production	2.A.3	CO ₂	13.325	-	5.000	2.500	5.590	0.000	0.000	0.000	0.000	0.000	-0.001
23	2.A.4 Other Process Uses of Carbonates	2.A.4	CO ₂	5.323	1.002	5.000	2.500	5.590	0.000	0.000	0.000	0.000	0.000	0.000
24	2.B.1 Ammonia Production	2.B.1	CO ₂	990.233	-	1.000	5.000	5.099	0.000	0.000	-0.019	0.000	0.000	-0.094

25	2.C Metal Production	2.C	CO ₂	26.080	-	5.000	2.500	5.590	0.000	0.000	0.000	0.000	0.000	-0.001
26	2.D Non-energy Products from Fuels and Solvent Use	2.D	CO ₂	77.241	120.764	30.000	5.000	30.414	0.004	0.000	0.001	0.002	0.091	0.003
27	3.G Liming	3.G	CO ₂	355.036	392.509	5.000	50.000	50.249	0.108	0.012	0.000	0.007	0.049	0.012
28	3.H Urea Application	3.H	CO ₂	44.471	28.305	5.000	50.000	50.249	0.001	0.000	0.000	0.001	0.004	-0.017
29	5.C Incineration and Open Burning of Waste	5.C	CO ₂	90.614	39.665	10.000	5.000	11.180	0.000	0.000	-0.001	0.001	0.010	-0.005
30	1.A.1 Fuel combustion - Energy Industries - Gaseous Fuels	1.A.1	CO ₂	1880.660	3888.852	1.000	2.500	2.693	0.031	0.001	0.034	0.069	0.098	0.084
Total CO₂				32840.667	38392.468				1.62			2.79		
							Level uncertainty, CO₂ 1.27			Trend uncertainty, CO₂ 1.67				
KEY CATEGORIES OF EMISSIONS AND REMOVALS		Gas	Emissions in 1990 (kt CO ₂ eq)	Emissions in 2015 (kt CO ₂ eq)	Activity Data (AD) Uncertainty (%)	Emission Factor (EF) Uncertainty (%)	Combined Uncertainty (%)	Contribution to Variance by Category in Year 2015	Combined Emissions Uncertainty Squared	Uncertainty in Total Emissions due to AD (%)	Uncertainty in Trend in Total Emissions due to EF (%)	Combined Uncertainty in Trend in Total Emissions (%)	Combined Trend Uncertainty Squared	
1	1.A.1 Fuel combustion - Energy Industries - Biomass	1.A.1	CH ₄	-	1.318	1.000	66.000	66.008	0.000	0.000	0.000	0.000	0.000	
2	1.A.1 Fuel combustion - Energy Industries - Gaseous Fuels	1.A.1	CH ₄	3.427	1.773	1.000	70.000	70.007	0.000	0.000	0.000	0.000	0.000	
3	1.A.1 Fuel combustion - Energy Industries - Liquid Fuels	1.A.1	CH ₄	0.389	0.180	1.000	66.000	66.008	0.000	0.000	0.000	0.000	0.000	
4	1.A.1 Fuel combustion - Energy Industries - Other Fossil Fuels	1.A.1	CH ₄	-	0.779	1.000	50.000	50.010	0.000	0.000	0.000	0.000	0.000	
5	1.A.1 Fuel combustion - Energy Industries - Peat	1.A.1	CH ₄	1.900	1.751	1.000	50.000	50.010	0.000	0.000	0.000	0.000	0.000	
6	1.A.1 Fuel combustion - Energy Industries - Solid Fuels	1.A.1	CH ₄	0.910	0.826	1.000	50.000	50.010	0.000	0.000	0.000	0.000	0.000	
7	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Biomass	1.A.2	CH ₄	1.911	5.366	10.000	50.000	50.990	0.000	0.000	0.000	0.000	0.001	
8	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	1.A.2	CH ₄	0.397	1.082	2.500	50.000	50.062	0.000	0.000	0.000	0.000	0.000	
9	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	1.A.2	CH ₄	2.057	1.237	10.000	50.000	50.990	0.000	0.000	0.000	0.000	0.000	
10	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Other Fossil Fuels	1.A.2	CH ₄	-	0.117	1.000	50.000	50.010	0.000	0.000	0.000	0.000	0.000	
11	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Peat	1.A.2	CH ₄	-	0.002	1.000	50.000	50.010	0.000	0.000	0.000	0.000	0.000	
12	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	1.A.2	CH ₄	2.302	1.112	2.000	50.000	50.040	0.000	0.000	0.000	0.000	0.000	
13	1.A.3.a Domestic Aviation	1.A.3.a	CH ₄	0.024	0.007	1.000	66.000	66.008	0.000	0.000	0.000	0.000	0.000	
14	1.A.3.b Road Transportation	1.A.3.b	CH ₄	47.516	15.326	1.250	71.000	71.011	0.000	0.000	-0.001	0.000	0.000	
15	1.A.3.c Railways	1.A.3.c	CH ₄	0.189	0.156	1.000	60.000	60.008	0.000	0.000	0.000	0.000	0.000	
16	1.A.3.d Domestic Navigation - Liquid Fuels	1.A.3.d	CH ₄	0.197	0.524	1.000	50.000	50.010	0.000	0.000	0.000	0.000	0.000	
17	1.A.3.e Other Transportation	1.A.3.e	CH ₄	0.141	0.311	1.000	50.000	50.010	0.000	0.000	0.000	0.000	0.000	
18	1.A.4 Other Sectors - Biomass	1.A.4	CH ₄	14.080	15.500	10.000	50.000	50.990	0.000	0.000	0.000	0.000	0.004	
19	1.A.4 Other Sectors - Gaseous Fuels	1.A.4	CH ₄	1.122	5.064	2.500	50.000	50.062	0.000	0.000	0.000	0.000	0.000	

20	1.A.4 Other Sectors - Liquid Fuels	1.A.4	CH ₄	11.271	13.225	10.000	66.000	66.753	0.000	0.000	0.000	0.000	0.003
21	1.A.4 Other Sectors - Peat	1.A.4	CH ₄	227.983	62.991	10.000	50.000	50.990	0.003	0.000	-0.003	0.001	0.016
22	1.A.4 Other Sectors - Solid Fuels	1.A.4	CH ₄	196.513	64.751	5.000	50.000	50.249	0.003	0.000	-0.003	0.001	0.008
23	1.B.1 Fugitive emissions from Solid Fuels	1.B.2	CH ₄	55.557	19.539	10.000	50.000	50.990	0.000	0.000	-0.001	0.000	0.005
24	1.B.2.a Fugitive Emissions from Fuels - Oil and Natural Gas - Oil	1.B.2.a	CH ₄	0.212	0.393	10.000	50.000	50.990	0.000	0.000	0.000	0.000	0.000
25	1.B.2.b Fugitive Emissions from Fuels - Oil and Natural Gas - Natural Gas	1.B.2.b	CH ₄	156.081	23.188	10.000	50.000	50.990	0.000	0.000	-0.003	0.000	0.006
26	3.A Enteric Fermentation	3.A	CH ₄	11356.973	10936.456	1.000	17.000	17.029	9.674	93.589	-0.021	0.195	0.276
27	3.B Manure Management	3.B	CH ₄	1342.286	1284.585	1.000	19.000	19.026	0.167	0.028	-0.003	0.023	0.032
28	5.A Solid Waste Disposal	5.A	CH ₄	1318.075	741.412	34.640	34.640	48.988	0.368	0.135	-0.012	0.013	0.647
29	5.B Biological treatment of solid waste: Composting	5.B	CH ₄	-	11.251	10.000	30.000	31.623	0.000	0.000	0.000	0.000	0.003
30	5.C Incineration and Open Burning of Waste	5.C	CH ₄	0.831	0.073	10.000	30.000	31.623	0.000	0.000	0.000	0.000	0.000
31	5.D Wastewater Treatment and Discharge	5.D	CH ₄	61.099	53.506	10.000	30.000	31.623	0.001	0.000	0.000	0.001	0.013
Total CH₄				14803.444	13263.800				10.22				0.86
									Level uncertainty, CH₄	3.20		Trend uncertainty, CH₄	0.93
Combined CO₂ and CH₄				47644.111	51656.267				11.83				3.65
									Level uncertainty, CO₂ and CH₄	3.44		Trend uncertainty, CO₂ & CH₄	1.91

	KEY CATEGORIES OF EMISSIONS AND REMOVALS	Gas	Emissions in 1990 (kt CO ₂ eq)	Emissions in 2015 (kt CO ₂ eq)	Activity Data (AD) Uncertainty (%)	Emission Factor (EF) Uncertainty (%)	Combined Uncertainty (%)	Contribution to Variance by Category in Year 2015	Combined Emissions Uncertainty Squared	Uncertainty in Trend in Total Emissions due to AD (%)	Uncertainty in Trend in Total Emissions due to EF (%)	Combined Uncertainty in Trend in Total Emissions (%)	Combined Trend Uncertainty Squared
1	1.A.1 Fuel combustion - Energy Industries - Biomass	1.A.1	N ₂ O	-	4.862	1.000	63.000	63.008	0.000	0.000	0.000	0.000	0.000
2	1.A.1 Fuel combustion - Energy Industries - Gaseous Fuels	1.A.1	N ₂ O	10.212	60.437	1.000	50.000	50.010	0.003	0.000	0.001	0.001	0.002
3	1.A.1 Fuel combustion - Energy Industries - Liquid Fuels	1.A.1	N ₂ O	1.472	0.448	1.000	50.000	50.010	0.000	0.000	0.000	0.000	0.000
4	1.A.1 Fuel combustion - Energy Industries - Other Fossil Fuels	1.A.1	N ₂ O	-	1.238	1.000	50.000	50.010	0.000	0.000	0.000	0.000	0.000
5	1.A.1 Fuel combustion - Energy Industries - Peat	1.A.1	N ₂ O	52.068	48.083	1.000	50.000	50.010	0.002	0.000	0.000	0.001	0.001
6	1.A.1 Fuel combustion - Energy Industries - Solid Fuels	1.A.1	N ₂ O	7.744	7.030	1.000	50.000	50.010	0.000	0.000	0.000	0.000	0.000
7	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Biomass	1.A.2	N ₂ O	3.036	8.527	10.000	50.000	50.990	0.000	0.000	0.000	0.000	0.002
8	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	1.A.2	N ₂ O	0.474	1.289	1.000	50.000	50.010	0.000	0.000	0.000	0.000	0.000
9	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	1.A.2	N ₂ O	4.827	2.816	10.000	50.000	50.990	0.000	0.000	0.000	0.000	0.001
10	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Other Fossil Fuels	1.A.2	N ₂ O	-	0.278	1.000	20.000	20.025	0.000	0.000	0.000	0.000	0.000
11	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Peat	1.A.2	N ₂ O	-	0.015	2.000	50.000	50.040	0.000	0.000	0.000	0.000	0.000

12	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	1.A.2	N ₂ O	4.117	1.988	1.000	50.000	50.010	0.000	0.000	0.000	0.000	0.000
13	1.A.3.a Domestic Aviation	1.A.3.a	N ₂ O	0.555	0.125	1.000	66.000	66.008	0.000	0.000	0.000	0.000	0.000
14	1.A.3.b Road Transportation	1.A.3.b	N ₂ O	48.334	101.998	1.250	68.000	68.011	0.013	0.000	0.001	0.002	0.003
15	1.A.3.c Railways	1.A.3.c	N ₂ O	15.487	12.778	1.000	50.000	50.010	0.000	0.000	0.000	0.000	0.000
16	1.A.3.d Domestic Navigation - Liquid Fuels	1.A.3.d	N ₂ O	0.672	1.784	1.000	90.000	90.006	0.000	0.000	0.000	0.000	0.000
17	1.A.3.e Other Transportation	1.A.3.e	N ₂ O	0.673	1.482	1.000	25.000	25.020	0.000	0.000	0.000	0.000	0.000
18	1.A.4 Other Sectors - Biomass	1.A.4	N ₂ O	2.233	2.459	10.000	50.000	50.990	0.000	0.000	0.000	0.000	0.001
19	1.A.4 Other Sectors - Gaseous Fuels	1.A.4	N ₂ O	0.268	1.207	2.500	50.000	50.062	0.000	0.000	0.000	0.000	0.000
20	1.A.4 Other Sectors - Liquid Fuels	1.A.4	N ₂ O	76.917	58.041	10.000	50.000	50.990	0.002	0.000	0.000	0.001	0.015
21	1.A.4 Other Sectors - Peat	1.A.4	N ₂ O	13.222	3.504	5.000	50.000	50.249	0.000	0.000	0.000	0.000	0.000
22	1.A.4 Other Sectors - Solid Fuels	1.A.4	N ₂ O	11.724	3.859	5.000	50.000	50.249	0.000	0.000	0.000	0.000	0.000
23	2.B.2 Nitric Acid Production	2.B.2	N ₂ O	995.320	-	1.000	10.000	10.050	0.000	0.000	-0.019	0.000	0.000
24	2.G Other Product Manufacture and Use	2.G	N ₂ O	31.342	41.440	5.000	5.000	7.071	0.000	0.000	0.000	0.001	0.005
25	3.B Manure Management	3.B	N ₂ O	479.698	505.730	11.225	50.000	51.245	0.187	0.035	0.000	0.009	0.143
26	3.D.1 Direct N ₂ O Emissions From Managed Soils	3.D	N ₂ O	6045.296	5595.694	7.800	100.000	100.304	87.863	7719.853	-0.015	0.100	1.100
27	3.D.2 Indirect N ₂ O Emissions From Managed Soils	3.D	N ₂ O	521.061	483.827	11.180	50.000	51.235	0.171	0.029	-0.001	0.009	0.136
28	5.B Biological treatment of solid waste: Composting	5.B	N ₂ O	-	8.047	10.000	10.000	14.142	0.000	0.000	0.000	0.000	0.002
29	5.C Incineration and Open Burning of Waste	5.C	N ₂ O	1.037	0.414	10.000	10.000	14.142	0.000	0.000	0.000	0.000	0.000
30	5.D Wastewater Treatment and Discharge	5.D	N ₂ O	95.637	119.796	10.000	10.000	14.142	0.001	0.000	0.000	0.002	0.030
Total N₂O				8423.424	7079.200			88.24					3.62
								9.39	Level uncertainty, N₂O			Trend uncertainty, N₂O	1.90
Combined CO₂, CH₄ and N₂O				56067.535	58735.467			100.08					7.28
								10.00	Level uncertainty, CO₂, CH₄ & N₂O			Trend uncertainty, CO₂, CH₄ & N₂O	2.70

	KEY CATEGORIES OF EMISSIONS AND REMOVALS	Gas	Emissions in 1990 (kt CO ₂ eq)	Emissions in 2015 (kt CO ₂ eq)	Activity Data (AD) Uncertainty (%)	Emission Factor (EF) Uncertainty (%)	Combined Uncertainty (%)	Contribution to Variance by Category in Year 2015	Combined Emissions Uncertainty Squared	Uncertainty in Trend in Total Emissions due to AD (%)	Uncertainty in Trend in Total Emissions due to EF (%)	Combined Uncertainty in Trend in Total Emissions (%)	Combined Trend Uncertainty Squared
1	2.E Electronics Industry & 2.F Product Uses and Substitutes for ODS	Aggregate F-gases	1.810	1119.808	20.000	10.000	22.361	0.175	0.031	0.020	0.020	0.565	0.199
2	2.G Other Product Manufacture and Use	Aggregate F-gases	33.423	22.938	10.000	0.000	10.000	0.000	0.000	0.000	0.000	0.006	0.000
	Total F-gases		35.23	1142.75				0.17					0.36

TOTAL for all gases			Level uncertainty, F-gases	0.42	Trend uncertainty, F-gases	0.60
	56102.768	59878.21		100.25		7.63
			Total level uncertainty for all GHGs	10.01	Total trend uncertainty for all GHGs	2.76

Equation 3.1 (chapter 3 of the 2006 IPCC guidelines Volume 1):

$$U_{total} = \sqrt{U_1^2 + U_2^2 + \dots + U_n^2}$$

Where:

U_{total} = the percentage uncertainty in the product of the quantities (half the 95% confidence interval divided by the total and expressed as a percentage);

U_n = the percentage uncertainties associated with each of the quantities.

Equation 3.2 (chapter 3 of the 2006 IPCC guidelines Volume 1):

$$U_{total} = \frac{\sqrt{(U_1 \cdot x_1)^2 + (U_2 \cdot x_2)^2 + \dots + (U_n \cdot x_n)^2}}{|x_1 + x_2 + \dots + x_n|}$$

Where:

U_{total} = the percentage uncertainty in the sum of the quantities (half the 95% confidence interval divided by the total (i.e., mean) and expressed as a percentage). This term ‘uncertainty’ is thus based upon the 95% confidence interval;

x_n and U_n = the uncertain quantities and the percentage uncertainties associated with them, respectively

A.5.2 Tier 1 Uncertainty Estimates 2015 (including LULUCF)

KEY CATEGORIES OF EMISSIONS AND REMOVALS		Gas	Emissions in 1990 (kt CO ₂ eq)	Emissions in 2015 (kt CO ₂ eq)	Activity Data (AD) Uncertainty (%)	Emission Factor (EF) Uncertainty (%)	Combined Uncertainty (%)	Contribution to Variance by Category in Year 2015	Combined Emissions Uncertainty Squared	Uncertainty in Trend in Total Emissions due to AD (%)	Uncertainty in Trend in Total Emissions due to EF (%)	Combined Uncertainty in Trend in Total Emissions (%)	Combined Trend Uncertainty Squared
1	1.A.1 Fuel combustion - Energy Industries - Gaseous Fuels	CO ₂	1880.660	3888.852	1.000	2.500	2.693	0.027	0.001	0.034	0.069	0.098	0.084
2	1.A.1 Fuel combustion - Energy Industries - Liquid Fuels	CO ₂	1254.902	588.388	1.000	2.500	2.693	0.001	0.000	-0.013	0.010	0.015	-0.033
3	1.A.1 Fuel combustion - Energy Industries - Other Fossil Fuels	CO ₂	-	86.724	1.000	5.000	5.099	0.000	0.000	0.002	0.002	0.002	0.008
4	1.A.1 Fuel combustion - Energy Industries - Peat	CO ₂	3164.784	2708.334	1.000	5.000	5.099	0.046	0.002	-0.012	0.048	0.068	-0.060
5	1.A.1 Fuel combustion - Energy Industries - Solid Fuels	CO ₂	4844.660	4359.075	1.000	5.000	5.099	0.120	0.014	-0.014	0.078	0.110	-0.072
6	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	CO ₂	873.019	2462.163	7.000	3.000	7.616	0.085	0.007	0.027	0.044	0.434	0.082
7	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	CO ₂	2198.375	1491.121	10.000	2.500	10.308	0.057	0.003	-0.015	0.027	0.376	-0.038
8	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Other Fossil Fuels	CO ₂	-	147.656	1.000	5.000	5.099	0.000	0.000	0.003	0.003	0.004	0.013
9	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Peat	CO ₂	-	3.335	2.000	5.000	5.385	0.000	0.000	0.000	0.000	0.000	0.000
10	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	CO ₂	871.235	420.718	2.000	5.000	5.385	0.001	0.000	-0.009	0.007	0.021	-0.045
11	1.A.3.a Domestic Aviation	CO ₂	51.132	10.373	1.000	2.500	2.693	0.000	0.000	-0.001	0.000	0.000	-0.002
12	1.A.3.b Road Transportation	CO ₂	4690.424	11211.611	1.250	3.000	3.250	0.322	0.104	0.111	0.200	0.353	0.332
13	1.A.3.c Railways	CO ₂	133.191	109.899	1.000	1.000	1.414	0.000	0.000	-0.001	0.002	0.003	-0.001
14	1.A.3.d Domestic Navigation - Liquid Fuels	CO ₂	84.900	219.427	1.000	2.000	2.236	0.000	0.000	0.002	0.004	0.006	0.005

15	1.A.3.e Other Transportation	CO ₂	62.043	141.548	1.000	2.500	2.693	0.000	0.000	0.001	0.003	0.004	0.003
16	1.A.4 Other Sectors - Gaseous Fuels	CO ₂	493.222	2305.656	2.500	2.500	3.536	0.016	0.000	0.032	0.041	0.145	0.079
17	1.A.4 Other Sectors - Liquid Fuels	CO ₂	3792.642	4137.568	10.000	5.000	11.180	0.519	0.270	0.002	0.074	1.043	0.008
18	1.A.4 Other Sectors - Peat	CO ₂	3259.106	857.787	10.000	20.000	22.361	0.089	0.008	-0.047	0.015	0.216	-0.934
19	1.A.4 Other Sectors - Solid Fuels	CO ₂	2485.971	830.625	5.000	10.000	11.180	0.021	0.000	-0.032	0.015	0.105	-0.325
20	2.A.1 Cement Production	CO ₂	884.000	1652.014	1.500	1.500	2.121	0.003	0.000	0.013	0.029	0.062	0.019
21	2.A.2 Lime Production	CO ₂	214.077	177.347	5.000	5.000	7.071	0.000	0.000	-0.001	0.003	0.022	-0.005
22	2.A.3 Glass Production	CO ₂	13.325	-	5.000	2.500	5.590	0.000	0.000	0.000	0.000	0.000	-0.001
23	2.A.4 Other Process Uses of Carbonates	CO ₂	5.323	1.002	5.000	2.500	5.590	0.000	0.000	0.000	0.000	0.000	0.000
24	2.B.1 Ammonia Production	CO ₂	990.233	-	1.000	5.000	5.099	0.000	0.000	-0.019	0.000	0.000	-0.094
25	2.C Metal Production	CO ₂	26.080	-	5.000	2.500	5.590	0.000	0.000	0.000	0.000	0.000	-0.001
26	2.D Non-energy Products from Fuels and Solvent Use	CO ₂	77.241	120.764	30.000	5.000	30.414	0.003	0.000	0.001	0.002	0.091	0.003
27	3.G Liming	CO ₂	355.036	392.509	5.000	50.000	50.249	0.094	0.009	0.000	0.007	0.049	0.012
28	3.H Urea Application	CO ₂	44.471	28.305	5.000	50.000	50.249	0.000	0.000	0.000	0.001	0.004	-0.017
29	4.A.1 Forest Land Remaining Forest Land	CO ₂	-2719.658	-134.678	51.000	114.000	124.888	-0.262	0.069	0.043	-0.002	-0.157	4.948
30	4.A.2 Land Converted to Forest Land	CO ₂	27.256	-3685.594	51.000	114.000	124.888	-7.170	51.416	-0.060	-0.060	-4.294	-6.840
31	4.B.1 Cropland Remaining Cropland	CO ₂	26.195	-53.465	20.592	69.149	72.150	-0.060	0.004	-0.001	-0.001	-0.025	-0.090
32	4.C.1 Grassland Remaining Grassland	CO ₂	6666.376	5309.831	12.215	90.000	90.825	7.513	56.444	-0.026	0.086	1.482	-2.329

33	4.C.2 Land Converted to Grassland	CO ₂	385.392	357.214	43.947	101.106	110.244	0.613	0.376	-0.001	0.006	0.359	-0.069	
34	4.D.1 Wetlands Remaining Wetland	CO ₂	1355.834	2394.179	21.492	101.449	103.701	3.868	14.960	0.016	0.039	1.176	1.619	
35	4.D.2 Land Converted to Wetlands	CO ₂	94.61	99.09	2.500	50.000	50.062	0.077	0.006	0.000	0.002	0.006	0.001	
36	4.E.2 Land Converted to Settlements	CO ₂	19.001	32.777	39.975	81.833	91.075	0.047	0.002	0.000	0.001	0.030	0.017	
37	4.F.2 Land Converted to Other Land	CO ₂	0.548	79.286	51.933	75.000	91.225	0.113	0.013	0.001	0.001	0.094	0.095	
38	4.G Harvested Wood Products	CO ₂	-413.540	-731.462	25.000	26.920	36.738	-0.419	0.175	-0.005	-0.012	-0.418	-0.132	
39	5.C Incineration and Open Burning of Waste	CO ₂	90.614	39.665	10.000	5.000	11.180	0.000	0.000	-0.001	0.001	0.010	-0.005	
Total CO ₂			38282.682	42059.640				5.73					104.51	
								Level uncertainty, CO ₂	2.39				Trend uncertainty, CO ₂	10.22

KEY CATEGORIES OF EMISSIONS AND REMOVALS		Gas	Emissions in 1990 (kt CO ₂ eq)	Emissions in 2015 (kt CO ₂ eq)	Activity Data (AD) Uncertainty (%)	Emission Factor (EF) Uncertainty (%)	Combined Uncertainty (%)	Contribution to Variance by Category in Year 2015	Combined Emissions Uncertainty Squared	Uncertainty in Trend in Total Emissions due to AD (%)	Uncertainty in Trend in Total Emissions due to EF (%)	Combined Uncertainty in Trend in Total Emissions (%)	Combined Trend Uncertainty Squared
1	1.A.1 Fuel combustion - Energy Industries - Biomass	CH ₄	-	1.318	1.000	66.000	66.008	0.000	0.000	0.000	0.000	0.000	0.002
2	1.A.1 Fuel combustion - Energy Industries - Gaseous Fuels	CH ₄	3.427	1.773	1.000	70.000	70.007	0.000	0.000	0.000	0.000	0.000	-0.002
3	1.A.1 Fuel combustion - Energy Industries - Liquid Fuels	CH ₄	0.389	0.180	1.000	66.000	66.008	0.000	0.000	0.000	0.000	0.000	0.000
4	1.A.1 Fuel combustion - Energy Industries - Other Fossil Fuels	CH ₄	-	0.779	1.000	50.000	50.010	0.000	0.000	0.000	0.000	0.000	0.001
5	1.A.1 Fuel combustion - Energy Industries - Peat	CH ₄	1.900	1.751	1.000	50.000	50.010	0.000	0.000	0.000	0.000	0.000	0.000

6	1.A.1 Fuel combustion - Energy Industries - Solid Fuels	CH ₄	0.910	0.826	1.000	50.000	50.010	0.000	0.000	0.000	0.000	0.000	0.000
7	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Biomass	CH ₄	1.911	5.366	10.000	50.000	50.990	0.000	0.000	0.000	0.000	0.001	0.003
8	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	CH ₄	0.397	1.082	2.500	50.000	50.062	0.000	0.000	0.000	0.000	0.000	0.001
9	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	CH ₄	2.057	1.237	10.000	50.000	50.990	0.000	0.000	0.000	0.000	0.000	-0.001
10	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Other Fossil Fuels	CH ₄	-	0.117	1.000	50.000	50.010	0.000	0.000	0.000	0.000	0.000	0.000
11	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Peat	CH ₄	-	0.002	1.000	50.000	50.010	0.000	0.000	0.000	0.000	0.000	0.000
12	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	CH ₄	2.302	1.112	2.000	50.000	50.040	0.000	0.000	0.000	0.000	0.000	-0.001
13	1.A.3.a Domestic Aviation	CH ₄	0.024	0.007	1.000	66.000	66.008	0.000	0.000	0.000	0.000	0.000	0.000
14	1.A.3.b Road Transportation	CH ₄	47.516	15.326	1.250	71.000	71.011	0.000	0.000	-0.001	0.000	0.000	-0.045
15	1.A.3.c Railways	CH ₄	0.189	0.156	1.000	60.000	60.008	0.000	0.000	0.000	0.000	0.000	0.000
16	1.A.3.d Domestic Navigation - Liquid Fuels	CH ₄	0.197	0.524	1.000	50.000	50.010	0.000	0.000	0.000	0.000	0.000	0.000
17	1.A.3.e Other Transportation	CH ₄	0.141	0.311	1.000	50.000	50.010	0.000	0.000	0.000	0.000	0.000	0.000
18	1.A.4 Other Sectors - Biomass	CH ₄	14.080	15.500	10.000	50.000	50.990	0.000	0.000	0.000	0.000	0.004	0.000
19	1.A.4 Other Sectors - Gaseous Fuels	CH ₄	1.122	5.064	2.500	50.000	50.062	0.000	0.000	0.000	0.000	0.000	0.003
20	1.A.4 Other Sectors - Liquid Fuels	CH ₄	11.271	13.225	10.000	66.000	66.753	0.000	0.000	0.000	0.000	0.003	0.001
21	1.A.4 Other Sectors - Peat	CH ₄	227.983	62.991	10.000	50.000	50.990	0.003	0.000	-0.003	0.001	0.016	-0.161
22	1.A.4 Other Sectors - Solid Fuels	CH ₄	196.513	64.751	5.000	50.000	50.249	0.003	0.000	-0.003	0.001	0.008	-0.129

23	1.B.1 Fugitive emissions from Solid Fuels	CH ₄	55.557	19.539	10.000	50.000	50.990	0.000	0.000	-0.001	0.000	0.005	-0.035	
24	1.B.2.a Fugitive Emissions from Fuels - Oil and Natural Gas - Oil	CH ₄	0.212	0.393	10.000	50.000	50.990	0.000	0.000	0.000	0.000	0.000	0.000	
25	1.B.2.b Fugitive Emissions from Fuels - Oil and Natural Gas - Natural Gas	CH ₄	156.081	23.188	10.000	50.000	50.990	0.000	0.000	-0.003	0.000	0.006	-0.128	
26	3.A Enteric Fermentation	CH ₄	11356.973	10936.456	1.000	17.000	17.029	8.418	70.857	-0.021	0.195	0.276	-0.358	
27	3.B Manure Management	CH ₄	1342.286	1284.585	1.000	19.000	19.026	0.145	0.021	-0.003	0.023	0.032	-0.050	
28	4.A LULUCF - Forest Land	CH ₄	58.583	72.949	30.000	100.000	104.403	0.119	0.014	0.000	0.001	0.050	0.020	
29	4.B.1 LULUCF - Cropland remaining Cropland	CH ₄	0.063	0.018	100.000	39.100	107.372	0.000	0.000	0.000	0.000	0.000	0.000	
30	4.C.1 LULUCF - Grassland Remaining Grassland	CH ₄	41.355	209.000	96.400	91.200	132.704	0.432	0.187	0.003	0.003	0.460	0.245	
31	4.D.1 LULUCF - Wetlands remaining Wetlands	CH ₄	126.557	88.843	86.000	66.500	108.712	0.150	0.023	-0.001	0.001	0.175	-0.046	
32	5.A Solid Waste Disposal	CH ₄	1318.075	741.412	34.640	34.640	48.988	0.320	0.102	-0.012	0.013	0.647	-0.411	
33	5.B Biological treatment of solid waste: Composting	CH ₄	-	11.251	10.000	30.000	31.623	0.000	0.000	0.000	0.000	0.003	0.006	
34	5.C Incineration and Open Burning of Waste	CH ₄	0.831	0.073	10.000	30.000	31.623	0.000	0.000	0.000	0.000	0.000	0.000	
35	5.D Wastewater Treatment and Discharge	CH ₄	61.099	53.506	10.000	30.000	31.623	0.001	0.000	0.000	0.001	0.013	-0.006	
Total CH ₄			15030.002	13634.609				9.59					1.17	
								Level uncertainty, CH ₄	3.10				Trend uncertainty, CH ₄	1.08
Combined CO ₂ and CH ₄			53312.684	55694.249				15.32					105.67	
								Level uncertainty, CO ₂ and CH ₄	3.91				Trend uncertainty, CO ₂ & CH ₄	10.28

	KEY CATEGORIES OF EMISSIONS AND REMOVALS	Gas	Emissions in 1990 (kt CO ₂ eq)	Emissions in 2015 (kt CO ₂ eq)	Activity Data (AD) Uncertainty (%)	Emission Factor (EF) Uncertainty (%)	Combined Uncertainty (%)	Contribution to Variance by Category in Year 2015	Combined Emissions Uncertainty Squared	Uncertainty in Trend in Total Emissions due to AD (%)	Uncertainty in Trend in Total Emissions due to EF (%)	Combined Uncertainty in Trend in Total Emissions (%)	Combined Trend Uncertainty Squared
1	1.A.1 Fuel combustion - Energy Industries - Biomass	N ₂ O	-	4.862	1.000	63.000	63.008	0.000	0.000	0.000	0.000	0.000	0.005
2	1.A.1 Fuel combustion - Energy Industries - Gaseous Fuels	N ₂ O	10.212	60.437	1.000	50.000	50.010	0.002	0.000	0.001	0.001	0.002	0.044
3	1.A.1 Fuel combustion - Energy Industries - Liquid Fuels	N ₂ O	1.472	0.448	1.000	50.000	50.010	0.000	0.000	0.000	0.000	0.000	-0.001
4	1.A.1 Fuel combustion - Energy Industries - Other Fossil Fuels	N ₂ O	-	1.238	1.000	50.000	50.010	0.000	0.000	0.000	0.000	0.000	0.001
5	1.A.1 Fuel combustion - Energy Industries - Peat	N ₂ O	52.068	48.083	1.000	50.000	50.010	0.001	0.000	0.000	0.001	0.001	-0.007
6	1.A.1 Fuel combustion - Energy Industries - Solid Fuels	N ₂ O	7.744	7.030	1.000	50.000	50.010	0.000	0.000	0.000	0.000	0.000	-0.001
7	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Biomass	N ₂ O	3.036	8.527	10.000	50.000	50.990	0.000	0.000	0.000	0.000	0.002	0.005
8	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Gaseous Fuels	N ₂ O	0.474	1.289	1.000	50.000	50.010	0.000	0.000	0.000	0.000	0.000	0.001
9	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Liquid Fuels	N ₂ O	4.827	2.816	10.000	50.000	50.990	0.000	0.000	0.000	0.000	0.001	-0.002
10	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Other Fossil Fuels	N ₂ O	-	0.278	1.000	20.000	20.025	0.000	0.000	0.000	0.000	0.000	0.000
11	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Peat	N ₂ O	-	0.015	2.000	50.000	50.040	0.000	0.000	0.000	0.000	0.000	0.000
12	1.A.2 Fuel combustion - Manufacturing Industries and Construction - Solid Fuels	N ₂ O	4.117	1.988	1.000	50.000	50.010	0.000	0.000	0.000	0.000	0.000	-0.002
13	1.A.3.a Domestic Aviation	N ₂ O	0.555	0.125	1.000	66.000	66.008	0.000	0.000	0.000	0.000	0.000	-0.001
14	1.A.3.b Road Transportation	N ₂ O	48.334	101.998	1.250	68.000	68.011	0.012	0.000	0.001	0.002	0.003	0.061
15	1.A.3.c Railways	N ₂ O	15.487	12.778	1.000	50.000	50.010	0.000	0.000	0.000	0.000	0.000	-0.003
16	1.A.3.d Domestic Navigation - Liquid Fuels	N ₂ O	0.672	1.784	1.000	90.000	90.006	0.000	0.000	0.000	0.000	0.000	0.002
17	1.A.3.e Other Transportation	N ₂ O	0.673	1.482	1.000	25.000	25.020	0.000	0.000	0.000	0.000	0.000	0.000
18	1.A.4 Other Sectors - Biomass	N ₂ O	2.233	2.459	10.000	50.000	50.990	0.000	0.000	0.000	0.000	0.001	0.000
19	1.A.4 Other Sectors - Gaseous Fuels	N ₂ O	0.268	1.207	2.500	50.000	50.062	0.000	0.000	0.000	0.000	0.000	0.001
20	1.A.4 Other Sectors - Liquid Fuels	N ₂ O	76.917	58.041	10.000	50.000	50.990	0.002	0.000	0.000	0.001	0.015	-0.021
21	1.A.4 Other Sectors - Peat	N ₂ O	13.222	3.504	5.000	50.000	50.249	0.000	0.000	0.000	0.000	0.000	-0.009
22	1.A.4 Other Sectors - Solid Fuels	N ₂ O	11.724	3.859	5.000	50.000	50.249	0.000	0.000	0.000	0.000	0.000	-0.008
23	2.B.2 Nitric Acid Production	N ₂ O	995.320	-	1.000	10.000	10.050	0.000	0.000	-0.019	0.000	0.000	-0.189
24	2.G Other Product Manufacture and Use	N ₂ O	31.342	41.440	5.000	5.000	7.071	0.000	0.000	0.000	0.001	0.005	0.001
25	3.B Manure Management	N ₂ O	479.698	505.730	11.225	50.000	51.245	0.163	0.027	0.000	0.009	0.143	-0.006
26	3.D.1 Direct N2O Emissions From Managed Soils	N ₂ O	6045.296	5595.694	7.800	100.000	100.304	76.451	5844.745	-0.015	0.100	1.100	-1.525
27	3.D.2 Indirect N2O Emissions From Managed Soils	N ₂ O	521.061	483.827	11.180	50.000	51.235	0.149	0.022	-0.001	0.009	0.136	-0.064
28	4.A LULUCF - Forest Land	N ₂ O	92.865	174.720	30.000	100.000	104.403	0.284	0.081	0.001	0.003	0.120	0.127
29	4.B.1 LULUCF - Cropland remaining Cropland	N ₂ O	0.019	0.005	100.000	100.000	141.421	0.000	0.000	0.000	0.000	0.000	0.000
30	4.C.1 LULUCF - Grassland Remaining Grassland	N ₂ O	0.887	14.706	91.023	100.000	135.222	0.031	0.001	0.000	0.000	0.031	0.022
31	4.C.2 LULUCF - Land converted to Grassland	N ₂ O			90.800	100.000	135.073	0.000	0.000	0.000	0.000	0.000	0.000
32	4.D.1 LULUCF - Wetlands remaining Wetlands	N ₂ O	28.891	16.434	86.000	100.000	131.894	0.034	0.001	0.000	0.000	0.032	-0.022
33	4.D.2 LULUCF - Land converted to Wetlands	N ₂ O			30.000	92.729	97.461	0.000	0.000	0.000	0.000	0.000	0.000
34	4.E.2 LULUCF - Land Converted to Settlements	N ₂ O	5.671	69.235	45.244	54.690	70.979	0.077	0.006	0.001	0.001	0.072	0.056
35	4.F.2 LULUCF - Land Converted to Other Land	N ₂ O	0.001	0.526	30.000	100.000	104.403	0.001	0.000	0.000	0.000	0.000	0.001
36	5.B Biological treatment of solid waste: Composting	N ₂ O	0.000	8.047	10.000	10.000	14.142	0.002	0.000	0.000	0.000	0.002	0.001
37	5.C Incineration and Open Burning of Waste	N ₂ O	1.037	0.414	10.000	10.000	14.142	0.000	0.000	0.000	0.000	0.000	0.000
38	5.D Wastewater Treatment and Discharge	N ₂ O	95.637	119.796	10.000	10.000	14.142	0.001	0.000	0.000	0.002	0.030	0.003
Total N₂O			8551.758	7354.824				77.21					3.66
							Level uncertainty, N₂O	8.79			Trend uncertainty, N₂O		1.91
Combined CO₂, CH₄ and N₂O			61864.443	63049.073				92.53					109.34
							Level uncertainty, CO₂, CH₄ & N₂O	9.62			Trend uncertainty, CO₂, CH₄ & N₂O		10.46

	KEY CATEGORIES OF EMISSIONS AND REMOVALS	Gas	Emissions in 1990 (kt CO ₂ eq)	Emissions in 2015 (kt CO ₂ eq)	Activity Data (AD) Uncertainty (%)	Emission Factor (EF) Uncertainty (%)	Combined Uncertainty (%)	Contribution to Variance by Category in Year 2015	Combined Emissions Uncertainty Squared	Uncertainty in Trend in Total Emissions due to AD (%)	Uncertainty in Trend in Total Emissions due to EF (%)	Combined Uncertainty in Trend in Total Emissions (%)	Combined Trend Uncertainty Squared	
1	2.E Electronics Industry & 2.F Product Uses and Substitutes for ODS	Aggregate F-gases	1.810	1119.808	20.000	10.000	22.361	0.152	0.023	0.020	0.020	0.565	0.199	
2	2.G Other Product Manufacture and Use	Aggregate F-gases	33.423	22.938	10.000	0.000	10.000	0.000	0.000	0.000	0.000	0.006	0.000	
Total F-gases			35.23	1142.75				0.15					0.36	
						Level uncertainty, F-gases			0.39	Trend uncertainty, F-gases				0.60
TOTAL for all gases			61899.68	64191.82				92.68					109.69	
						Total level uncertainty for all GHGs			9.63	Total trend uncertainty for all GHGs				10.47

Equation 3.1 (chapter 3 of the 2006 IPCC guidelines Volume 1):

$$U_{total} = \sqrt{U_1^2 + U_2^2 + \dots + U_n^2}$$

Where:

U_{total} = the percentage uncertainty in the product of the quantities (half the 95% confidence interval divided by the total and expressed as a percentage);

U_n = the percentage uncertainties associated with each of the quantities.

Equation 3.2 (chapter 3 of the 2006 IPCC guidelines Volume 1):

$$U_{total} = \frac{\sqrt{(U_1 \cdot x_1)^2 + (U_2 \cdot x_2)^2 + \dots + (U_n \cdot x_n)^2}}{|x_1 + x_2 + \dots + x_n|}$$

Where:

U_{total} = the percentage uncertainty in the sum of the quantities (half the 95% confidence interval divided by the total (i.e., mean) and expressed as a percentage). This term 'uncertainty' is thus based upon the 95% confidence interval;

x_n and U_n = the uncertain quantities and the percentage uncertainties associated with them, respectively.

Annex B

Summary of Greenhouse Gas Emissions by sector for the With Measures Scenario 1990-2035 (Kt CO₂ equivalent)

	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035
Energy Industries	11434.98	13553.17	16245.03	15858.06	13385.81	11803.22	10239.06	11585.02	12847.89	14580.93
Residential	7523.66	6452.05	6462.60	7271.95	7800.95	6041.36	6134.56	6344.19	6368.51	6444.25
Manufacturing Combustion	3961.75	4347.62	5642.37	5870.71	4497.09	4548.82	5311.66	5399.01	5571.66	6205.61
Commercial / Public Services	2244.14	2101.91	2364.13	2428.22	2317.60	1740.79	1930.16	2130.31	2239.97	2392.67
Transport	5135.48	6271.71	10788.98	13121.30	11528.46	11827.35	13278.75	15071.82	14933.11	14781.10
Industrial Processes	3236.94	2989.36	3787.40	2749.05	1446.80	1992.57	2328.85	2677.17	2999.58	3365.50
F-Gases	35.23	284.29	955.35	1019.96	1011.70	1142.75	915.69	836.46	721.66	691.78
Agriculture	20963.29	21929.50	21318.16	20347.33	19178.90	19807.19	20800.19	20803.28	20312.87	20295.11
Waste	1567.29	1842.96	1511.63	1315.05	524.59	974.16	622.57	546.66	499.72	459.87
National Total	56102.77	59772.57	69075.66	69981.63	61691.90	59878.21	61561.49	65393.92	66494.97	69216.82
Total (excluding LULUCF)	56102.77	59772.57	69075.66	69981.63	61691.90	59878.21	61561.49	65393.92	66494.97	69216.82
Total (including LULUCF)	61899.75	66482.06	75014.23	75184.83	65861.78	64193.65	66198.81	71409.40	74044.96	76843.59
Memo items										
International Aviation	1080.55	1162.56	1828.63	2526.76	2337.80	2547.11	2349.36	2664.37	2816.93	3003.11
International Maritime Transport	57.36	373.21	482.83	333.69	434.72	496.50	496.50	496.50	496.50	496.50

Summary of Greenhouse Gas Emissions by sector for the With Additional Measures Scenario 1990-2035 (Kt CO₂ equivalent)

	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035
Energy Industries	11434.98	13553.17	16245.03	15858.06	13385.81	11803.22	8707.29	9561.00	10490.81	11631.75
Residential	7523.66	6452.05	6462.60	7271.95	7800.95	6041.36	6060.69	6188.56	6096.82	6072.91
Manufacturing Combustion	3961.75	4347.62	5642.37	5870.71	4497.09	4548.82	5153.81	5233.61	5401.68	6024.33
Commercial / Public Services	2244.14	2101.91	2364.13	2428.22	2317.60	1740.79	1592.13	1743.77	1824.24	1905.35
Transport	5135.48	6271.71	10788.98	13121.30	11528.46	11827.35	13071.93	14839.00	14701.66	14550.69
Industrial Processes	3236.94	2989.36	3787.40	2749.05	1446.80	1992.57	2328.85	2677.17	2999.58	3365.50
F-Gases	35.23	284.29	955.35	1019.96	1011.70	1142.75	915.69	836.46	721.66	691.78
Agriculture	20963.29	21929.50	21318.16	20347.33	19178.90	19807.19	20643.41	20646.50	20156.08	20138.32
Waste	1567.29	1842.96	1511.63	1315.05	524.59	974.16	622.57	546.66	499.72	459.87
National Total	56102.77	59772.57	69075.66	69981.63	61691.90	59878.21	59096.36	62272.75	62892.25	64840.50
Total (excluding LULUCF)	56102.77	59772.57	69075.66	69981.63	61691.90	59878.21	59096.36	62272.75	62892.25	64840.50
Total (including LULUCF)	61899.75	66482.06	75014.23	75184.83	65861.78	64191.89	63733.67	68288.23	70442.24	72467.27
Memo items										
International Aviation	1080.55	1162.56	1828.63	2526.76	2337.80	2547.11	2349.36	2664.37	2816.93	3003.11
International Maritime Transport	57.36	373.21	482.83	333.69	434.72	496.50	496.50	496.50	496.50	496.50

Summary of Greenhouse Gas Emissions by gas for the With Measures Scenario 1990-2035 (Kt CO₂ equivalent)

KtCO ₂ e	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035
Carbon Dioxide	32840.7	35793.19	45192.87	48027.69	41630.06	38392.84	39713.01	43693.76	45481.1	48363.16
Methane	14803.41	14996.77	14292.22	13511.18	11980.58	13263.43	13239.1	13105.75	12617.01	12468.23
Nitrous Oxide	8423.424	8698.323	8635.213	7422.801	7069.567	7079.2	7693.694	7757.951	7675.2	7693.644
F-gases	35.2332	284.29	955.35	1019.96	1011.695	1142.75	915.686	836.4571	721.6584	691.7834
Total	56102.77	59772.57	69075.66	69953.25	61691.9	59878.21	61561.49	65393.92	66494.97	69216.82

Summary of Greenhouse Gas Emissions by gas for the With Additional Measures Scenario 1990-2035 (Kt CO₂ equivalent)

KtCO ₂ e	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035
Carbon Dioxide	32840.7	35793.19	45192.87	48027.69	41630.06	38392.84	37380.25	40694.34	42001.52	44108.19
Methane	14803.41	14996.77	14292.22	13511.18	11980.58	13263.43	13256.97	13122.99	12631.1	12482.17
Nitrous Oxide	8423.424	8698.323	8635.213	7422.801	7069.567	7079.2	7543.442	7618.955	7537.974	7558.355
F-gases	35.2332	284.29	955.35	1019.96	1011.695	1142.75	915.686	836.4571	721.6584	691.7834
Total	56102.77	59772.57	69075.66	69981.63	61691.9	59878.21	59096.36	62272.75	62892.25	64840.5



Roinn Cumarsáide, Gníomhaithe
ar son na hAeráide & Comhshaoil
Department of Communications,
Climate Action & Environment

Third Biennial Report Ireland

A report under the United Nations Framework

Convention on Climate Change

Third Biennial Report – Ireland

This is Ireland's third Biennial Report, as required under Decision 2/CP.17 of the Conference of Parties under the United Nations Framework Convention on Climate Change (UNFCCC)

Ireland's third Biennial Report provides information on Ireland's greenhouse gas emissions, emission reduction action and projections. It also includes up to date information on the provision of public financial support, on technology development and transfer support, and on capacity building support.

Information on Greenhouse Gas Emissions and Trends

Ireland's GHG emission inventory represents the official annual report of all anthropogenic emissions and removals of greenhouse gases in Ireland. It measures Ireland's progress against obligations under the UNFCCC, the Kyoto Protocol, and the Climate and Energy obligations of the European Union.

Ireland's most recent information on GHG emissions as communicated to the UNFCCC is set out in Chapter 3 of Ireland's Seventh National Communication. The National Communication also outlines the main components of Ireland's national system and a description of the structure and functions of Ireland's national registry. The information contained in Ireland's third Biennial Report summarises this information, accounting for Ireland's emissions by gas and by sector.

Quantified Economy-Wide Emissions Reduction Target

As a Member State of the European Union, Ireland has committed to a quantified economy-wide emission reduction target through the pledge submitted by the EU on to reduce its greenhouse gas emissions by 20% by 2020, compared with 1990 levels (FCCC/SB/2011/INF.1/Rev.1 of 7 June 2011)

The EU also provided additional information relating to its quantified economy-wide emission reduction target in 2012 as part of a submission on clarifying developed country Party targets (FCCC/AWGLCA/2012/MISC.1).

This target translates into a reduction of 21% for those sectors covered by the European Union Emissions Trading Scheme (EU ETS) and a 10% target for those sectors not covered by the scheme (outlined in Decision 406/2009/EC). The EU ETS accounts on average for 45% of EU Member State emissions but only 28% of Irish emissions.

The non-ETS target covers emissions from all sources outside the EU ETS, except for international maritime emissions, emissions from some aviation sectors, and those from land use, land-use change and forestry (LULUCF). As outlined in the Seventh National Communication, Ireland has a smaller heavy industry sector than most EU Member States. The reduced scale of Irish industrial emissions relative to the EU average means Ireland's emission reduction target for the non-ETS sector applies to roughly 70% of all Irish emissions.

Progress in Achievement of Quantified Economy-Wide Emissions Reduction Target – Information on Mitigation Actions and their Effects

Ireland's has a Quantified Emission Limitation or Reduction Commitment (2013–2020) (percentage of base year or period), or QELRC, of 80 as set out in the Doha amendment of Annex B to the Kyoto Protocol.¹⁴⁸ The QELRCs for the European Union and its Member States for a second commitment period are based on the understanding that these will be fulfilled jointly with the European Union and its Member States, in accordance with Article 4 of the Kyoto Protocol. The joint assigned amount for the European Union, its Member States and Iceland is calculated pursuant to the QELRC listed in the third column of the table contained in Annex B to the Kyoto Protocol, while the assigned amount of each Member State is determined in accordance with the terms of the joint fulfilment agreement. The assigned amount for Ireland is fixed based on Annex II to European Commission decision 2013/162/EU and as adjusted by Commission implementing decision 2013/634/EU.

The assigned amount for Ireland for the 8 year second commitment period before including deforestation in the base year is 343,467,221 t CO₂ in accordance with the joint fulfilment agreement by the European Union, its Member States and Iceland. When the provisions of Article 3, paragraph 7 bis, are included, Ireland's assigned amount is 343,519,892 t CO₂; (Annual Emission Allocations 2013–2020, 343,467,221 kt CO₂ (as set under the EU agreement) + (8,229.962 kt CO₂ × 0.8 × 8)). These numbers were determined following the expert review of Ireland's report to facilitate the calculation of the assigned amount for the second commitment period of the Kyoto Protocol¹⁴⁹ based on Ireland's greenhouse gas inventory submission in 2016.

¹⁴⁸ Doha amendment to the Kyoto Protocol ([FCCC/KP/CMP/2012/13/Add.1](#))

¹⁴⁹ Report on the review of the report to facilitate the calculation of the assigned amount for the second commitment period of the Kyoto Protocol of Ireland ([FCCC/IRR/2016/IRL](#))

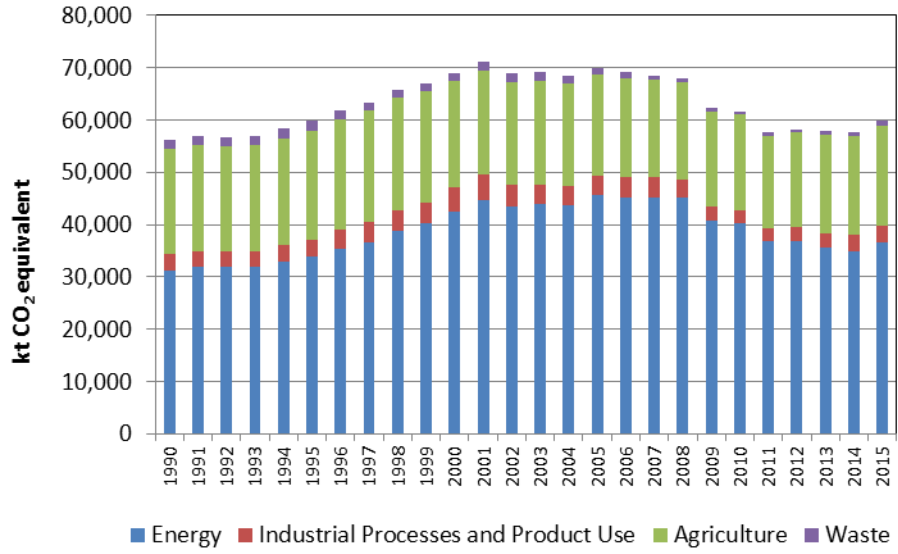


Figure 3.1 Trend in Greenhouse Gas emissions by Sector (excluding LULUCF) 1990-2015

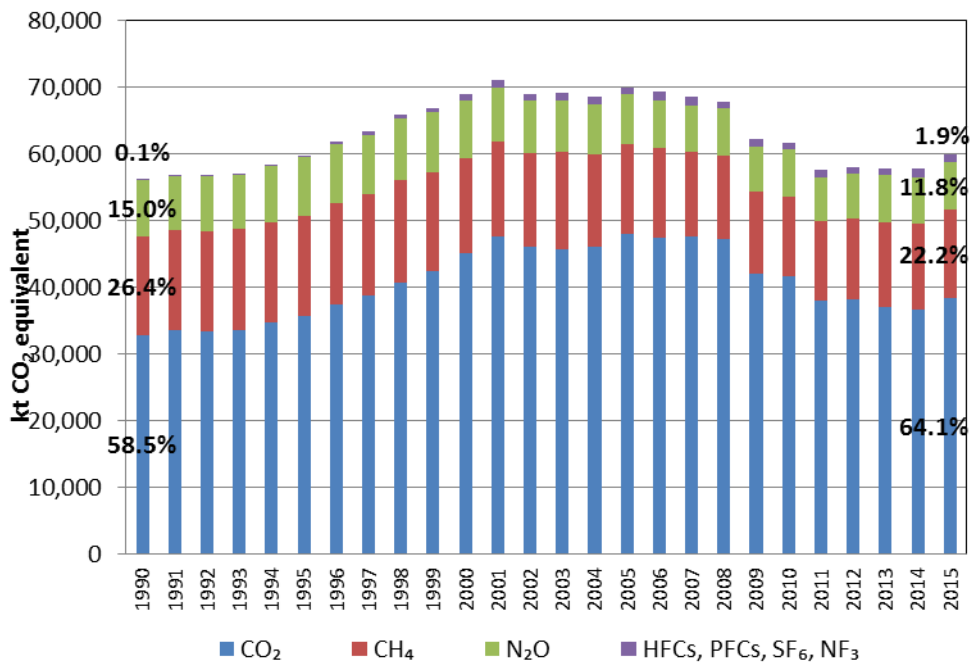


Figure 3.2 Trend in Greenhouse Gas emissions by Gas (excluding LULUCF) 1990-2015

Summary of Key Variables and Assumptions Used in the Projections Analysis

Projections of Ireland's greenhouse gas emissions can be found in Chapter 5 of the National Communication.

The Environmental Protection Agency (EPA) is responsible for developing annual national emission projections for greenhouse gases for all key sectors of the economy, in collaboration with relevant State and other bodies. In addition to informing national policy development, projections are compiled to meet EU reporting obligations (Monitoring Mechanism Regulation No 525/2013¹⁵⁰). The latest projections were published in April 2017 and projected Irish GHG emissions out to 2035¹⁵¹ using two scenarios: a With Measures scenario and a With Additional Measures scenario:

- The With Measures scenario assumes a business as usual scenario, based on measures already put in place at the end of 2015. It assumes that no additional policies and measures beyond these are implemented.
- The With Additional Measures scenario assumes implementation of the With Measures scenario along with additional policy measures being brought forward by 2020, particularly in relation to the Irish Government's renewable energy and energy efficiency targets. In respect of 2017, this scenario takes account of an expected shortfall in achieving full energy efficiency targets and renewable energy targets for electricity, transport and heat as set out in Ireland's National Renewable Energy Action Plan¹⁵² (NREAP) and National Energy Efficiency Action Plan (NEEAP¹⁵³).

Sectoral and overall results of the sensitivity analysis split on emissions covered by Decision 406/2009/EC and total emissions included in the scope of the Union's emissions trading scheme established by Directive 2003/87/EC are outlined in Chapter 5.8 of the National Communication.

¹⁵⁰ Regulation (EU) No 525/2013 of the European Parliament and of the Council of 21 May 2013 on a mechanism for monitoring and reporting greenhouse gas emissions and for reporting other information at national and Union level relevant to climate change and repealing Decision No. 280/2004/EC

¹⁵¹ For 2017 reporting the Monitoring Mechanism Regulation (Regulation (EU)) No. 525/2013) requires Member States to report greenhouse gas emission projections out to 2035

¹⁵² [https://www.dcae.gov.ie/en-ie/energy/topics/Renewable-Energy/irelands-national-renewable-energy-action-plan-\(nreap\)/Pages/Action-Plan.aspx](https://www.dcae.gov.ie/en-ie/energy/topics/Renewable-Energy/irelands-national-renewable-energy-action-plan-(nreap)/Pages/Action-Plan.aspx)

¹⁵³ [https://www.dcae.gov.ie/en-ie/energy/topics/Energy-Efficiency/national-energy-efficiency-action-plan-\(neeap\)/Pages/National-Energy-Efficiency-Action-Plan-\(NEEAP\).aspx](https://www.dcae.gov.ie/en-ie/energy/topics/Energy-Efficiency/national-energy-efficiency-action-plan-(neeap)/Pages/National-Energy-Efficiency-Action-Plan-(NEEAP).aspx)

Information on Updated Greenhouse Gas Projections (With Measures, With Additional Measures)

Chapter 5 of the National Communication gives a detailed outline of the process by which Ireland complies with its reporting requirements under EU and UN obligations. Ireland's Environmental Protection Agency produces an annual report of greenhouse gas emission projections, most recently in April 2017¹⁵⁴.

Details of the variables and assumptions in this regard are outlined in the previous section and in the National Communication.

¹⁵⁴ <http://www.epa.ie/climate/emissionsinventoriesandprojections/nationalemissionsprojections/>

Provision of Public Financial Support

Ireland's climate finance support largely targets adaptation support in agriculture, food and energy systems and helps strengthen the resilience of vulnerable households and communities, particularly in sub-Saharan Africa where Ireland supports seven key partner countries (Ethiopia, Malawi, Uganda, Tanzania, Zambia, Mozambique and Sierra Leone). The majority of Ireland's financial support is channelled through Irish Aid, Ireland's overseas development programme.

Ireland's climate finance is 100% grant funded with the majority supporting adaptation goals and most of Irish Aid support is provided for Least Developed Countries.

Ireland reported climate finance of €33.67m in 2014 and €36 million in 2015.

For the year 2016, Ireland reported a climate finance contribution of **€52.7 million** - including a first contribution of €2 million to the Green Climate Fund and a contribution of €1 million to the Least Developed Countries Fund.

The reason underpinning what appears to be a significant increase over previous years in the reported figure for 2016 is better identification and reporting of supported climate activities. In 2015 Ireland reported only on bilateral funding provided at mission level. In 2016, improved reporting enabled the identification and inclusion of public funding provided to civil society organisations in key partner countries. This has resulted in a more complete picture of Ireland's total climate finance contributions being captured than has been the case heretofore and has given rise to a higher figure for 2016.

Table 7 provides a detailed breakdown of Ireland's multilateral and bilateral public financial support.

Additional information in relation to Ireland's projects and support in its key partner countries can be found in the National Communication.

Provision of Technology Development and Transfer Support

The effective development and transfer of environmentally sound technologies is critical in enabling developing countries to pursue their objectives for sustainable development in a climate-friendly

manner. Technology in the context of the UNFCCC can include physical technologies, knowledge and techniques. Ireland's examples of support include activities which have a significant research component along with activities supporting new technologies.

While Ireland has few stand-alone 'technology transfer' projects per se, funding for climate-related activities often includes technology-related components. Ireland's expertise in the agriculture area in particular has enabled it to support the achievement of better functioning climate-resilient food systems and markets, which are accessible to and which benefit the poor.

Table 8 gives ten of Ireland's most up-to-date examples of support for technology development and transfer in 2016.

Provision of Capacity Building Support

Table 9 of Ireland's Third Biennial Report provides ten up-to-date examples of capacity-building support from 2016. While the UNFCCC asks Parties to report on capacity-building support, there is an absence of an agreed methodology. The majority of Ireland's overseas support programmes are administered by Irish Aid and include some level of capacity building. Over the 2013 – 2016 period in particular, Ireland's Climate Smart Agriculture for smallholder farmer projects in Ethiopia saw the provision of capacity building support at government level and while enhancing food security and improving nutrition and household resilience.

The examples included in Table 9 reflect a specific focus on training individuals and groups in engaging with climate change activities and on building institutional capacity.

Table 1: Emission Trends: Summary (Sheet 1 of 2)

	Base year ^a (kt CO ₂ eq)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
CO ₂ emissions without net CO ₂ from LULUCF	32,840.70	32,840.70	33,580.65	33,416.68	33,647.95	34,770.75	35,793.19	37,409.63	38,750.75	40,648.09	42,375.27	45,192.87	47,557.09	46,027.06	45,627.64
CO ₂ emissions with net CO ₂ from LULUCF	38,282.71	38,282.71	39,080.44	39,063.05	38,693.03	40,196.74	42,028.68	43,137.00	43,176.85	45,671.33	47,445.55	50,653.38	53,657.07	52,635.64	51,991.27
CH ₄ emissions without CH ₄ from LULUCF	14,803.41	14,803.41	14,969.35	15,071.96	15,074.08	14,988.81	14,996.77	15,225.62	15,190.00	15,408.31	14,895.64	14,292.22	14,306.66	14,204.66	14,806.94
CH ₄ emissions with CH ₄ from LULUCF	15,029.97	15,029.97	15,161.33	15,259.65	15,326.42	15,254.64	15,305.32	15,575.06	15,469.22	15,647.85	15,127.73	14,576.59	14,704.83	14,478.56	15,300.25
N ₂ O emissions without N ₂ O from LULUCF	8,423.42	8,423.42	8,238.04	8,241.63	8,249.66	8,466.10	8,698.32	8,827.18	8,827.55	9,245.93	8,988.61	8,635.21	8,204.98	7,858.54	7,714.31
N ₂ O emissions with N ₂ O from LULUCF	8,551.76	8,551.76	8,368.50	8,370.53	8,391.92	8,615.92	8,863.89	9,002.52	8,999.68	9,415.74	9,162.96	8,828.94	8,426.24	8,068.70	7,970.00
HFCs	1.23	1.23	1.41	1.65	3.59	10.96	103.19	171.07	283.86	374.29	376.41	456.66	589.53	606.37	685.12
PFCs	0.12	0.12	9.87	19.62	39.11	58.61	97.61	133.29	169.01	79.22	254.82	397.76	379.51	267.89	285.95
Unspecified mix of HFCs and PFCs	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
SF ₆	33.88	33.88	38.87	43.86	52.9	61.95	79.11	97.46	126.12	88.74	64.19	51.76	64.63	64.48	109.95
NF ₃	NO	NO	NO	NO	NO	NO	4.37	4.72	6.11	4.19	3.79	49.17	21.78	46.58	46.63
Total (without LULUCF)	56,102.77	56,102.77	56,838.19	56,795.40	57,067.30	58,357.18	59,772.57	61,868.97	63,353.39	65,848.76	66,958.74	69,075.66	71,124.17	69,075.59	69,276.55
Total (with LULUCF)	61,899.68	61,899.68	62,660.42	62,758.36	62,506.98	64,198.82	66,482.17	68,121.12	68,230.84	71,281.36	72,435.45	75,014.25	77,843.59	76,168.23	76,389.18
Total (without LULUCF, with indirect)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total (with LULUCF, with indirect)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1. Energy	31,118.48	31,118.48	31,963.99	31,850.61	32,021.17	32,985.66	33,893.13	35,498.82	36,605.20	38,812.66	40,228.00	42,526.11	44,627.23	43,403.41	44,034.69
2. Industrial processes and product use	3,272.17	3,272.17	2,985.56	2,936.96	2,932.97	3,207.02	3,273.64	3,477.90	3,985.71	3,836.26	3,937.77	4,742.75	4,875.71	4,279.93	3,611.53
3. Agriculture	20,144.82	20,144.82	20,240.44	20,294.19	20,349.92	20,357.49	20,762.83	21,169.99	21,313.09	21,706.54	21,293.62	20,295.16	19,996.11	19,660.94	19,843.15
4. Land Use, Land-Use Change and Forestry ^b	5,796.91	5,796.91	5,822.23	5,962.96	5,439.67	5,841.63	6,709.61	6,252.15	4,877.45	5,432.59	5,476.71	5,938.59	6,719.43	7,092.64	7,112.63
5. Waste	1,567.29	1,567.29	1,648.19	1,713.64	1,763.23	1,807.02	1,842.96	1,722.25	1,449.39	1,493.30	1,499.35	1,511.63	1,625.12	1,731.30	1,787.18
6. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total (including LULUCF)	61,899.68	61,899.68	62,660.42	62,758.36	62,506.98	64,198.82	66,482.17	68,121.12	68,230.84	71,281.36	72,435.45	75,014.25	77,843.59	76,168.23	76,389.18

Table 1: Emission Trends: Summary (Sheet 2 of 2)

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Change from base to latest reported year ((%))
CO ₂ emissions without net CO ₂ from LULUCF	46,118.30	48,027.69	47,485.33	47,576.06	47,251.61	42,068.72	41,630.06	37,964.95	38,144.11	37,122.84	36,633.05	38,392.84	16.91
CO ₂ emissions with net CO ₂ from LULUCF	50,836.85	52,682.33	52,991.31	51,786.65	50,307.22	44,578.72	45,007.95	41,444.76	42,116.19	40,795.22	40,618.58	42,060.01	9.87
CH ₄ emissions without CH ₄ from LULUCF	13,838.38	13,511.18	13,461.84	12,801.90	12,604.12	12,232.19	11,980.58	11,936.38	12,235.71	12,564.38	12,881.41	13,263.43	-10.4
CH ₄ emissions with CH ₄ from LULUCF	14,231.67	13,816.29	13,785.81	13,134.58	12,947.89	12,556.79	12,470.17	12,329.37	12,569.97	12,956.01	13,260.76	13,634.24	-9.29
N ₂ O emissions without N ₂ O from LULUCF	7,605.66	7,422.80	7,185.86	6,993.07	6,990.47	6,901.15	7,069.57	6,649.62	6,747.88	7,112.48	7,048.96	7,079.20	-15.96
N ₂ O emissions with N ₂ O from LULUCF	7,852.61	7,666.25	7,430.88	7,249.68	7,265.63	7,173.66	7,372.05	6,925.16	7,016.60	7,389.29	7,324.65	7,354.82	-14
HFCs	682	678.41	898.82	905.91	845.77	915.09	932.02	955.16	948.61	1,070.01	1,152.57	1,076.80	87,154.19
PFCs	234.81	216.39	190.96	168.1	136.14	83.63	46.58	15.88	9.56	8.32	3.56	20.5	17,013.94
Unspecified mix of HFCs and PFCs	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0
SF ₆	65.34	96.78	60.21	62.94	54.69	39.18	33.09	45.45	37.39	43.53	37.4	44.49	31.32
NF ₃	18.08	28.38	28.21	37.67	NO	NO	NO	NO	0.78	0.9	0.96	0.96	100
Total (without LULUCF)	68,562.57	69,981.63	69,311.22	68,545.65	67,882.79	62,239.95	61,691.90	57,567.45	58,124.04	57,922.47	57,757.92	59,878.21	6.73
Total (with LULUCF)	73,921.37	75,184.82	75,386.18	73,345.53	71,557.34	65,347.07	65,861.86	61,715.79	62,699.10	62,263.30	62,398.47	64,191.82	3.7
Total (without LULUCF, with indirect)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0
Total (with LULUCF, with indirect)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0
1. Energy	43,826.44	45,648.81	45,151.83	45,115.23	45,209.88	40,742.36	40,359.59	36,871.72	36,953.58	35,724.96	34,994.70	36,541.63	17.43
2. Industrial processes and product use	3,655.83	3,769.00	3,875.26	3,927.37	3,495.36	2,678.21	2,458.49	2,332.39	2,535.56	2,576.73	3,001.92	3,135.31	-4.18
3. Agriculture	19,572.03	19,248.76	18,932.99	18,629.40	18,464.63	18,278.60	18,349.23	17,748.11	18,094.93	18,923.95	18,882.49	19,227.11	-4.56
4. Land Use, Land-Use Change and Forestry ^b	5,358.80	5,203.19	6,074.96	4,799.88	3,674.55	3,107.12	4,169.96	4,148.35	4,575.06	4,340.82	4,640.56	4,313.61	-25.59
5. Waste	1,508.27	1,315.05	1,351.14	873.64	712.91	540.78	524.59	615.22	539.97	696.84	878.81	974.16	-37.84
6. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0
Total (including LULUCF)	73,921.37	75,184.82	75,386.18	73,345.53	71,557.34	65,347.07	65,861.86	61,715.79	62,699.10	62,263.30	62,398.47	64,191.82	3.7

(1) Further detailed information could be found in the common reporting format tables of the Party's greenhouse gas inventory, namely "Emission trends (CO₂)", "Emission trends (CH₄)", "Emission trends (N₂O)" and "Emission trends (HFCs, PFCs and SF₆)", which is included in an annex to this biennial report.

(2) 2015 is the latest reported inventory year.

(3) 1 kt CO₂ eq equals 1 Gg CO₂ eq.

Abbreviation: LULUCF = land use, land-use change and forestry

^a The column "Base year" should be filled in only by those Parties with economies in transition that use a base year different from 1990 in accordance with the relevant decisions of the Conference of the Parties. For these Parties, this different base year is used to calculate the percentage change in the final column of this table.

^b Includes net CO₂, CH₄ and N₂O from LULUCF.

Table 1 Emission Trends: CO₂ (Sheet 1 of 8)

	Base year ^a (kt)	1990	1991	1992	1993	1994	1995	1996
1. Energy	30,140.30	30,140.30	31,005.85	30,956.38	31,128.60	32,101.25	32,990.42	34,535.33
A. Fuel combustion (sectoral approach)	30,140.27	30,140.27	31,005.82	30,956.35	31,128.57	32,101.22	32,990.39	34,535.30
1. Energy industries	11,145.01	11,145.01	11,604.43	12,263.69	12,282.24	12,618.22	13,301.42	14,016.85
2. Manufacturing industries and construction	3,942.63	3,942.63	4,055.13	3,752.28	3,969.39	4,225.44	4,329.83	4,163.98
3. Transport	5,021.69	5,021.69	5,199.86	5,614.73	5,577.05	5,799.89	6,054.20	7,023.59
4. Other sectors	10,030.94	10,030.94	10,146.40	9,325.65	9,299.89	9,457.66	9,304.94	9,330.87
5. Other	IE	IE	IE	IE	IE	IE	IE	IE
B. Fugitive emissions from fuels	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.04
1. Solid fuels	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.04
C. CO ₂ transport and storage	NO	NO	NO	NO	NO	NO	NO	NO
2. Industrial processes	2,210.28	2,210.28	2,122.90	2,059.05	2,024.41	2,262.44	2,176.16	2,257.95
A. Mineral industry	1,116.73	1,116.73	992.39	932.97	951.13	1,081.70	1,084.18	1,198.39
B. Chemical industry	990.23	990.23	1,030.32	1,003.56	946.19	1,056.63	973.44	922.85
C. Metal industry	26.08	26.08	23.44	20.56	26.08	21.28	24.8	27.28
D. Non-energy products from fuels and solvent use	77.24	77.24	76.76	101.97	101.02	102.83	93.75	109.43
E. Electronic industry								
F. Product uses as ODS substitutes								
G. Other product manufacture and use	NO	NO	NO	NO	NO	NO	NO	NO
H. Other	NO	NO	NO	NO	NO	NO	NO	NO
3. Agriculture	399.51	399.51	360.97	309.92	403.24	315.05	534.28	524.14
A. Enteric fermentation								
B. Manure management								
C. Rice cultivation								
D. Agricultural soils								
E. Prescribed burning of savannas								
F. Field burning of agricultural residues								
G. Liming	355.04	355.04	315.15	255.6	357.3	269.64	494.6	484.03
H. Urea application	44.47	44.47	45.83	54.32	45.94	45.41	39.68	40.11
I. Other carbon-containing fertilizers	NO	NO	NO	NO	NO	NO	NO	NO
J. Other	NO	NO	NO	NO	NO	NO	NO	NO

Note: All footnotes for this table are given at the end of the table

Table 1 Emission Trends CO₂ (Sheet 2 of 8)

	Base year (kt)	1990	1991	1992	1993	1994	1995	1996
4. Land Use, Land-Use Change and Forestry	5,442.02	5,442.02	5,499.79	5,646.37	5,045.08	5,425.98	6,235.48	5,727.37
A. Forest land	-2,692.40	-2,692.40	-2,792.79	-2,147.89	-2,837.59	-2,361.22	-1,971.33	-1,806.50
B. Cropland	26.2	26.2	92.27	-51.07	-8.96	92.96	113.04	-54.25
C. Grassland	7,051.77	7,051.77	7,126.46	6,943.94	6,430.23	6,407.36	6,584.13	6,309.24
D. Wetlands	1,450.45	1,450.45	1,465.56	1,443.69	2,028.43	1,909.90	2,169.88	2,028.12
E. Settlements	19	19	17.72	17.96	18.96	22.28	18.69	23.64
F. Other land	0.55	0.55	0.56	0.57	0.57	0.58	0.85	16.9
G. Harvested wood products	-413.54	-413.54	-409.98	-560.83	-586.57	-645.88	-679.79	-789.78
H. Other	NO	NO	NO	NO	NO	NO	NO	NO
5. Waste	90.61	90.61	90.93	91.33	91.7	92.01	92.33	92.21
A. Solid waste disposal	NO	NO	NO	NO	NO	NO	NO	NO
B. Biological treatment of solid waste								
C. Incineration and open burning of waste	90.61	90.61	90.93	91.33	91.7	92.01	92.33	92.21
D. Waste water treatment and discharge								
E. Other	NO	NO	NO	NO	NO	NO	NO	NO
6. Other (as specified in the summary table in CRF)	NO	NO	NO	NO	NO	NO	NO	NO
International bunkers	1,126.32	1,126.32	1,143.75	955.44	1,509.57	1,308.87	1,520.28	1,555.24
Aviation	1,069.54	1,069.54	1,036.71	901.96	1,338.96	1,185.87	1,150.90	1,056.03
Navigation	56.78	56.78	107.04	53.48	170.61	122.99	369.39	499.22
Multilateral operations	NO	NO	NO	NO	NO	NO	NO	NO
CO₂ emissions from biomass	500.82	500.82	479.54	424.19	429.2	431.66	424.65	468.27
CO₂ captured	NO	NO	NO	NO	NO	NO	NO	NO
Long-term storage of C in waste disposal sites	NE	NE	NE	NE	NE	NE	NE	NE
Indirect N₂O								
Indirect CO₂ (3)	NE, NO, IE	NE, NO, IE	NE, NO, IE	NE, NO, IE	NE, NO, IE	NE, NO, IE	NE, NO, IE	NE, NO, IE
Total CO₂ equivalent emissions with land use, land-use change and forestry	38,282.71	38,282.71	39,080.44	39,063.05	38,693.03	40,196.74	42,028.68	43,137.00
Total CO₂ equivalent emissions, including indirect CO₂, with land use, land-use change and forestry	NA	NA	NA	NA	NA	NA	NA	NA

Note: All footnotes for this table are given at the end of the table

Table 1 Emission Trends CO₂ (Sheet 3 of 8)

	1997	1998	1999	2000	2001	2002	2003	2004
1. Energy	35,623.38	37,761.29	39,451.31	41,738.45	43,827.22	42,631.50	42,605.56	43,084.52
A. Fuel combustion (sectoral approach)	35,623.33	37,761.23	39,412.98	41,738.38	43,771.10	42,631.43	42,605.49	43,084.46
1. Energy industries	14,674.03	15,057.14	15,713.09	16,028.39	17,239.00	16,315.15	15,611.30	15,234.86
2. Manufacturing industries and construction	4,531.29	4,569.06	4,789.51	5,617.86	5,573.76	5,298.38	5,488.05	5,666.09
3. Transport	7,344.83	8,618.23	9,532.18	10,561.82	11,079.75	11,280.50	11,491.16	12,211.72
4. Other sectors	9,073.18	9,516.79	9,378.20	9,530.30	9,878.59	9,737.41	10,014.97	9,971.80
5. Other	IE	IE	IE	IE	IE	IE	IE	IE
B. Fugitive emissions from fuels	0.05	0.06	38.33	0.07	56.12	0.07	0.07	0.06
1. Solid fuels	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	0.05	0.06	38.33	0.07	56.12	0.07	0.07	0.06
C. CO ₂ transport and storage	NO	NO	NO	NO	NO	NO	NO	NO
2. Industrial processes	2,586.86	2,475.96	2,424.36	2,972.52	3,224.13	2,978.72	2,448.29	2,619.43
A. Mineral industry	1,384.92	1,288.13	1,353.71	1,908.78	2,061.44	2,063.38	2,342.32	2,507.06
B. Chemical industry	1,073.12	1,058.81	942.82	882.3	1,041.18	810.9	0.3	NO
C. Metal industry	26.96	28.64	26.8	28.8	12	NO	NO	NO
D. Non-energy products from fuels and solvent use	101.85	100.39	101.03	152.64	109.51	104.45	105.67	112.37
E. Electronic industry								
F. Product uses as ODS substitutes								
G. Other product manufacture and use	NO	NO	NO	NO	NO	NO	NO	NO
H. Other	NO	NO	NO	NO	NO	NO	NO	NO
3. Agriculture	461.5	349.45	430.85	408.63	423.76	311.07	422.86	271.55
A. Enteric fermentation								
B. Manure management								
C. Rice cultivation								

D. Agricultural soils								
E. Prescribed burning of savannas								
F. Field burning of agricultural residues								
G. Liming	423.49	305.58	383.23	366.38	385.28	273.9	386.76	240.8
H. Urea application	38.01	43.87	47.63	42.25	38.47	37.17	36.1	30.75

Note: All footnotes for this table are given at the end of the table

Table 1 Emission Trends CO₂ (Sheet 4 of 8)

	1997	1998	1999	2000	2001	2002	2003	2004
I. Other carbon-containing fertilizers	NO	NO	NO	NO	NO	NO	NO	NO
J. Other	NO	NO	NO	NO	NO	NO	NO	NO
4. Land Use, Land-Use Change and Forestry	4,426.10	5,023.24	5,070.28	5,460.50	6,099.98	6,608.58	6,363.62	4,718.56
A. Forest land	-3,035.49	-2,375.93	-2,424.80	-1,908.47	-1,782.88	-1,644.59	-2,173.87	-3,327.71
B. Cropland	-212.76	43.73	5.82	6.07	94.23	212.77	73.44	52.94
C. Grassland	6,590.28	6,581.57	6,687.49	6,827.67	6,661.14	6,595.45	6,635.44	6,427.13
D. Wetlands	1,834.93	1,631.76	1,641.27	1,554.10	2,114.15	2,271.47	2,873.74	2,516.23
E. Settlements	25.89	27.94	29.9	86.27	98.96	96.14	105.55	108.76
F. Other land	17.17	17.43	17.7	18.12	30.35	30.77	31.2	31.62
G. Harvested wood products	-793.92	-903.26	-887.11	-1,123.27	-1,115.97	-953.42	-1,181.87	-1,090.41
H. Other	NO	NO	NO	NO	NO	NO	NO	NO
5. Waste	79.01	61.39	68.75	73.27	81.98	105.77	150.93	142.79
A. Solid waste disposal	NO	NO	NO	NO	NO	NO	NO	NO
B. Biological treatment of solid waste								
C. Incineration and open burning of waste	79.01	61.39	68.75	73.27	81.98	105.77	150.93	142.79
D. Waste water treatment and discharge								
E. Other	NO	NO	NO	NO	NO	NO	NO	NO
6. Other (as specified in the summary table in CRF)	NO	NO	NO	NO	NO	NO	NO	NO
International bunkers	1,754.75	1,814.69	2,101.27	2,288.28	2,698.62	2,782.70	2,812.30	2,627.74
Aviation	1,277.39	1,315.15	1,557.28	1,810.43	2,188.99	2,327.68	2,272.06	2,153.56
Navigation	477.36	499.54	543.98	477.85	509.63	455.02	540.24	474.19
Multilateral operations	NO	NO	NO	NO	NO	NO	NO	NO
CO₂ emissions from biomass	493.25	587.22	557.22	597.82	654.24	643.32	612.42	715.32
CO₂ captured	NO	NO	NO	NO	NO	NO	NO	NO
Long-term storage of C in waste disposal sites	NE	NE	NE	NE	NE	NE	NE	NE
Indirect N₂O								

Indirect CO₂ (3)	NE, NO, IE	NE, NO, IE	NE, NO, IE	NE, NO, IE	NE, NO, IE	NE, NO, IE	NE, NO, IE	NE, NO, IE
Total CO₂ equivalent emissions with land use, land-use change and forestry	43,176.85	45,671.33	47,445.55	50,653.38	53,657.07	52,635.64	51,991.27	50,836.85
Total CO₂ equivalent emissions, including indirect CO₂, with land use, land-use change and forestry	NA	NA	NA	NA	NA	NA	NA	NA

Note: All footnotes for this table are given at the end of the table

Table 1 Emission Trends CO₂ (Sheet 5 of 8)

	2005	2006	2007	2008	2009	2010
1. Energy	44,893.69	44,417.34	44,379.54	44,478.03	40,057.30	39,696.72
A. Fuel combustion (sectoral approach)	44,893.64	44,417.29	44,379.49	44,477.99	40,057.26	39,696.67
1. Energy industries	15,657.29	14,906.98	14,406.63	14,495.44	12,926.12	13,176.05
2. Manufacturing industries and construction	5,838.94	5,722.52	5,782.42	5,626.81	4,481.77	4,472.90
3. Transport	12,906.10	13,591.35	14,188.55	13,500.85	12,295.75	11,392.53
4. Other sectors	10,491.30	10,196.44	10,001.88	10,854.88	10,353.61	10,655.20
5. Other	IE	IE	IE	IE	IE	IE
B. Fugitive emissions from fuels	0.05	0.05	0.05	0.04	0.04	0.04
1. Solid fuels	NO	NO	NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	0.05	0.05	0.05	0.04	0.04	0.04
C. CO ₂ transport and storage	NO	NO	NO	NO	NO	NO
2. Industrial processes	2,712.09	2,659.23	2,713.64	2,418.68	1,599.78	1,406.08
A. Mineral industry	2,552.80	2,538.74	2,582.80	2,303.11	1,486.14	1,300.01
B. Chemical industry	NO	NO	NO	NO	NO	NO
C. Metal industry	NO	NO	NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	159.3	120.49	130.83	115.57	113.64	106.06
E. Electronic industry						
F. Product uses as ODS substitutes						
G. Other product manufacture and use	NO	NO	NO	NO	NO	NO
H. Other	NO	NO	NO	NO	NO	NO
3. Agriculture	294.63	284.41	400.12	292.97	348.25	473.1
A. Enteric fermentation						
B. Manure management						
C. Rice cultivation						

D. Agricultural soils						
E. Prescribed burning of savannas						
F. Field burning of agricultural residues						
G. Liming	266.73	254.86	376.77	262.21	307.32	427.93
H. Urea application	27.9	29.55	23.36	30.76	40.93	45.16

Note: All footnotes for this table are given at the end of the table

Table 1 Emission Trends CO₂ (Sheet 6 of 8)

	2005	2006	2007	2008	2009	2010
I. Other carbon-containing fertilizers	NO	NO	NO	NO	NO	NO
J. Other	NO	NO	NO	NO	NO	NO
4. Land Use, Land-Use Change and Forestry	4,654.64	5,505.98	4,210.59	3,055.61	2,510.01	3,377.89
A. Forest land	-3,033.06	-2,978.25	-3,505.85	-4,896.65	-4,985.99	-4,104.46
B. Cropland	-35.7	-110.22	-67.05	60.61	-9.2	-91.59
C. Grassland	6,412.91	6,156.82	6,153.28	6,034.81	6,370.20	5,933.18
D. Wetlands	2,289.92	2,031.09	2,356.51	2,020.29	1,783.56	2,350.93
E. Settlements	118.21	193.48	462.61	455.48	51.18	60.14
F. Other land	32.04	1,450.34	9.49	19.62	11.1	11.09
G. Harvested wood products	-1,129.67	-1,237.28	-1,198.40	-638.55	-710.84	-781.41
H. Other	NO	NO	NO	NO	NO	NO
5. Waste	127.27	124.35	82.76	61.94	63.38	54.17
A. Solid waste disposal	NO	NO	NO	NO	NO	NO
B. Biological treatment of solid waste						
C. Incineration and open burning of waste	127.27	124.35	82.76	61.94	63.38	54.17
D. Waste water treatment and discharge						
E. Other	NO	NO	NO	NO	NO	NO
6. Other (as specified in the summary table in CRF)	NO	NO	NO	NO	NO	NO
International bunkers	2,832.21	3,285.79	3,409.80	3,059.36	2,544.18	2,745.33
Aviation	2,501.97	2,881.46	3,052.83	2,838.50	2,240.57	2,315.09
Navigation	330.25	404.32	356.97	220.86	303.61	430.24
Multilateral operations	NO	NO	NO	NO	NO	NO
CO₂ emissions from biomass	902.29	931.42	1,008.87	1,081.84	1,223.83	1,366.14
CO₂ captured	NO	NO	NO	NO	NO	NO

Long-term storage of C in waste disposal sites	NE	NE	NE	NE	NE	NE
Indirect N₂O						
Indirect CO₂ (3)	NE, NO, IE	NE, NO, IE	NE, NO, IE	NE, NO, IE	NE, NO, IE	NE, NO, IE
Total CO₂ equivalent emissions with land use, land-use change and forestry	52,682.33	52,991.31	51,786.65	50,307.22	44,578.72	45,007.95
Total CO₂ equivalent emissions, including indirect CO₂, with land use, land-use change and forestry	NA	NA	NA	NA	NA	NA

Note: All footnotes for this table are given at the end of the table

Table 1 Emission Trends CO₂ (Sheet 7 of 8)

	2011	2012	2013	2014	2015	Change from base to latest reported year (%)
1. Energy	36,255.48	36,350.11	35,129.54	34,420.27	35,981.23	19.38
A. Fuel combustion (sectoral approach)	36,255.44	36,350.08	35,129.52	34,420.25	35,980.86	19.38
1. Energy industries	11,798.09	12,633.59	11,239.25	11,018.01	11,631.37	4.36
2. Manufacturing industries and construction	4,138.35	4,168.19	4,217.73	4,299.83	4,524.99	14.77
3. Transport	11,087.46	10,707.58	10,934.61	11,212.24	11,692.86	132.85
4. Other sectors	9,231.54	8,840.72	8,737.94	7,890.17	8,131.64	-18.93
5. Other	IE	IE	IE	IE	IE	0
B. Fugitive emissions from fuels	0.03	0.03	0.02	0.02	0.37	1,142.26
1. Solid fuels	NO	NO	NO	NO	NO	0
2. Oil and natural gas and other emissions from energy production	0.03	0.03	0.02	0.02	0.37	1,142.26
C. CO ₂ transport and storage	NO	NO	NO	NO	NO	0
2. Industrial processes	1,275.00	1,498.23	1,412.89	1,766.22	1,951.13	-11.72
A. Mineral industry	1,168.75	1,393.44	1,301.70	1,650.45	1,830.36	63.9
B. Chemical industry	NO	NO	NO	NO	NO	
C. Metal industry	NO	NO	NO	NO	NO	
D. Non-energy products from fuels and solvent use	106.25	104.79	111.2	115.77	120.76	56.35
E. Electronic industry						
F. Product uses as ODS substitutes						
G. Other product manufacture and use	NO	NO	NO	NO	NO	0
H. Other	NO	NO	NO	NO	NO	0
3. Agriculture	393	250.72	537.35	407.4	420.81	5.33
A. Enteric fermentation						

B. Manure management						
C. Rice cultivation						
D. Agricultural soils						
E. Prescribed burning of savannas						
F. Field burning of agricultural residues						
G. Liming	360.68	229.4	515.69	382.32	392.51	10.55
H. Urea application	32.32	21.32	21.66	25.09	28.31	-36.35
I. Other carbon-containing fertilizers	NO	NO	NO	NO	NO	0
J. Other	NO	NO	NO	NO	NO	0

Table 1 Emission Trends: CO₂ (Sheet 8 of 8)

	2011	2012	2013	2014	2015	Change from base to latest reported year (%)
4. Land Use, Land-Use Change and Forestry	3,479.81	3,972.08	3,672.39	3,985.52	3,667.17	-32.61
A. Forest land	-3,994.96	-3,411.92	-3,672.98	-3,413.60	-3,820.27	41.89
B. Cropland	-2.95	35.91	39.16	-8.57	-53.47	-304.1
C. Grassland	5,760.09	5,725.62	5,737.87	5,764.56	5,667.04	-19.64
D. Wetlands	2,425.21	2,045.12	2,207.82	2,327.07	2,493.26	71.9
E. Settlements	24.52	227.46	35.74	28.35	32.78	72.5
F. Other land	11.08	11.07	11.06	53.7	79.29	14,372.39
G. Harvested wood products	-743.18	-661.17	-686.28	-765.99	-731.46	76.88
H. Other	NO	NO	NO	NO		
5. Waste	41.47	45.05	43.05	39.16	39.66	-56.23
A. Solid waste disposal	NO	NO	NO	NO	NO	0
B. Biological treatment of solid waste						
C. Incineration and open burning of waste	41.47	45.05	43.05	39.16	39.66	-56.23
D. Waste water treatment and discharge						
E. Other	NO	NO	NO	NO	NO	0
6. Other (as specified in the summary table in CRF)	NO	NO	NO	NO	NO	0
International bunkers	2,408.13	2,138.77	2,461.71	2,644.14	3,013.64	167.57
Aviation	2,074.20	1,741.62	2,010.65	2,229.01	2,522.29	135.83
Navigation	333.93	397.15	451.06	415.13	491.35	765.42
Multilateral operations	NO	NO	NO	NO	NO	0
CO₂ emissions from biomass	1,389.82	1,517.56	1,683.81	1,910.13	1,870.83	273.56
CO₂ captured	NO	NO	NO	NO	NO	0
Long-term storage of C in waste disposal sites	NE	NE	NE	NE		

Indirect N₂O						
Indirect CO₂ (3)	NE, NO, IE	NE, NO, IE	NE, NO, IE	NE, NO, IE	NO, NE, IE	0
Total CO₂ equivalent emissions with land use, land-use change and forestry	41,444.76	42,116.19	40,795.22	40,618.58	42,060.01	9.87
Total CO₂ equivalent emissions, including indirect CO₂, with land use, land-use change and forestry	NA	NA	NA	NA	NA	0

Abbreviations: CRF = common reporting format, LULUCF = land use, land-use change and forestry

^a The column "Base year" should be filled in only by those Parties with economies in transition that use a base year different from 1990 in accordance

^b Fill in net emissions/removals as reported in CRF table Summary 1.A of the latest reported inventory year. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

Table 1. Emission Trends: CH₄ (Sheet 1 of 6)

	Base year ^a (kt)	1990	1991	1992	1993	1994	1995	1996	1997
1. Energy	28.97	28.97	28.01	25.02	24.37	22.36	20.9	20.65	18.88
A. Fuel combustion (sectoral approach)	20.49	20.49	20.14	17.53	17.06	15.33	14.12	14.14	12.64
1. Energy industries	0.27	0.27	0.27	0.27	0.29	0.29	0.31	0.36	0.37
2. Manufacturing industries and construction	0.27	0.27	0.27	0.23	0.24	0.23	0.24	0.26	0.26
3. Transport	1.92	1.92	1.98	2.02	1.9	1.85	1.84	1.82	1.72
4. Other sectors	18.04	18.04	17.63	15.02	14.62	12.95	11.72	11.7	10.29
5. Other	IE	IE	IE	IE	IE	IE	IE	IE	IE
B. Fugitive emissions from fuels	8.47	8.47	7.87	7.49	7.31	7.04	6.78	6.51	6.24
1. Solid fuels	2.22	2.22	1.8	1.63	1.51	1.41	1.33	1.26	1.21
2. Oil and natural gas and other emissions from energy production	6.25	6.25	6.07	5.86	5.81	5.63	5.45	5.25	5.04
C. CO ₂ transport and storage									
2. Industrial processes	NO	NO	NO	NO	NO	NO	NO	NO	NO
A. Mineral industry									
B. Chemical industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	NO	NO	NO	NO	NO	NO	NO	NO	NO
E. Electronic industry									
F. Product uses as ODS substitutes									
G. Other product manufacture and use	NO	NO	NO	NO	NO	NO	NO	NO	NO
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Agriculture	507.97	507.97	512.32	516.89	515.64	512.41	512.72	526.96	537.76
A. Enteric fermentation	454.28	454.28	458.16	462.24	461.23	458.6	459.2	471.59	481.39
B. Manure management	53.69	53.69	54.17	54.65	54.41	53.81	53.51	55.38	56.37
C. Rice cultivation	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Agricultural soils	NE	NE	NE	NE	NE	NE	NE	NE	NE
E. Prescribed burning of savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Field burning of agricultural residues	NO	NO	NO	NO	NO	NO	NO	NO	NO
G. Liming									
H. Urea application									
I. Other carbon-containing fertilizers									
J. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
4. Land use, land-use change and forestry	9.06	9.06	7.68	7.51	10.09	10.63	12.34	13.98	11.17
A. Forest land	2.34	2.34	2.25	2.2	2.44	2.56	2.81	2.95	2.69
B. Cropland	0	0	0	0	0	0	0	0	0
C. Grassland	1.65	1.65	1.07	1.39	2.52	2.72	3.29	4.56	3.48
D. Wetlands	5.06	5.06	4.37	3.91	5.14	5.35	6.24	6.47	5
E. Settlements	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Other land	NO	NO	NO	NO	NO	NO	NO	NO	NO
G. Harvested wood products									
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO

Table 1. Emission Trends: CH₄ (Sheet 2 of 6)

	Base year ^a (kt)	1990	1991	1992	1993	1994	1995	1996	1997
5. Waste	55.2	55.2	58.44	60.97	62.95	64.78	66.26	61.41	50.95
A. Solid waste disposal	52.72	52.72	55.94	58.46	60.42	62.24	63.71	58.87	48.51
B. Biological treatment of solid waste	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Incineration and open burning of waste	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.04
D. Waste water treatment and discharge	2.44	2.44	2.46	2.48	2.49	2.5	2.51	2.5	2.4
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
6. Other (as specified in the summary table in CRF)	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total CH₄ emissions with CH₄ from LULUCF	601.2	601.2	606.45	610.39	613.06	610.19	612.21	623	618.77
Memo items:									
Aviation	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Navigation	0.01	0.01	0.01	0	0.02	0.01	0.03	0.05	0.05
Multilateral operations	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO₂ emissions from biomass									
CO₂ captured									
Long-term storage of C in waste disposal sites									
Indirect N₂O									
Indirect CO₂ (3)									
CO₂ emissions from biomass									
CO₂ captured									
Long-term storage of C in waste disposal sites									
Indirect N₂O									
Indirect CO₂ (3)									

Table 1. Emission Trends: CH₄ (Sheet 3 of 6)

	1998	1999	2000	2001	2002	2003	2004	2005	2006
1. Energy	18.87	16.21	15.91	15.84	14.44	40.48	13.57	13.51	12.71
A. Fuel combustion (sectoral approach)	13.31	10.82	10.77	10.41	10.13	9.65	9.45	9.86	9.55
1. Energy industries	0.37	0.4	0.44	0.46	0.43	0.41	0.36	0.37	0.35
2. Manufacturing industries and construction	0.28	0.29	0.34	0.35	0.34	0.36	0.39	0.45	0.43
3. Transport	1.78	1.74	1.62	1.59	1.47	1.39	1.36	1.36	1.3
4. Other sectors	10.88	8.4	8.38	8	7.88	7.49	7.34	7.68	7.47
5. Other	IE	IE	IE	IE	IE	IE	IE	IE	IE
B. Fugitive emissions from fuels	5.56	5.39	5.15	5.43	4.32	30.83	4.12	3.65	3.17
1. Solid fuels	1.16	1.12	1.08	1.05	1.02	0.99	0.97	0.94	0.92
2. Oil and natural gas and other emissions from energy production	4.4	4.27	4.07	4.38	3.3	29.84	3.15	2.71	2.25
C. CO ₂ transport and storage									
2. Industrial processes	NO	NO	NO	NO	NO	NO	NO	NO	NO
A. Mineral industry									
B. Chemical industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	NO	NO	NO	NO	NO	NO	NO	NO	NO
E. Electronic industry									
F. Product uses as ODS substitutes									
G. Other product manufacture and use	NO	NO	NO	NO	NO	NO	NO	NO	NO
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Agriculture	544.19	526.55	502.49	499.16	493.32	491.08	490.06	484.27	481.6
A. Enteric fermentation	487.18	471.83	450.43	447.19	441.94	440.32	439.53	433.73	431.58
B. Manure management	57.01	54.72	52.05	51.97	51.38	50.76	50.52	50.54	50.02
C. Rice cultivation	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Agricultural soils	NE	NE	NE	NE	NE	NE	NE	NE	NE
E. Prescribed burning of savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Field burning of agricultural residues	NO	NO	NO	NO	NO	NO	NO	NO	NO
G. Liming									
H. Urea application									
I. Other carbon-containing fertilizers									
J. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
4. Land use, land-use change and forestry	9.58	9.28	11.37	15.93	10.96	19.73	15.73	12.2	12.96
A. Forest land	2.56	2.55	2.82	3.25	2.7	3.64	3.22	2.85	2.85
B. Cropland	0	0	0	0	0	0.01	0	0	0
C. Grassland	2.91	2.79	3.64	5.86	3.98	7.31	6.47	5.35	6.16
D. Wetlands	4.11	3.94	4.91	6.82	4.28	8.78	6.04	4	3.94
E. Settlements	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Other land	NO	NO	NO	NO	NO	NO	NO	NO	NO

G. Harvested wood products									
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO

Table 1. Emission Trends: CH₄ (Sheet 4 of 6)

	1998	1999	2000	2001	2002	2003	2004	2005	2006
5. Waste	53.28	53.07	53.29	57.27	60.43	60.72	49.91	42.67	44.16
A. Solid waste disposal	50.54	50.45	50.73	54.58	57.51	58.29	47.63	40.28	41.97
B. Biological treatment of solid waste	NO	NO	NO	0.09	0.14	0.19	0.2	0.32	0.32
C. Incineration and open burning of waste	0.04	0.06	0.06	0.08	0.18	0.24	0.14	0.09	0.09
D. Waste water treatment and discharge	2.7	2.56	2.5	2.52	2.61	2.01	1.93	1.97	1.77
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
6. Other (as specified in the summary table in CRF)	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total CH₄ emissions with CH₄ from LULUCF	625.91	605.11	583.06	588.19	579.14	612.01	569.27	552.65	551.43
Memo items:									
Aviation	0.01	0.01	0.01	0.01	0.01	0.01	0.03	0.02	0.01
Navigation	0.05	0.05	0.05	0.05	0.04	0.05	0.04	0.03	0.04
Multilateral operations	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO₂ emissions from biomass									
CO₂ captured									
Long-term storage of C in waste disposal sites									
Indirect N₂O									
Indirect CO₂ (3)									
CO₂ emissions from biomass									
CO₂ captured									
Long-term storage of C in waste disposal sites									
Indirect N₂O									
Indirect CO₂ (3)									

Table 1. Emission Trends: CH₄ (Sheet 5 of 6)

	2007	2008	2009	2010	2011	2012	2013	2014	2015	Change - base to latest reported year (%)
1. Energy	13.07	12.97	12.42	11.74	10.76	10.4	10.62	9.83	9.45	-67.39
A. Fuel combustion (sectoral approach)	9.32	9.63	9.86	9.38	8.61	8.43	8.87	7.9	7.74	-62.25
1. Energy industries	0.36	0.29	0.28	0.28	0.23	0.28	0.27	0.27	0.27	0.02
2. Manufacturing industries and construction	0.42	0.39	0.34	0.35	0.31	0.3	0.31	0.35	0.36	33.7
3. Transport	1.24	1.15	1.02	0.9	0.83	0.75	0.69	0.65	0.65	-66.04
4. Other sectors	7.31	7.8	8.22	7.85	7.23	7.11	7.6	6.63	6.46	-64.18
5. Other	IE	IE	IE	IE	IE	IE	IE	IE	IE	0
B. Fugitive emissions from fuels	3.75	3.34	2.56	2.35	2.16	1.96	1.75	1.93	1.71	-79.82
1. Solid fuels	0.9	0.88	0.87	0.85	0.83	0.82	0.81	0.79	0.78	-64.83
2. Oil, natural gas, other emissions from energy production	2.85	2.46	1.69	1.51	1.32	1.14	0.94	1.13	0.93	-85.15
C. CO ₂ transport and storage										
2. Industrial processes	NO	NO	NO	NO	NO	NO	NO	NO	NO	0
A. Mineral industry										
B. Chemical industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	0
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	0
D. Non-energy products from fuels and solvent use	NO	NO	NO	NO	NO	NO	NO	NO	NO	0
E. Electronic industry										
F. Product uses as ODS substitutes										
G. Other product manufacture and use	NO	NO	NO	NO	NO	NO	NO	NO	NO	0
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	0
3. Agriculture	472.3	470.22	462.93	453.84	448.87	464.37	470.95	476.94	488.84	-3.77
A. Enteric fermentation	423.48	421.56	414.8	406.48	401.81	415.17	421.31	426.75	437.46	-3.7
B. Manure management	48.82	48.65	48.13	47.36	47.06	49.2	49.64	50.19	51.38	-4.3
C. Rice cultivation	NO	NO	NO	NO	NO	NO	NO	NO	NO	0
D. Agricultural soils	NE	NE	NE	NE	NE	NE	NE	NE	NE	0
E. Prescribed burning of savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	0
F. Field burning of agricultural residues	NO	NO	NO	NO	NO	NO	NO	NO	NO	0
G. Liming										
H. Urea application										
I. Other carbon-containing fertilizers										
J. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	0

Table 1. Emission Trends: CH₄ (Sheet 6 of 6)

	2007	2008	2009	2010	2011	2012	2013	2014	2015	Change from base to latest reported year (%)
4. Land use, land-use change and forestry	13.31	13.75	12.98	19.58	15.72	13.37	15.67	15.17	14.83	63.67
A. Forest land	2.89	2.9	2.8	3.64	3.04	2.79	3.09	3.03	2.92	24.52
B. Cropland	0	0	0	0	0	0	0	0	0	-72.02
C. Grassland	6.26	7	6.85	9.48	8.44	7.4	8.29	8.14	8.36	405.38
D. Wetlands	4.15	3.85	3.33	6.46	4.23	3.18	4.29	4	3.55	-29.8
E. Settlements	NO	NO	NO	NO	NO	NO	NO	NO	NO	0
F. Other land	NO	NO	NO	NO	NO	NO	NO	NO	NO	0
G. Harvested wood products										
H. Other	NO	NO	NO	NO	NO	NO	NO	NO		
5. Waste	26.7	20.97	13.94	13.65	17.82	14.66	21.01	28.48	32.25	-41.58
A. Solid waste disposal	24.64	18.55	11.39	11.15	15.26	12.11	18.44	25.92	29.66	-43.75
B. Biological treatment of solid waste	0.29	0.38	0.49	0.49	0.53	0.52	0.53	0.45	0.45	100
C. Incineration and open burning of waste	0	0	0	0	0.02	0	0	0	0	-91.22
D. Waste water treatment and discharge	1.77	2.03	2.06	2.01	2	2.03	2.03	2.11	2.14	-12.43
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	0
6. Other (as specified in the summary table in CRF)	NO	NO	NO	NO	NO	NO	NO	NO	NO	0
Total CH₄ emissions with CH₄ from LULUCF	525.38	517.92	502.27	498.81	493.17	502.8	518.24	530.43	545.37	-9.29
Memo items:										
Aviation	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	-32.09
Navigation	0.03	0.02	0.03	0.04	0.03	0.04	0.04	0.04	0.05	778.21
Multilateral operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	0
CO₂ emissions from biomass										
CO₂ captured										
Long-term storage of C in waste disposal sites										
Indirect N₂O	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE
Indirect CO₂ (3)										

Abbreviations: CRF = common reporting format, LULUCF = land use, land-use change and forestry.

a The column "Base year" should be filled in only by those Parties with economies in transition that use a base year different from 1990 in accordance with the relevant decisions of the Conference of the Parties. For these Parties, this different base year is used to calculate the percentage change in the final column of this table.

Table 1 Emission Trends N₂O (sheet 1 of 6)

	Base Year ^a (kt)	1990	1991	1992	1993	1994	1995	1996	1997
1. Energy	0.85	0.85	0.86	0.9	0.95	1.09	1.28	1.5	1.71
A. Fuel combustion (sectoral approach)	0.85	0.85	0.86	0.9	0.95	1.09	1.28	1.5	1.71
1. Energy industries	0.24	0.24	0.25	0.25	0.24	0.25	0.25	0.26	0.26
2. Manufacturing industries and construction	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
3. Transport	0.22	0.22	0.22	0.27	0.33	0.43	0.58	0.85	1.05
4. Other sectors	0.35	0.35	0.36	0.35	0.35	0.37	0.41	0.35	0.35
5. Other	IE	IE	IE	IE	IE	IE	IE	IE	IE
B. Fugitive emissions from fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO
1. Solid fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. CO ₂ transport and storage									
2. Industrial processes	3.45	3.45	2.73	2.73	2.73	2.73	2.73	2.73	2.73
A. Mineral industry									
B. Chemical industry	3.34	3.34	2.62	2.62	2.62	2.62	2.62	2.62	2.62
C. Metal industry									
D. Non-energy products from fuels and solvent use	NO	NO	NO	NO	NO	NO	NO	NO	NO
E. Electronic industry									
F. Product uses as ODS substitutes									
G. Other product manufacture and use	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Agriculture	23.64	23.64	23.73	23.7	23.68	24.27	24.87	25.07	24.86
A. Enteric fermentation									
B. Manure management	1.61	1.61	1.64	1.66	1.67	1.68	1.69	1.76	1.83
C. Rice cultivation									
D. Agricultural soils	22.03	22.03	22.08	22.04	22	22.59	23.17	23.31	23.03
E. Prescribed burning of savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Field burning of agricultural residues	NO	NO	NO	NO	NO	NO	NO	NO	NO
G. Liming									
H. Urea application									
I. Other carbon containing fertilizers									
J. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO

Table 1 Emission Trends N₂O (sheet 2 of 6)

	Base year ^a (kt)	1990	1991	1992	1993	1994	1995	1996	1997
4. Land use, land-use change and forestry	0.43	0.43	0.44	0.43	0.48	0.5	0.56	0.59	0.58
A. Forest land	0.31	0.31	0.33	0.34	0.36	0.37	0.4	0.41	0.42
B. Cropland	0	0	0	0	0	0	0	0	0
C. Grassland	0	0	0.01	0	0	0	0.01	0.01	0.03
D. Wetlands	0.1	0.1	0.08	0.07	0.09	0.1	0.12	0.13	0.09
E. Settlements	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.04
F. Other land	0	0	0	0	0	0	0	0	0
G. Harvested wood products									
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
5. Waste	0.32	0.32	0.32	0.33	0.33	0.32	0.32	0.32	0.32
A. Solid waste disposal									
B. Biological treatment of solid waste	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Incineration and open burning of waste	0	0	0	0	0	0	0	0	0
D. Waste water treatment and discharge	0.32	0.32	0.32	0.33	0.32	0.32	0.31	0.31	0.32
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
6. Other (as specified in the summary table in CRF)	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total direct N₂O emissions with N₂O from LULUCF	28.7	28.7	28.08	28.09	28.16	28.91	29.74	30.21	30.2
Memo items:									
Aviation	0.04	0.04	0.03	0.03	0.04	0.04	0.04	0.04	0.04
Navigation	0	0	0	0	0	0	0.01	0.01	0.01
Multilateral operations	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO₂ emissions from biomass									
CO₂ captured									
Long-term storage of C in waste disposal sites									
Indirect N₂O	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE
Indirect CO₂ (3)									

Table 1 Emission Trends N₂O (sheet 3 of 6)

	1998	1999	2000	2001	2002	2003	2004	2005	2006
1. Energy	1.95	1.25	1.31	1.36	1.38	1.4	1.35	1.4	1.4
A. Fuel combustion (sectoral approach)	1.95	1.25	1.31	1.36	1.38	1.4	1.35	1.4	1.4
1. Energy industries	0.25	0.26	0.26	0.28	0.32	0.35	0.31	0.34	0.36
2. Manufacturing industries and construction	0.05	0.05	0.05	0.06	0.05	0.06	0.06	0.07	0.07
3. Transport	1.29	0.58	0.63	0.65	0.64	0.62	0.62	0.61	0.6
4. Other sectors	0.35	0.36	0.37	0.37	0.37	0.38	0.36	0.39	0.37
5. Other	IE	IE	IE	IE	IE	IE	IE	IE	IE
B. Fugitive emissions from fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO
1. Solid fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. CO ₂ transport and storage									
2. Industrial processes	2.73	2.73	2.73	2	1.06	0.12	0.12	0.12	0.13
A. Mineral industry									
B. Chemical industry	2.62	2.62	2.62	1.89	0.94	NO	NO	NO	NO
C. Metal industry									
D. Non-energy products from fuels and solvent use	NO	NO	NO	NO	NO	NO	NO	NO	NO
E. Electronic industry									
F. Product uses as ODS substitutes									
G. Other product manufacture and use	0.11	0.11	0.11	0.12	0.12	0.12	0.12	0.12	0.13
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Agriculture	26.01	25.84	24.58	23.8	23.55	23.97	23.65	22.98	22.18
A. Enteric fermentation									
B. Manure management	1.87	1.8	1.71	1.73	1.73	1.72	1.71	1.74	1.71
C. Rice cultivation									
D. Agricultural soils	24.15	24.04	22.87	22.08	21.82	22.25	21.94	21.24	20.47
E. Prescribed burning of savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Field burning of agricultural residues	NO	NO	NO	NO	NO	NO	NO	NO	NO
G. Liming									
H. Urea application									
I. Other carbon containing fertilizers									
J. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO

Table 1 Emission Trends N₂O (sheet 4 of 6)

	1998	1999	2000	2001	2002	2003	2004	2005	2006
4. Land use, land-use change and forestry	0.57	0.59	0.65	0.74	0.71	0.86	0.83	0.82	0.82
A. Forest land	0.43	0.44	0.46	0.48	0.49	0.5	0.5	0.51	0.52
B. Cropland	0	0	0	0	0	0	0	0	0
C. Grassland	0.03	0.04	0.05	0.04	0.04	0.04	0.05	0.05	0.05
D. Wetlands	0.07	0.06	0.09	0.14	0.07	0.18	0.12	0.07	0.07
E. Settlements	0.04	0.04	0.06	0.09	0.1	0.13	0.16	0.19	0.18
F. Other land	0	0	0	0	0	0	0	0	0
G. Harvested wood products									
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
5. Waste	0.34	0.35	0.36	0.37	0.39	0.4	0.4	0.41	0.41
A. Solid waste disposal									
B. Biological treatment of solid waste	NO	NO	NO	0.01	0.01	0.01	0.01	0.02	0.02
C. Incineration and open burning of waste	0	0	0	0	0.01	0.01	0.01	0.01	0.01
D. Waste water treatment and discharge	0.33	0.35	0.35	0.36	0.37	0.38	0.38	0.38	0.39
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
6. Other (as specified in the summary table in CRF)	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total direct N₂O emissions with N₂O from LULUCF	31.6	30.75	29.63	28.28	27.08	26.74	26.35	25.73	24.94
Memo items:									
Aviation	0.04	0.05	0.06	0.07	0.08	0.07	0.07	0.08	0.09
Navigation	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Multilateral operations	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO₂ emissions from biomass									
CO₂ captured									
Long-term storage of C in waste disposal sites									
Indirect N₂O	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE
Indirect CO₂ (3)									

Table 1 Emission Trends N₂O (sheet 5 of 6)

	2007	2008	2009	2010	2011	2012	2013	2014	2015	Change from base to latest reported year (%)
1. Energy	1.37	1.37	1.26	1.24	1.16	1.15	1.11	1.1	1.09	27.64
A. Fuel combustion (sectoral approach)	1.37	1.37	1.26	1.24	1.16	1.15	1.11	1.1	1.09	27.64
1. Energy industries	0.39	0.48	0.46	0.48	0.44	0.45	0.42	0.42	0.41	70.78
2. Manufacturing industries and construction	0.06	0.06	0.05	0.05	0.05	0.04	0.04	0.05	0.05	19.76
3. Transport	0.57	0.44	0.4	0.38	0.37	0.37	0.38	0.4	0.4	79.8
4. Other sectors	0.36	0.39	0.34	0.32	0.31	0.29	0.26	0.24	0.23	-33.82
5. Other	IE	IE	IE	IE	IE	IE	IE	IE	IE	0
B. Fugitive emissions from fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	0
1. Solid fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	0
2. Oil and natural gas and other emissions from energy production	NO	NO	NO	NO	NO	NO	NO	NO	NO	0
C. CO ₂ transport and storage										
2. Industrial processes	0.13	0.13	0.14	0.14	0.14	0.14	0.14	0.14	0.14	-95.96
A. Mineral industry										
B. Chemical industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	
C. Metal industry										
D. Non-energy products from fuels and solvent use	NO	NO	NO	NO	NO	NO	NO	NO	NO	0
E. Electronic industry										
F. Product uses as ODS substitutes										
G. Other product manufacture and use	0.13	0.13	0.14	0.14	0.14	0.14	0.14	0.14	0.14	32.22
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	0
3. Agriculture	21.55	21.53	21.33	21.91	20.58	20.92	22.19	21.98	22.1	-6.54
A. Enteric fermentation										
B. Manure management	1.68	1.69	1.67	1.62	1.6	1.68	1.69	1.68	1.7	5.43
C. Rice cultivation										
D. Agricultural soils	19.87	19.84	19.67	20.29	18.98	19.25	20.5	20.3	20.4	-7.41
E. Prescribed burning of savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	0
F. Field burning of agricultural residues	NO	NO	NO	NO	NO	NO	NO	NO	NO	0
G. Liming										
H. Urea application										
I. Other carbon containing fertilizers										
J. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	0

Table 1 Emission Trends N₂O (sheet 6 of 6)

	2007	2008	2009	2010	2011	2012	2013	2014	2015	Change from base to latest reported year (%)
4. Land use, land-use change and forestry	0.86	0.92	0.91	1.02	0.92	0.9	0.93	0.93	0.92	114.77
A. Forest land	0.53	0.54	0.55	0.57	0.57	0.57	0.58	0.58	0.59	88.14
B. Cropland	0	0	0	0	0	0	0	0	0	-72.02
C. Grassland	0.05	0.05	0.05	0.04	0.05	0.06	0.05	0.05	0.05	1,558.02
D. Wetlands	0.07	0.06	0.05	0.13	0.07	0.05	0.07	0.07	0.06	-43.12
E. Settlements	0.21	0.26	0.26	0.27	0.23	0.23	0.23	0.23	0.23	1,120.86
F. Other land	0	0	0	0	0	0	0	0	0	69,486.07
G. Harvested wood products										
H. Other	NO	NO	NO	NO	NO	NO	NO	NO		
5. Waste	0.41	0.42	0.43	0.43	0.43	0.43	0.43	0.43	0.43	32.67
A. Solid waste disposal										
B. Biological treatment of solid waste	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	100
C. Incineration and open burning of waste	0	0	0	0	0	0	0	0	0	-60.06
D. Waste water treatment and discharge	0.39	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	25.26
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	0
6. Other (as specified in the summary table in CRF)	NO	NO	NO	NO	NO	NO	NO	NO	NO	0
Total direct N₂O emissions with N₂O from LULUCF	24.33	24.38	24.07	24.74	23.24	23.55	24.8	24.58	24.68	-14
Memo items:										
Aviation	0.1	0.09	0.07	0.08	0.07	0.06	0.07	0.07	0.08	130.08
Navigation	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	778.21
Multilateral operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	0
CO₂ emissions from biomass										
CO₂ captured										
Long-term storage of C in waste disposal sites										
Indirect N₂O	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	NE, NO	0
Indirect CO₂ (3)										

Abbreviations: CRF = common reporting format, LULUCF = land use, land-use change and forestry.

a The column "Base year" should be filled in only by those Parties with economies in transition that use a base year different from 1990 in accordance with the relevant decisions of the Conference of the Parties. For these Parties, this different base year is used to calculate the percentage change in the final column of this table.

Table 1. Emission trends: HFCs, PFCs, SF₆ and NF₃ (Sheet 1 of 5)

	Base year ^a (kt)	1990	1991	1992	1993	1994	1995	1996	1997	1998
Emissions of HFCs and PFCs - (kt CO ₂ equivalent)	1.35	1.35	11.28	21.27	42.71	69.57	200.8	304.35	452.87	453.5
Emissions of HFCs - (kt CO ₂ equivalent)	1.23	1.23	1.41	1.65	3.59	10.96	103.19	171.07	283.86	374.29
HFC-23	0	0	0	0	0	0	0	0	0	0
HFC-32	NO	NO	NO	NO	NO	NO	NO	NO	NO	0
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	NO	NO	NO	NO	NO	NO	NO	0	0
HFC-134	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-134a	0	0	0	0	0	0.01	0.07	0.11	0.19	0.25
HFC-143	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-143a	NO	NO	NO	NO	NO	NO	NO	NO	0	0
HFC-152	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-152a	0	0	0	0	0	0	0	0	0.01	0.01
HFC-161	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-227ea	NO	NO	NO	NO	NO	NO	NO	0	0	0
HFC-236cb	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-236ea	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-236fa	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-245ca	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-245fa	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-365mfc	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Unspecified mix of HFCs(4) - (kt CO ₂ equivalent)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CF ₄	0	0	0	0	0	0	0	0	0	0
C ₂ F ₆	0	0	0	0	0	0	0.01	0.01	0.01	0.01
C ₃ F ₈	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C ₄ F ₁₀	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
c-C ₄ F ₈	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C ₅ F ₁₂	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C ₆ F ₁₄	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C ₁₀ F ₁₈	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
c-C ₃ F ₆	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Unspecified mix of PFCs(4) - (kt CO ₂ equivalent)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Unspecified mix of HFCs and PFCs - (kt CO ₂ equivalent)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
SF ₆	0	0	0	0	0	0	0	0	0.01	0
NF ₃	NO	NO	NO	NO	NO	NO	0	0	0	0

Table 1. Emission trends: HFCs, PFCs, SF₆ and NF₃ (sheet 2 of 5)

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Emissions of HFCs and PFCs - (kt CO₂ equivalent)	631.23	854.42	969.05	874.26	971.07	916.81	894.79	1,089.77	1,074.01	981.9
Emissions of HFCs - (kt CO₂ equivalent)	376.41	456.66	589.53	606.37	685.12	682	678.41	898.82	905.91	845.77
HFC-23	0	0	0	0	0	0	0	0	0	0
HFC-32	0	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02
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	0.01	0.02	0.04	0.05	0.05	0.05	0.04	0.07	0.07	0.06
HFC-134	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-134a	0.22	0.2	0.17	0.17	0.2	0.2	0.22	0.24	0.24	0.26
HFC-143	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-143a	0	0.01	0.04	0.04	0.04	0.04	0.04	0.06	0.06	0.05
HFC-152	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-152a	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
HFC-161	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-227ea	0	0	0	0.01	0.01	0.01	0.01	0.01	0.01	0.01
HFC-236cb	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-236ea	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-236fa	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-245ca	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-245fa	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-365mfc	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Unspecified mix of HFCs(4) - (kt CO₂ equivalent)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

Table 1. Emission trends: HFCs, PFCs, SF₆ and NF₃ (Sheet 3 of 5)

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
CF4	0	0.01	0.01	0.01	0.01	0.01	0.01	0	0	0
C2F6	0.02	0.03	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01
C3F8	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C4F10	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
c-C4F8	NO	NO	NO	0	0	0	0	0	0	0
C5F12	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C6F14	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C10F18	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
c-C3F6	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Unspecified mix of PFCs(4) - (kt CO2 equivalent)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Unspecified mix of HFCs and PFCs - (kt CO2 equivalent)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
SF6	0	0	0	0	0	0	0	0	0	0
NF3	0	0	0	0	0	0	0	0	0	NO

Table 1. Emission trends: HFCs, PFCs, SF₆ and NF₃ (Sheet 4 of 5)

	2009	2010	2011	2012	2013	2014	2015	Change from base to latest reported year (%)
Emissions of HFCs and PFCs - (kt CO ₂ equivalent)	998.72	978.6	971.04	958.16	1,078.34	1,156.13	1,097.29	80,949.20
Emissions of HFCs - (kt CO ₂ equivalent)	915.09	932.02	955.16	948.61	1,070.01	1,152.57	1,076.80	87,154.19
HFC-23	0	0	0	0	0	0	0	605.95
HFC-32	0.02	0.02	0.02	0.02	0.03	0.03	0.04	100
HFC-41	NO	NO	NO	NO	NO	NO	NO	0
HFC-43-10mee	NO	NO	NO	NO	NO	NO	NO	0
HFC-125	0.07	0.07	0.07	0.07	0.09	0.1	0.1	100
HFC-134	NO	NO	NO	NO	NO	NO	NO	0
HFC-134a	0.27	0.28	0.28	0.28	0.29	0.3	0.29	64,164.22
HFC-143	NO	NO	NO	NO	NO	NO	NO	0
HFC-143a	0.05	0.05	0.06	0.06	0.07	0.07	0.06	100
HFC-152	NO	NO	NO	NO	NO	NO	NO	0
HFC-152a	0.01	0.01	0.01	0.01	0.01	0.01	0.01	12,433.97
HFC-161	NO	NO	NO	NO	NO	NO	NO	0
HFC-227ea	0.01	0.01	0.01	0.01	0.01	0.01	0.01	100
HFC-236cb	NO	NO	NO	NO	NO	NO	NO	0
HFC-236ea	NO	NO	NO	NO	NO	NO	NO	0
HFC-236fa	NO	NO	NO	NO	NO	NO	NO	0
HFC-245ca	NO	NO	NO	NO	NO	NO	NO	0
HFC-245fa	NO	NO	NO	NO	NO	NO	NO	0
HFC-365mfc	NO	NO	NO	NO	NO	NO	NO	0

Unspecified mix of HFCs(4) - (kt CO ₂ equivalent)	NO	NO	NO	NO	NO	NO	NO	0
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Table 1. Emission trends: HFCs, PFCs, SF₆ and NF₃ (Sheet 5 of 5)

	2009	2010	2011	2012	2013	2014	2015	Change from base to latest reported year (%)
CF ₄	0	0	0	0	0	0	0	67,081.82
C ₂ F ₆	0.01	0	0	0	0	0	0	5,125.00
C ₃ F ₈	NO	NO	NO	NO	NO	NO	NO	0
C ₄ F ₁₀	NO	NO	NO	NO	NO	NO	NO	0
c-C ₄ F ₈	0	0	0	0	0	0	0	100
C ₅ F ₁₂	NO	NO	NO	NO	NO	NO	NO	0
C ₆ F ₁₄	NO	NO	NO	NO	NO	NO	NO	0
C10F18	NO	NO	NO	NO	NO	NO	NO	0
c-C3F6	NO	NO	NO	NO	NO	NO	NO	0
Unspecified mix of PFCs(4) - (kt CO ₂ equivalent)	NO	NO	NO	NO	NO	NO	NO	0
Unspecified mix of HFCs and PFCs - (kt CO₂ equivalent)	NO	NO	NO	NO	NO	NO	NO	0
SF ₆	0	0	0	0	0	0	0	31.32
NF ₃	NO	NO	NO	0	0	0	0	100

Abbreviations: CRF = common reporting format, LULUCF = land use, land-use change and forestry.

a The column "Base year" should be filled in only by those Parties with economies in transition that use a base year different from 1990 in accordance with the relevant decisions of the Conference of the Parties. For these Parties, this different base year is used to calculate the percentage change in the final column of this table.

cEnter actual emissions estimates. If only potential emissions estimates are available, these should be reported in this table and an indication for this be provided in the documentation box. Only in these rows are the emissions expressed as CO₂ equivalent emissions.

dIn accordance with the "Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part I: UNFCCC reporting guidelines on annual inventories", HFC and PFC emissions should be reported for each relevant chemical. However, if it is not possible to report values for each chemical (i.e. mixtures, confidential data, lack of disaggregation), this row could be used for reporting aggregate figures for HFCs and PFCs, respectively. Note that the unit used for this row is kt of CO₂ equivalent

Table 2: Description of quantified economy-wide emission reduction target**Emission reduction target: base year and target**

Base year/ base period	1990
Emission reductions target (% of base year/base period)	20.00
Emission reductions target (% of 1990)	20.00
Period for reaching target	BY-2020

Gases covered

Gases covered	Covered	Base Year	GWP reference source
CO ₂	Yes	1990	4th AR
CH ₄	Yes	1990	4th AR
N ₂ O	Yes	1990	4th AR
HFCs	Yes	1995	4th AR
PFCs	Yes	1995	4th AR
SF ₆	Yes	1995	4th AR
NF ₃	Yes	1995	4th AR
Other Specify			

Sectors covered

Sectors covered	Covered
Energy	Yes
Transport ^f	Yes
Industrial processes ^g	Yes
Agriculture	Yes
LULUCF	No
Waste	Yes
Other Specify	

Role of LULUCF sector

LULUCF in base year level and target	Excluded
Contribution of LULUCF is calculated using	

Market-based mechanisms under the Convention

Possible scale of contributions of market-based mechanisms under the Convention (estimated kt CO ₂ eq)	
CERs	0.00
ERUs	0.00
AAUs ⁱ	0.00
Carry-over units ^l	0.00
Other mechanism units under the Convention (specify) ^k	

Other market-based mechanisms

Possible scale of contributions of other market-based mechanisms (estimated kt CO ₂ eq)	
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Any other information

Any other information	<p>Under the EU Effort Sharing Decision (406/2009/EC), Ireland has an emissions-reduction target for the period 2013-2020 requiring that emissions in 2020 be 20% below their level in 2005.</p> <p>Ireland has not required any market-based mechanisms at the time of reporting but expects to do so by the end of the 2013-2020 period</p>
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Abbreviations: LULUCF = land use, land-use change and forestry.

Abbreviations: GWP = global warming potential

Abbreviations: AAU = assigned amount unit, CER = certified emission reduction, ERU = emission reduction unit.

^a Reporting by a developed country Party on the information specified in the common tabular format does not prejudice the position of other Parties with regard to the treatment of units from market-based mechanisms under the Convention or other market-based mechanisms towards achievement of quantified economy-wide emission reduction targets.

^b Optional

^c Please specify the reference for the GWP: Second Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) or the Fourth Assessment Report of the IPCC.

^d Specify other gases

^e More than one selection will be allowed. If Parties use sectors other than those indicated above, the explanation of how these sectors relate to the sectors defined by the IPCC should be provided.

^f Transport is reported as a subsector of the energy sector.

^g Industrial processes refer to the industrial processes and solvent and other product use sectors.

^h Specify other sectors

ⁱ AAUs issued to or purchased by a Party.

^j Units carried over from the first to the second commitment periods of the Kyoto Protocol, as described in decision 13/CMP.1 and consistent with decision 1/CMP.8.

^k As indicated in paragraph 5(e) of the guidelines contained in annex I of decision 2/CP.17 .

^l This information could include information on the domestic legal status of the target or the total assigned amount of emission units for the period for reaching a target. Some of this information is presented in the narrative part of the biennial report.

Table 3: Progress in achievement of the quantified economy-wide emission reduction target: information on mitigation actions and their effects

Name of mitigation action	Incl. in with measures GHG projection scenario	Sectors affected	GHGs affected	Objective and/or activity affected	Type of instrument	Status of implementation	Brief description	Start year of implementation	Implementing entity or entities	Estimate of mitigation impact (not cumulative) (kt CO ₂ eq)			
										2020	2025	2030	2035
Sustainable Energy Authority of Ireland Large Industry Programme	Yes	Energy consumption (comprising consumption of fuels and electricity by end users such as households, services, industry and agriculture)	Carbon dioxide (CO ₂), Methane (CH ₄), Nitrous oxide (N ₂ O)	Efficiency improvement in industrial end-use sectors (Energy consumption)	Voluntary/negotiated agreements	Implemented	The Large Industry Energy Network (LIEN) is a voluntary network, facilitated by the Sustainable Energy Authority of Ireland, of companies working to maintain strong energy management and environmental protection practices.	2000	Other: Sustainable Energy Authority of Ireland	485.97	483.04	486.63	492.49
Accelerated Capital Allowance for energy efficient equipment	Yes	Energy consumption (comprising consumption of fuels and electricity by end users such as households, services, industry and agriculture)	Carbon dioxide (CO ₂), Methane (CH ₄), Nitrous oxide (N ₂ O)	Efficiency improvement of appliances (Energy consumption), Efficiency improvement in services/ tertiary sector (Energy consumption), Efficiency improvement in industrial end-use sectors (Energy consumption)	Fiscal	Implemented	The Accelerated Capital Allowance for Energy Efficiency Equipment (ACA), introduced in 2008, aims to improve the energy efficiency of Irish companies by encouraging them to purchase energy saving technologies. The ACA is a tax incentive for companies paying corporation tax and aims to encourage investment in energy efficient equipment. The ACA offers an attractive incentive whereby it allows companies to write off 100% of the purchase value of qualifying energy efficient equipment against their profit in the year of purchase.	2008	Government: Department Of Finance, Other: The Office of the Revenue Commissioners	141.90	138.94	142.55	148.45

Name of mitigation action	Incl. in with measures GHG projection scenario	Sectors affected	GHGs affected	Objective and/or activity affected	Type of instrument	Status of implementation	Brief description	Start year of implementation	Implementing entity or entities	2020	2025	2030	2035
Better Energy Workplaces - Public and Business sectors	Yes	Energy consumption (comprising consumption of fuels and electricity by end users such as households, services, industry and agriculture)	Carbon dioxide (CO ₂), Methane (CH ₄), Nitrous oxide (N ₂ O)	Efficiency improvements of buildings (Energy consumption), Efficiency improvement in services/ tertiary sector (Energy consumption)	Economic	Expired (only if the policy or measure has an effect, or is expected to continue to have an effect on GHG emissions)	Stimulating energy-saving actions in the business and public sectors. Support was available for sustainable energy upgrades to buildings, services, facilities and processes, involving investment actions comprising individual or packaged measures, aimed at achieving on-going and lasting energy savings. Projects entailing upgrades to thermal, electrical or transport energy performance are all considered eligible. In addition the wider programme helps businesses and the public sector to improve their energy efficiency and competitiveness through networking, training and advisory programmes and integration of energy management into workplaces	2011	Other: Sustainable Energy Authority of Ireland	97.16	96.44	97.32	98.75
CHP Deployment - Public and Business sectors	Yes	Energy supply (comprising extraction, transmission, distribution and storage of fuels as well as energy and electricity production), Energy consumption (comprising consumption of fuels and electricity by end users such as households, services, industry and agriculture)	Carbon dioxide (CO ₂), Methane (CH ₄), Nitrous oxide (N ₂ O)	Switch to less carbon-intensive fuels (Energy supply), Increase in renewable energy (Energy supply), Efficiency improvements of buildings (Energy consumption)	Economic	Expired (only if the policy or measure has an effect, or is expected to continue to have an effect on greenhouse gas emissions)	The CHP Deployment programme provided grants for selected renewable and alternative heat sources and was designed to prime the market and to establish a supply chain. The CHP Deployment programme provided grant aid towards the installation of small scale CHP, up to 1 MWe at sites with a suitable heat load.	2006	Other: Sustainable Energy Authority of Ireland	150.34	150.35	150.35	150.35

Name of mitigation action	Incl. in with measures GHG projection scenario	Sectors affected	GHGs affected	Objective and/or activity affected	Type of instrument	Status of implementation	Brief description	Start year of implementation	Implementing entity or entities	2020	2025	2030	2035
Renewable Heat (ReHeat) Deployment Programme - Public and Business sectors	Yes	Energy consumption (comprising consumption of fuels and electricity by end users such as households, services, industry and agriculture), Energy supply (comprising extraction, transmission, distribution and storage of fuels as well as energy and electricity production)	Carbon dioxide (CO ₂), Methane (CH ₄), Nitrous oxide (N ₂ O)	Efficiency improvement in services/ tertiary sector (Energy consumption), Increase in renewable energy (Energy supply), The ReHeat programme provided grant aid towards the installation of renewable and alternative heating technologies in the tertiary sector ()	Economic	Expired (only if the policy or measure has an effect, or is expected to continue to have an effect on greenhouse gas emissions)	The ReHeat programme provided grants for selected renewable and alternative heat sources and was designed to prime the market and to establish a supply chain.	2008	Other: Sustainable Energy Authority of Ireland	101.30	101.30	101.30	101.30
Carbon Tax	Yes	Energy consumption (comprising consumption of fuels and electricity by end users such as households, services, industry and agriculture), Transport, Cross-cutting	Carbon dioxide (CO ₂), Methane (CH ₄), Nitrous oxide (N ₂ O)	Efficiency improvements of buildings (Energy consumption), Demand management/reduction (Energy consumption), Demand management/reduction (Transport), Cross sectoral tax on fuel used for heating and transport ()	Fiscal	Implemented	Incorporate a price signal for carbon on the non-ETS sector, specifically fuels used for heating and transport. The tax applies to petrol, diesel, kerosene, marked gas oil (for agricultural use), Liquid Petroleum Gas (LPG), fuel oil, natural gas, coal and commercial peat.	2008	Other: Revenue Commissioners	325.56	325.56	325.41	324.75
Public Sector Retrofit (including Sustainable Energy Authority of Ireland Public Sector Programme)	Yes	Energy consumption (comprising consumption of fuels and electricity by end users such as households, services, industry and agriculture)	Carbon dioxide (CO ₂), Methane (CH ₄), Nitrous oxide (N ₂ O)	Efficiency improvement in services/ tertiary sector (Energy consumption), Efficiency improvements of buildings (Energy consumption)	Economic, Information, Education	Implemented	The programme aims to increase energy efficiency by providing a range of funded services including advice, mentoring and training to participating Public Sector bodies. Implementation of measures to enable the public sector contribute to its requirements under the national target of increasing energy efficiency nationally by 20% by 2020.	2011	Government :Department of Communications, Climate Action and Environment, Other: Sustainable Energy Authority of Ireland	398.89	396.31	399.47	404.62

Name of mitigation action	Incl. in with measur es GHG projectio n scenario	Sectors affected	GHGs affected	Objective and/or activity affected	Type of instrument	Status of implementa tion	Brief description	Start year of implem entatio n	Implementing entity or entities	2020	2025	2030	2035
Supports for Exemplar Energy Efficiency Projects (SEEEP) and Energy Efficiency Retrofit Fund (EERF) - Public and Business sectors	Yes	Energy consumption (comprising consumption of fuels and electricity by end users such as households, services, industry and agriculture)	Carbon dioxide (CO2), Methane (CH4), Nitrous oxide (N2O)	Efficiency improvement in services/ tertiary sector (Energy consumption), Efficiency improvements of buildings (Energy consumption)	Economic	Expired (only if the policy or measure has an effect, or is expected to continue to have an effect on greenhouse gas emissions)	The Supports for Exemplar Energy Efficiency Projects (SEEEP) programme aimed to achieve significant energy efficiency gains through increasing the capability of the supply chain and stimulating direct employment focusing on energy efficiency projects. The Energy Efficiency Retrofit Fund (EERF) provided for funding towards the implementation of a limited number of qualifying energy efficiency projects.	2009	Government: Department of Communications, Climate Action and Environment, Other: Sustainable Energy Authority of Ireland	52.28	51.94	52.36	53.03
Public Sector Building Demonstration Programme	Yes	Energy consumption (comprising consumption of fuels and electricity by end users such as households, services, industry and agriculture)	Carbon dioxide (CO2), Methane (CH4), Nitrous oxide (N2O)	Efficiency improvements of buildings (Energy consumption), Efficiency improvement in services/ tertiary sector (Energy consumption)	Economic, Information, Research, Education	Expired (only if the policy or measure has an effect, or is expected to continue to have an effect on greenhouse gas emissions)	The Public Sector Building Demonstration Programme offered financial support to public and commercial sector organisations to stimulate the innovative application of sustainable energy design strategies, technologies and services in new and retrofit projects, acting as both an exemplar for good practice and as a demand leader for the services and technologies involved.	2001	Government: Department of Communications, Climate Action and Environment, Other: Sustainable Energy Authority of Ireland	27.64	27.46	27.68	28.04
Small and Medium Enterprises (SME) Programme	Yes	Energy consumption (comprising consumption of fuels and electricity by end users such as households, services, industry and agriculture)	Carbon dioxide (CO2), Methane (CH4), Nitrous oxide (N2O)	Efficiency improvement in services/ tertiary sector (Energy consumption), Efficiency improvements of buildings (Energy consumption), Demand management/reduction (Energy consumption)	Education, Information	Implemented	The programme aims to increase energy efficiency in SMEs through providing advice, mentoring and training to participating SMEs	2008	Other: Sustainable Energy Authority of Ireland	62.55	62.18	62.63	63.37

Name of mitigation action	Incl. in with measures GHG projection scenario	Sectors affected	GHGs affected	Objective and/or activity affected	Type of instrument	Status of implementation	Brief description	Start year of implementation	Implementing entity or entities	2020	2025	2030	2035
2005 Building Regulations Part L Conservation of Fuel and Energy - Buildings other than dwellings	Yes	Energy consumption (comprising consumption of fuels and electricity by end users such as households, services, industry and agriculture)	Carbon dioxide (CO ₂), Methane (CH ₄), Nitrous oxide (N ₂ O)	Efficiency improvements of buildings (Energy consumption)	Regulatory	Expired (only if the policy or measure has an effect, or is expected to continue to have an effect on greenhouse gas emissions)	The measure imposes minimum efficiency standards for new Buildings other than Dwellings	2005	Government: Department of Housing, Planning, Community and Local Government	313.50	313.51	313.51	313.51
2002 Building Regulations - Part L Conservation of Fuel and Energy in Dwellings	Yes	Energy consumption (comprising consumption of fuels and electricity by end users such as households, services, industry and agriculture)	Carbon dioxide (CO ₂), Methane (CH ₄), Nitrous oxide (N ₂ O)	Efficiency improvements of buildings (Energy consumption)	Regulatory	Expired (only if the policy or measure has an effect, or is expected to continue to have an effect on greenhouse gas emissions)	The measure imposes minimum efficiency standards for new dwellings from 2002 onwards. The 2002 Part L Building Regulations was the first in a series of incrementally improved efficiency standards which is now moving towards low to zero carbon housing.	2003	Government: Department of Housing, Planning, Community and Local Government	443.05	443.06	443.06	443.06
2008 Building Regulations Part L Conservation of Fuel and Energy in Dwellings	Yes	Energy consumption (comprising consumption of fuels and electricity by end users such as households, services, industry and agriculture)	Carbon dioxide (CO ₂), Methane (CH ₄), Nitrous oxide (N ₂ O)	Efficiency improvements of buildings (Energy consumption)	Regulatory	Expired (only if the policy or measure has an effect, or is expected to continue to have an effect on greenhouse gas emissions)	The 2008 Part L Building Regulations for Dwellings were one of a series of incrementally improved efficiency standards which is now moving towards low to zero carbon housing.	2008	Government: Department of Housing, Planning, Community and Local Government	160.31	160.32	160.32	160.32

Name of mitigation action	Incl. in with measures GHG projection scenario	Sectors affected	GHGs affected	Objective and/or activity affected	Type of instrument	Status of implementation	Brief description	Start year of implementation	Implementing entity or entities	2020	2025	2030	2035
2011 Part L Conservation of Fuel and Energy in Dwellings	Yes	Energy consumption (comprising consumption of fuels and electricity by end users such as households, services, industry and agriculture)	Carbon dioxide (CO ₂), Methane (CH ₄), Nitrous oxide (N ₂ O)	Efficiency improvements of buildings (Energy consumption)	Regulatory	Implemented	The 2011 Part L Building Regulations for dwellings are one of a series of incrementally improved efficiency standards which is moving towards low to zero carbon housing. The measure imposes minimum efficiency standards for new dwellings.	2012	Government: Department of Housing, Planning, Community and Local Government	50.92	50.92	50.92	50.92
Energy Efficient Boiler Regulation	Yes	Energy consumption (comprising consumption of fuels and electricity by end users such as households, services, industry and agriculture)	Carbon dioxide (CO ₂), Methane (CH ₄), Nitrous oxide (N ₂ O)	Efficiency improvements of buildings (Energy consumption)	Regulatory	Implemented	The measure set a minimum seasonal efficiency of 86% for boilers installed in existing or new dwellings from 2008 and 90% from 2011. The 2008 Part L Building Regulations imposed a minimum boiler efficiency of 86% for all boilers installed in new or existing buildings. This was further improved to a minimum boiler efficiency of 90% in 2011 Building Regulations.	2008	Government: Department of Communications, Climate Action and Environment	142.60	142.60	142.60	142.60
Domestic Lighting (Eco-Design Directive)	Yes	Energy consumption (comprising consumption of fuels and electricity by end users such as households, services, industry and agriculture)	Carbon dioxide (CO ₂)	Demand management/reduction (Energy consumption)	Regulatory	Implemented	The measure is a phasing out of incandescent lights through the Energy related Products Directive (2009/125/EC) and Commission Regulation (EC) No 244/2009. Commission Regulation (EC) No 244/2009 of 18 March 2009 implements Directive 2005/32/EC (superseded by Directive 2009/125/EC) with regard to eco-design requirements for non-directional household lamps. The regulation provides for the phased introduction of minimum efficiency standards for lamps and effectively phases out incandescent lamps.	2008	Government: Department of Jobs, Enterprise & Innovation	42.14	41.19	42.36	44.27

Name of mitigation action	Incl. in with measures GHG projection scenario	Sectors affected	GHGs affected	Objective and/or activity affected	Type of instrument	Status of implementation	Brief description	Start year of implementation	Implementing entity or entities	2020	2025	2030	2035
Greener Homes Scheme	Yes	Energy consumption (comprising consumption of fuels and electricity by end users such as households, services, industry and agriculture)	Carbon dioxide (CO2), Methane (CH4), Nitrous oxide (N2O)	Efficiency improvements of buildings (Energy consumption)	Economic, Voluntary/negotiated agreements, Information, Education	Expired (only if the policy or measure has an effect, or is expected to continue to have an effect on greenhouse gas emissions)	The measure provided grant aid for the installation of renewable domestic heating systems.	2006	Other: Sustainable Energy Authority of Ireland	26.62	26.58	26.63	26.70
Warmer Homes Scheme	Yes	Energy consumption (comprising consumption of fuels and electricity by end users such as households, services, industry and agriculture)	Carbon dioxide (CO2), Methane (CH4), Nitrous oxide (N2O)	Efficiency improvements of buildings (Energy consumption)	Economic, Voluntary/negotiated agreements, Information, Education	Implemented	The measure targets vulnerable and fuel poor homes and provides funding for the installation of domestic energy efficiency upgrades via regional not-for-profit organisations and private contractors.	2000	Other: Sustainable Energy Authority of Ireland	82.81	82.74	82.75	82.58
Better Energy Homes (Residential retrofit)	Yes	Energy consumption (comprising consumption of fuels and electricity by end users such as households, services, industry and agriculture)	Carbon dioxide (CO2), Methane (CH4), Nitrous oxide (N2O)	Efficiency improvements of buildings (Energy consumption)	Economic, Information, Education	Implemented	Stimulating energy-efficiency actions to reduce energy usage by homeowners and the general public. Sustainable Energy Authority of Ireland grant-aids householders who want to make their homes more energy-efficient by providing incentives towards the implementation of energy efficiency measures including attic and wall insulation and heating controls with efficient boilers and/or solar thermal.	2011	Government: Department of Communications, Climate Action and Environment, Other: Sustainable Energy Authority of Ireland	293.78	293.56	293.70	293.59

Name of mitigation action	Incl. in with measure's GHG proj'n scenario	Sectors affected	GHGs affected	Objective and/or activity affected	Type of instrument	Status of implementation	Brief description	Start year of implementation	Implementing entity or entities	2020	2025	2030	2035
Public Transport efficiency	Yes	Transport	Carbon dioxide (CO ₂), Methane (CH ₄), Nitrous oxide (N ₂ O)	Improved behaviour (Transport), Modal shift to public transport or non-motorized transport (Transport), Improved transport infrastructure (Transport)	Voluntary/negotiated agreements, Information, Education	Implemented	The aim of the measure is to promote efficiency in the public transport system including: Eco-driving in buses; Efficiency in suburban electric rail; Efficiency in national rail network	2009	Other: Irish Rail, Bus Eireann, Dublin Bus, Other: Sustainable Energy Authority of Ireland	41.55	41.59	41.58	41.57
Electric vehicle deployment	No	Transport	Carbon dioxide (CO ₂), Methane (CH ₄), Nitrous oxide (N ₂ O)	Low carbon fuels/electric cars (Transport)	Economic, Fiscal	Planned	Grant support for new electric vehicles. Electric vehicles were identified as an important element in efforts to achieve both energy efficiency and renewable energy targets as part of the EU Climate Change-Energy Package.	2011	Government: Department of Communications, Climate Action and Environment, Other: Sustainable Energy Authority of Ireland	-0.89	-0.55	-0.82	-1.14
Vehicle Registration Tax and Annual Motor Tax	Yes	Transport	Carbon dioxide (CO ₂), Methane (CH ₄), Nitrous oxide (N ₂ O)	Efficiency improvements of vehicles (Transport), Demand management/reduction (Transport)	Regulatory, Education, Fiscal	Implemented	The measure was a fundamental shift in the Vehicle Registration Tax and Annual Motor Tax regime whereby vehicles have been taxed on the basis of their CO ₂ emission levels since 1st July 2008.	2008	Government: Department of Finance	172.15	172.28	172.24	172.20
Improved fuel economy of the private car fleet (EU Regulation)	Yes	Transport	Carbon dioxide (CO ₂), Methane (CH ₄), Nitrous oxide (N ₂ O)	Efficiency improvements of vehicles (Transport)	Regulatory	Implemented	The EU, through Regulation 443/2009 has mandated an improvement in average new car efficiency to 130 g CO ₂ /km by 2015 with a target of 95 g CO ₂ /km for 2020	2012	Other: European Commission, Other: National Standards Authority of Ireland	226.96	227.13	227.08	227.03

Name of mitigation action	Incl. in with measures GHG projection scenario	Sectors affected	GHGs affected	Objective and/or activity affected	Type of instrument	Status of implementation	Brief description	Start year of implementation	Implementing entity or entities	2020	2025	2030	2035
Aviation Efficiency	Yes	Transport	Carbon dioxide (CO2), Methane (CH4), Nitrous oxide (N2O)	Demand management/reduction (Transport)	Voluntary/negotiated agreements	Implemented	The aim is to increase operational efficiency in aviation through international co-operation in air space control. The Irish and UK National Supervisory Authorities (NSAs) created the UK-Ireland Functional Airspace Block in 2008 to create a seamless and cost efficient operation across joint airspace. This has included efficiency in savings of fuel and CO2 emissions.	2008	Other: Irish Aviation Authority, Other: UK National Air Traffic Services	66.49	66.54	66.53	66.51
Reduction in natural gas combusted at compressor stations for natural gas pipeline transport	No	Transport	Carbon dioxide (CO2), Methane (CH4), Nitrous oxide (N2O)	Reduced natural gas demand under the with additional measures scenario ()	Other	Planned	This reduction in emissions arise due to the reduced demand for natural gas in the with additional measures scenario when compared to the with measures scenario.	2016	Other: Bord Gais Energy, Government: Department of Communications, Climate Action and Environment	7.59	8.69	9.33	10.83
Energy Efficiency in Power Generation	Yes	Energy supply (comprising extraction, transmission, distribution and storage of fuels as well as energy and electricity production)	Carbon dioxide (CO2), Methane (CH4), Nitrous oxide (N2O)	Increase in renewable energy (Energy supply), Reduction of losses (Energy supply), Efficiency improvement in the energy and transformation sector (Energy supply)	Planning, Economic	Implemented	Investment in new, efficient power generation plant and renewable electricity generation. This PAM includes the promotion and prioritising energy efficiency in investment decisions for new generation plant, promoting competition in the All-Island Single Electricity Market and providing incentives to encourage large energy users to reduce peak energy use	2008	Government: Department of Communications, Climate Action and Environment, Other: Commission for Energy Regulation	827.13	862.59	862.49	862.40

Name of mitigation action	Incl. in with measure's GHG projection scenario	Sectors affected	GHGs affected	Objective and/or activity affected	Type of instrument	Status of implementation	Brief description	Start year of implementation	Implementing entity or entities	2020	2025	2030	2035
Energy Efficiency in Electricity Transmission and Distribution	Yes	Energy supply (comprising extraction, transmission, distribution and storage of fuels as well as energy and electricity production)	Carbon dioxide (CO ₂), Methane (CH ₄), Nitrous oxide (N ₂ O)	Reduction of losses (Energy supply)	Planning, Economic	Implemented	Upgrades to the electricity transmission and distribution networks to improve efficiency. Measures to improve efficiency include placing targets for reduced losses on the Transmission System Operator.	2008	Government: Department of Communications, Climate Action and Environment, Other: Commission for Energy Regulation	39.19	38.30	39.39	41.16
Replacement of coal fired electricity generation with natural gas	No	Energy supply (comprising extraction, transmission, distribution and storage of fuels as well as energy and electricity production)	Carbon dioxide (CO ₂), Methane (CH ₄), Nitrous oxide (N ₂ O)	Switch to less carbon-intensive fuels (Energy supply)	Research, Planning	Planned	This measure, which is included in the with additional measures scenario is aimed at examining the effect of replacing coal fired electricity generation with natural gas fired electricity generation.	2025	Government: Department of Communications, Climate Action and Environment, Other: Commission for Energy Regulation	Mitigation impact not estimated	587.06	920.36	1,512.73
Mobile Air Conditioning Directive (Directive 2006/40/EC)	Yes	Industrial processes (comprising industrial activities that chemically or physically transform materials leading to greenhouse gas emissions, use of greenhouse gases in products and non-energy uses of fossil fuel carbon)	Hydrofluorocarbons (HFC)	Reduction of emissions of fluorinated gases (Industrial processes)	Regulatory	Implemented	The Directive lays down the requirements for the EC type-approval or national type-approval of vehicles as regards emissions from, and the safe functioning of, air conditioning systems fitted to vehicles. It also lays down provisions on retrofitting and refilling of such systems.	2011	Government: Department of Transport, Tourism and Sport	65.87	123.11	206.61	229.34

Name of mitigation action	Incl. in with measure's GHG projection scenario	Sectors affected	GHGs affected	Objective and/or activity affected	Type of instrument	Status of implementation	Brief description	Start year of implementation	Implementing entity or entities	2020	2025	2030	2035
Landfill Directive (1999/31/EC)	Yes	Waste management/waste	Methane (CH4)	Improved landfill management (Waste), Reduced landfilling (Waste), Enhanced CH4 collection and use (Waste)	Regulatory, Planning	Implemented	This Directive by way of strict operational and technical requirements aims as far as is possible to reduce the negative effects of landfills on the environment, in particular the pollution of surface water, groundwater, soil and air, and on the global environment.	1999	Government: Department of Communications, Climate Action and Environment, Other: Environmental Protection Agency	80.53	313.46	420.83	491.96
Nitrogen Fertilizer Use Efficiency in Agriculture	No	Agriculture	Nitrous oxide (N2O), Carbon dioxide (CO2)	Reduction of fertilizer/manure use on cropland (Agriculture)	Voluntary/negotiated agreements, Education	Planned	Nutrient Management Planning is an integral part of the of the Green, Low-Carbon, Agri-Environmental Scheme (GLAS) which was set up under the Rural Development Programme 2014-2020. In this measure it is envisaged that nitrification and urease inhibitors will be used in conjunction with nitrogen fertilizers, thereby reducing gaseous losses and reducing total fertilizer nitrogen use.	2018	Government: Department of Agriculture, Food and the Marine	156.79	156.79	156.79	156.79
Renewables - With Measures scenario (Electricity Generation)	Yes	Energy supply (comprising extraction, transmission, distribution and storage of fuels as well as energy and electricity production)	Carbon dioxide (CO2), Methane (CH4), Nitrous oxide (N2O)	Increase in renewable energy (Energy supply)	Regulatory, Economic	Implemented	This measure encompasses the development of renewable energy in electricity generation under the With Measures scenario. Under this measure RES-E is 22.7% in 2020.	2005	Government: Department of Communications, Climate Action and Environment, Other: Commission for Energy Regulation	1,381.79	1,370.12	1,364.49	1,358.84

Name of mitigation action	Incl. in with measures GHG projection scenario	Sectors affected	GHGs affected	Objective and/or activity affected	Type of instrument	Status of implementation	Brief description	Start year of implementation	Implementing entity or entities	2020	2025	2030	2035
Renewables - With Measures scenario (Transport)	Yes	Transport	Carbon dioxide (CO ₂), Methane (CH ₄), Nitrous oxide (N ₂ O)	Low carbon fuels/electric cars (Transport)	Regulatory, Economic	Implemented	This measure encompasses the development of renewable energy in transport under the With Measures scenario. Under this measure RES-T is 5.5% in 2020.	2005	Government: Department of Transport, Tourism and Sport	430.59	490.16	484.50	477.66
Directive 2009/28/EC on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC- Heat component	No	Energy supply (comprising extraction, transmission, distribution and storage of fuels as well as energy and electricity production)	Carbon dioxide (CO ₂), Methane (CH ₄), Nitrous oxide (N ₂ O)	Increase in renewable energy (Energy supply)	Regulatory	Planned	The Irish Government has set a target of 12% renewable heat by 2020. This renewable heat target in conjunction with renewable fuel penetration in the transport sector (RES-T) and renewable electricity targets (RES-E) forms part of Ireland's overall renewable energy target of 16% by 2020 under Directive 2009/28/EC. The recent 2017 energy forecasts reflects current progress and the trajectory towards achieving 2020 targets. Based on the current trajectory, by 2020 this PaM under the With Additional Measures scenario assumes Ireland will have achieved 9% renewable heat (RES-H) share in 2020.	2016	Government: Department of Communications, Climate Action and Environment, Other: Sustainable Energy Authority of Ireland	488.30	626.11	775.97	958.54

Name of mitigation action	Incl. in with measure's GHG projection scenario	Sectors affected	GHGs affected	Objective and/or activity affected	Type of instrument	Status of implementation	Brief description	Start year of implementation	Implementing entity or entities	2020	2025	2030	2035
Directive 2009/28/EC on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC - Electricity component	No	Energy supply (comprising extraction, transmission, distribution and storage of fuels as well as energy and electricity production)	Carbon dioxide (CO ₂), Methane (CH ₄), Nitrous oxide (N ₂ O)	Increase in renewable energy (Energy supply)	Regulatory	Planned	The Irish Government has set a target of 40% electricity consumption from renewables sources by 2020. This renewable electricity target in conjunction with renewable fuel penetration in the transport sector (RES-T) and renewable fuels for heat (RES-H) forms part of Ireland's overall renewable energy target of 16% by 2020 under Directive 2009/28/EC. The recent 2017 energy forecasts reflects current progress and the trajectory towards achieving 2020 targets. Based on the current trajectory, by 2020 this PaM under the With Additional Measures scenario assumes Ireland will have achieved 37.3% renewable heat (RES-E) share in 2020.	2016	Government: Department of Communications, Climate Action and Environment, Other: Commission for Energy Regulation	1,535.91	1,440.93	1,440.93	1,440.93
Directive 2009/28/EC - on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC-Transport component	No	Transport	Carbon dioxide (CO ₂), Methane (CH ₄), Nitrous oxide (N ₂ O)	Low carbon fuels/electric cars (Transport)	Regulatory	Planned	The Irish Government has set a target of 10% renewable fuels in transport by 2020. This renewable fuels in transport target in conjunction with renewable electricity targets (RES-E) and renewable fuels for heat (RES-H) forms part of Ireland's overall renewable energy target of 16% by 2020 under Directive 2009/28/EC. The recent 2017 energy forecasts reflects current progress and the trajectory towards achieving 2020 targets. Based on the current trajectory, by 2020 this PaM under the With Additional Measures scenario assumes Ireland will have achieved 8% renewable heat (RES-T) share in 2020.	2016	Government: Department of Transport, Tourism and Sport	193.82	218.70	216.70	214.17

Name of mitigation action	Incl. in with measures GHG projection scenario	Sectors affected	GHGs affected	Objective and/or activity affected	Type of instrument	Status of implementation	Brief description	Start year of implementation	Implementing entity or entities	2020	2025	2030	2035
Better Energy Communities	Yes	Cross-cutting	Carbon dioxide (CO2), Methane (CH4), Nitrous oxide (N2O)	Multi-sectoral policy (Cross-cutting)	Fiscal	Adopted	The Better Energy Communities scheme, introduced in 2012, supports sustainable energy upgrades to existing buildings, services, facilities and processes in the community sector. It promotes projects with an aggregation of upgrades across sectors within a single project and favours projects where deeper retrofit can be demonstrated.	2012	Other: Sustainable Energy Authority of Ireland	96.35	96.28	96.34	96.39

Energy Efficiency Obligation Scheme	Yes	Cross-cutting	Carbon dioxide (CO2), Methane (CH4), Nitrous oxide (N2O)	Multi-sectoral policy (Cross-cutting)	Regulatory	Implemented	<p>The Energy Efficiency Obligation Scheme (EEOS) is being implemented pursuant to the Energy Efficiency Directive 2012, Article 7. The Directive imposes a legal obligation on Member States to achieve new savings each year from 1 January 2014 to 31 December 2020 of 1.5% of the annual energy sales to final customers of all energy distributors and all retail energy sales companies by volume, averaged over the most recent three-year period prior to 1 January 2013. The target is cumulative, which means that it is based on incremental annual savings that deliver a total volume of savings at the end of the obligation period in 2020. Ireland has chosen to effect the provisions of Article 7(9) of the Directive, opting to combine alternative policy measures and an energy efficiency obligation scheme to meet the national target. Obligated parties under the EEOS are energy distributors and retail energy sales companies that have market sales in Ireland of greater than 600 GWh final sales in any relevant year, regardless of the sector they supply. Obligated parties' targets are allocated according to their proportion of energy market sales volume in Ireland. Member States are obliged to put in place measurement, control and verification systems to verify savings by obligated parties. The positions against targets for each year are to be achieved, audited and finalised by 31 March of the following year. The target allocated to obligated parties is 550 GWh PPE for the period 2014 to 2016, 625GWh PPE for 2017 and 700GWh PPE from 2018 to 2020. This is sub-sectoralised as 75% non-residential, 20% residential and 5% energy poverty residential. The minimum achievement for the period 2014-2016 is Year 1 60%, Year 2 75% cumulative and Year 3 90% cumulative. From Year 4 onwards, the minimum cumulative achievement will be 95% cumulative. Obligated parties can choose to achieve energy savings independently or through partnerships with service providers in the market. The scheme permits the exchange of validated savings between obligated parties in certain circumstances. Obligated parties can buyout up to a maximum of 30% of their total cumulative target, whether or not they have achieved their minimum cumulative target. For any portion of the minimum annual target not achieved, exchanged or bought out, a penalty will be imposed. The price of buyout and penalty will be set and published by the Minister and reviewed as appropriate. In the Residential and Energy Poverty sectors energy savings from energy conservation measures are calculated using deemed credits per measure based on Building Ratings under EPBD In the Non-Residential sector scaled or measured savings based on ISO 50015, IPMVP or equivalent are used to calculate savings. Project data is uploaded to SEAI bespoke systems and is subject to Evaluation and Audit.</p>	2014	Government : Department of Communications, Climate Action and Environment , Other: Sustainable Energy Authority of Ireland	523.16	520.77	523.25	526.16
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Name of mitigation action	Incl. in with measures GHG projection scenario	Sector s affected	GHGs affected	Objective and/or activity affected	Type of instrument	Status of implementation	Brief description	Start year of implementation	Implementing entity or entities	2020	2025	2030	2035
Buildings remainder	No	Cross-cutting	Carbon dioxide (CO2), Methane (CH4), Nitrous oxide (N2O)	Multi-sectoral policy (Cross-cutting)	Economic, Fiscal, Regulatory	Planned	The savings associated with this measure are anticipated to come from a combination of extension to existing policies and measures in the buildings sector and roll out of (yet to be determined) programmes following various pilots currently being conducted. The policy mix could include economic, fiscal, regulatory, information and other measures.	2016	Government: Department of Communications, Climate Action and Environment, Other: Sustainable Energy Authority of Ireland	83.60	83.42	83.45	83.45

Table 4: Report on progress

		Base year/period (1990)	2010	2011	2012	2013	2014	2015	2016
Total (without LULUCF)	kt CO ₂ eq	56,102.80*	61,691.90*	57,567.40*	58,124.00*	57,922.50*	57,757.90*	59,878.20*	
Contribution from LULUCF ^c	kt CO ₂ eq							NA	NA
Market-based mechanisms under the Convention	number of units							NA	NA
	kt CO ₂ eq							NA	NA
Other market-based mechanisms	number of units								
	kt CO ₂ eq								

Table 4(a) I: Progress in achieving the quantified economy-wide emission reduction targets — further information on mitigation actions relevant to the contribution of the land use, land-use change and forestry sector (sheet 1 of 2)

	Unit	Net GHG emissions/removals from LULUCF categories	Base year/period or reference level value	Contribution from LULUCF for reported year	Cumulative contribution from LULUCF	Accounting approach
2015						
Total LULUCF	kt CO ₂ eq					
A. Forest land	kt CO ₂ eq					
1. Forest land remaining forest land	kt CO ₂ eq	NA	NA	NA	NA	
2. Land converted to forest land	kt CO ₂ eq	NA	NA	NA	NA	
3. Other ⁹	kt CO ₂ eq					
B. Cropland	kt CO ₂ eq					
1. Cropland remaining cropland	kt CO ₂ eq	NA	NA	NA	NA	
2. Land converted to cropland	kt CO ₂ eq	NA	NA	NA	NA	
3. Other ⁹	kt CO ₂ eq					
C. Grassland	kt CO ₂ eq					
1. Grassland remaining grassland	kt CO ₂ eq	NA	NA	NA	NA	
2. Land converted to grassland	kt CO ₂ eq	NA	NA	NA	NA	
3. Other ⁹	kt CO ₂ eq					
D. Wetlands	kt CO ₂ eq					
1. Wetland remaining wetland	kt CO ₂ eq	NA	NA	NA	NA	
2. Land converted to wetland	kt CO ₂ eq					
3. Other ⁹	kt CO ₂ eq					
E. Settlements	kt CO ₂ eq					
1. Settlements remaining settlements	kt CO ₂ eq	NA	NA	NA	NA	
2. Land converted to settlements	kt CO ₂ eq	NA	NA	NA	NA	
3. Other ⁹	kt CO ₂ eq					
F. Other land	kt CO ₂ eq					
1. Other land remaining other land	kt CO ₂ eq	NA	NA	NA	NA	
2. Land converted to other land	kt CO ₂ eq	NA	NA	NA	NA	
3. Other ⁹	kt CO ₂ eq					
G. Other	kt CO ₂ eq					
Harvested wood products	kt CO ₂ eq	NA	NA	NA	NA	

Table 4(a) I: Progress in achieving the quantified economy-wide emission reduction targets — further information on mitigation actions relevant to the contribution of the land use, land-use change and forestry sector (sheet 2 of 2)

	Unit	Net GHG emissions/removals from LULUCF categories	Base year/period or reference level value	Contribution from LULUCF for reported year	Cumulative contribution from LULUCF	Accounting approach
2016						
Total LULUCF	kt CO ₂ eq					
A. Forest land	kt CO ₂ eq					
1. Forest land remaining forest land	kt CO ₂ eq	NA	NA	NA	NA	
2. Land converted to forest land	kt CO ₂ eq	NA	NA	NA	NA	
3. Other ⁹	kt CO ₂ eq					
B. Cropland	kt CO ₂ eq					
1. Cropland remaining cropland	kt CO ₂ eq	NA	NA	NA	NA	
2. Land converted to cropland	kt CO ₂ eq	NA	NA	NA	NA	
3. Other ⁹	kt CO ₂ eq					
C. Grassland	kt CO ₂ eq					
1. Grassland remaining grassland	kt CO ₂ eq	NA	NA	NA	NA	
2. Land converted to grassland	kt CO ₂ eq	NA	NA	NA	NA	
3. Other ⁹	kt CO ₂ eq					
D. Wetlands	kt CO ₂ eq					
1. Wetland remaining wetland	kt CO ₂ eq	NA	NA	NA	NA	
2. Land converted to wetland	kt CO ₂ eq	NA	NA	NA	NA	
3. Other ⁹	kt CO ₂ eq					
E. Settlements	kt CO ₂ eq					
1. Settlements remaining settlements	kt CO ₂ eq	NA	NA	NA	NA	
2. Land converted to settlements	kt CO ₂ eq	NA	NA	NA	NA	
3. Other ⁹	kt CO ₂ eq					
F. Other land	kt CO ₂ eq					
1. Other land remaining other land	kt CO ₂ eq	NA	NA	NA	NA	
2. Land converted to other land	kt CO ₂ eq	NA	NA	NA	NA	
3. Other ⁹	kt CO ₂ eq					
G. Other	kt CO ₂ eq					
Harvested wood products	kt CO ₂ eq	NA	NA	NA	NA	

Table 4 (a) II. Progress in achievement of the quantified economy-wide emission reduction targets – further information on mitigation actions relevant to the counting of emissions and removals from the land use, land use change and forestry sector in relation to activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol ^{a, b, c}

Greenhouse Gas Source and Sink Activities	Base year ^d	Net emissions/removals ^e									Accounting Parameters ^h	Acco Qu
		2013	2014	2015	2016	2017	2018	2019	2020	Total ^f		
	(kt CO ₂ eq)											
A. Article 3.3 activities												
A.1. Afforestation/reforestation		-3,711.44	-3,702.66	-3,802.49						-11,216.59		-1
Excluded emissions from natural disturbances(5)		NA	NA	NA						NA		NA
Excluded subsequent removals from land subject to natural disturbances(6)		NA	NA	NA						NA		NA
A.2. Deforestation		190.94	223.2	266.2						680.34		
B. Article 3.4 activities												
B.1. Forest management										-1,221.84		
Net emissions/removals^e		-435.55	-256.6	-529.69						-1,221.84		
Excluded emissions from natural disturbances(5)		NA	NA	NA						NA		NA
Excluded subsequent removals from land subject to natural disturbances(6)		NA	NA	NA						NA		NA
Any debits from newly established forest (CEF-ne)(7),(8)		NO	NO	NO						NO		NO
Forest management reference level (FMRL)(9)											-142.07	
Technical corrections to FMRL(10)											-470.85	
Forest management cap^l											15708.78	
B.2. Cropland management (if elected)	26.27	36.12	42.82	9.29						88.24		
B.3. Grazing land management (if elected)	7076.42	5,883.29	5,908.47	5,790.13						17,581.88		-3
B.4. Revegetation (if elected)	NA	NA	NA	NA						NA		NA
B.5. Wetland drainage and rewetting (if elected)	NA	NA	NA	NA						NA		NA

Note: 1 kt CO₂ eq equals 1 Gg CO₂ eq.

Table 4 (a) II. Progress in achievement of the quantified economy-wide emission reduction targets – further information on mitigation actions relevant to the counting of emissions and removals from the land use, land use change and forestry sector in relation to activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol ^{a, b, c}

Abbreviations: CRF = common reporting format, LULUCF = land use, land-use change and forestry.

^a Reporting by a developed country Party on the information specified in the common tabular format does not prejudice the position of other Parties with regard to the treatment of units from market-based mechanisms under the Convention or other market-based mechanisms towards achievement of quantified economy-wide emission reduction targets.

^b Developed country Parties with a quantified economy-wide emission reduction target as communicated to the secretariat and contained in document FCCC/SB/2011/INF.1/Rev.1 or any update to that document, that are Parties to the Kyoto Protocol, may use table 4(a)II for reporting of accounting quantities if LULUCF is contributing to the attainment of that target.

^c Parties can include references to the relevant parts of the national inventory report, where accounting methodologies regarding LULUCF are further described in the documentation box or in the biennial reports.

^d Net emissions and removals in the Party's base year, as established by decision 9/CP.2.

^e All values are reported in the information table on accounting for activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol, of the CRF for the relevant inventory year as reported in the current submission and are automatically entered in this table.

^f Additional columns for relevant years should be added, if applicable.

^g Cumulative net emissions and removals for all years of the commitment period reported in the current submission.

^h The values in the cells "3.3 offset" and "Forest management cap" are absolute values.

ⁱ The accounting quantity is the total quantity of units to be added to or subtracted from a Party's assigned amount for a particular activity in accordance with the provisions of Article 7, paragraph 4, of the Kyoto Protocol.

^j In accordance with paragraph 4 of the annex to decision 16/CMP.1, debits resulting from harvesting during the first commitment period following afforestation and reforestation since 1990 shall not be greater than the credits accounted for on that unit of land.

^k In accordance with paragraph 10 of the annex to decision 16/CMP.1, for the first commitment period a Party included in Annex I that incurs a net source of emissions under the provisions of Article 3 paragraph 3, may account for anthropogenic greenhouse gas emissions by sources and removals by sinks in areas under forest management under Article 3, paragraph 4, up to a level that is equal to the net source of emissions under the provisions of Article 3, paragraph 3, but not greater than 9.0 megatonnes of carbon times five, if the total anthropogenic greenhouse gas emissions by sources and removals by sinks in the managed forest since 1990 is equal to, or larger than, the net source of emissions incurred under Article 3, paragraph 3.

^l In accordance with paragraph 11 of the annex to decision 16/CMP.1, for the first commitment period of the Kyoto Protocol only, additions to and subtractions from the assigned amount of a Party resulting from Forest management under Article 3, paragraph 4, after the application of paragraph 10 of the annex to decision 16/CMP.1 and resulting from forest management project activities undertaken under Article 6, shall not exceed the value inscribed in the appendix of the annex to decision 16/CMP.1, times five.

Table 4(b). Reporting on progress

	Quantity of units	kt CO ₂ eq
2015		
Kyoto Protocol Units ^d		
AAUs	NA	NA
ERUs	NA	NA
CERs	NA	NA
tCERs	NA	NA
ICERs	NA	NA
Units from market-based mechanisms under the Convention ^{d, e}		
Units from other market-based mechanisms ^{d, e}		
Total		
2016		
Kyoto Protocol Units ^d		
AAUs	NA	NA
ERUs	NA	NA
CERs	NA	NA
tCERs	NA	NA
ICERs	NA	NA
Units from market-based mechanisms under the Convention ^{d, e}		
Units from other market-based mechanisms ^{d, e}		
Total		

Abbreviations: AAUs = assigned amount units, CERs = certified emission reductions, ERUs = emission reduction units, ICERs = long-term certified emission reductions, tCERs = temporary certified emission reductions.

Note: 2011 is the latest reporting year.

^a Reporting by a developed country Party on the information specified in the common tabular format does not prejudice the position of other Parties with regard to the treatment of units from market-based mechanisms under the Convention or other market-based mechanisms towards achievement of quantified economy-wide emission reduction targets.

^b For each reported year, information reported on progress made towards the emission reduction target shall include, in addition to the information noted in paragraphs 9(a-c) of the reporting guidelines, on the use of units from market-based mechanisms.

^c Parties may include this information, as appropriate and if relevant to their target.

^d Units surrendered by that Party for that year that have not been previously surrendered by that or any other Party.

^e Additional rows for each market-based mechanism should be added, if applicable.

Table 5: Summary of key variables and assumptions used in the projections analysis

Key underlying assumptions	Unit	Historical						Projected				
		1990	1995	2000	2005	2010	2011	2015	2020	2025	2030	2035
GDP growth rate	%	4.08	12.75	9.02	5.92	-0.62	1.48	3.73	3.17	2.89	2.73	2.59
Population	thousands	3,506.70	3,061.40	3,789.60	4,134.10	4,554.80	4,574.90	4,635.29	4,833.79	5,026.75	5,208.87	5,397.60
Population growth	%	0.57	0.42	1.28	2.19	-0.46	0.44	0.56	0.83	0.74	0.72	0.71
Number of households	thousands	1,159.00	1,253.00	1,429.00	1,730.00	1,985.48	1,994.88	1,958.38	2,017.85	2,112.26	2,206.11	2,304.14
International oil price	USD / boe				60.50	75.59	104.02	49.68	56.84	62.80	69.39	76.66
International coal price	USD / boe				17.00	21.89	27.81	10.78	9.86	11.59	10.56	9.73
International gas price	USD / boe				40.40	43.20	57.20	33.22	20.42	24.59	27.31	25.19

^a Parties should include key underlying assumptions as appropriate.

^b Parties should include historical data used to develop the greenhouse gas projections reported.

Table 6 (a): Information on updated greenhouse gas emissions ^a (with measures)

GHG emissions projections	Unit	GHG emissions and removals ^b							GHG emission projections - Scenarios	
		Base year (1990)	1990	1995	2000	2005	2010	2015	With measures	
									2020	2030
Sector ^{d, e}										
Energy	kt CO ₂ eq	25,982.97	25,982.97	27,621.39	31,737.07	32,527.46	28,831.09	24,714.26	24,248.66	27,737.52
Transport	kt CO ₂ eq	5,135.48	5,135.48	6,271.71	10,788.98	13,121.30	11,528.36	11,830.91	13,278.75	14,933.11
Industry/industrial processes	kt CO ₂ eq	3,272.17	3,272.17	3,273.64	4,742.75	3,769.00	2,458.44	3,133.28	3,244.54	3,721.24
Agriculture	kt CO ₂ eq	20,144.82	20,144.82	20,762.83	20,295.16	19,248.76	18,349.23	19,227.36	20,166.97	19,603.38
Forestry/LULUCF	kt CO ₂ eq	5,796.98	5,796.98	6,709.50	5,938.57	5,203.20	4,169.88	4,313.67	4,637.32	7,549.99
Waste management/waste	kt CO ₂ eq	1,567.29	1,567.29	1,842.96	1,511.63	1,315.05	524.59	974.16	622.57	499.72
Other (specify)	kt CO ₂ eq									
Gas										
CO ₂ emissions including net CO ₂ from LULUCF	kt CO ₂ eq	38,282.71	38,282.71	42,028.68	50,653.38	52,682.33	45,007.95	42,060.01	43,703.32	52,360.68
CO ₂ emissions excluding net CO ₂ from LULUCF	kt CO ₂ eq	32,840.70	32,840.70	35,793.19	45,192.87	48,027.69	41,630.06	38,392.84	39,713.01	45,481.10
CH ₄ emissions including CH ₄ from LULUCF	kt CO ₂ eq	15,029.97	15,029.97	15,305.32	14,576.59	13,816.29	12,470.17	13,634.24	13,606.80	12,989.58
CH ₄ emissions excluding CH ₄ from LULUCF	kt CO ₂ eq	14,803.41	14,803.41	14,996.77	14,292.22	13,511.18	11,980.58	13,263.43	13,239.10	12,617.01
N ₂ O emissions including N ₂ O from LULUCF	kt CO ₂ eq	8,551.76	8,551.76	8,863.89	8,828.94	7,666.25	7,372.05	7,354.82	7,973.00	7,973.05
N ₂ O emissions excluding N ₂ O from LULUCF	kt CO ₂ eq	8,423.42	8,423.42	8,698.32	8,635.21	7,422.80	7,069.57	7,079.20	7,693.69	7,675.20
HFCs	kt CO ₂ eq	1.23	1.23	103.19	456.66	678.41	932.02	1,076.80	838.73	629.57
PFCs	kt CO ₂ eq	0.12	0.12	97.61	397.76	216.39	46.58	20.5	24.63	32.83
SF ₆	kt CO ₂ eq	33.88	33.88	79.11	51.76	96.78	33.09	44.49	51.17	57.72
NF ₃	kt CO ₂ eq	NO	NO	4.37	49.17	28.38	NO	0.96	1.15	1.54
Other (specify)	kt CO ₂ eq									
Total with LULUCF ^f	kt CO ₂ eq	61,899.67	61,899.67	66,482.17	75,014.26	75,184.83	65,861.86	64,191.82	66,198.80	74,044.97
Total without LULUCF	kt CO ₂ eq	56,102.76	56,102.76	59,772.56	69,075.65	69,981.63	61,691.90	59,878.22	61,561.48	66,494.97

Table 6 (a): Information on updated greenhouse gas emissions ^a (with measures)

Abbreviations: GHG = greenhouse gas, LULUCF = land use, land-use change and forestry.

^a In accordance with the "Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part II: UNFCCC reporting guidelines on national communications", at a minimum Parties shall report a 'with measures' scenario, and may report 'without measures' and 'with additional measures' scenarios. If a Party chooses to report 'without measures' and/or 'with additional measures' scenarios they are to use tables 6(b) and/or 6(c), respectively. If a Party does not choose to report 'without measures' or 'with additional measures' scenarios then it should not include tables 6(b) or 6(c) in the biennial report.

^b Emissions and removals reported in these columns should be as reported in the latest GHG inventory and consistent with the emissions and removals reported in the table on GHG emissions and trends provided in this biennial report. Where the sectoral breakdown differs from that reported in the GHG inventory Parties should explain in their biennial report how the inventory sectors relate to the sectors reported in this table.

^c 2018 is the reporting due-date year (i.e. 2014 for the first biennial report).

^d In accordance with paragraph 34 of the "Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part II: UNFCCC reporting guidelines on national communications", projections shall be presented on a sectoral basis, to the extent possible, using the same sectoral categories used in the policies and measures section. This table should follow, to the extent possible, the same sectoral categories as those listed in paragraph 17 of those guidelines, namely, to the extent appropriate, the following sectors should be considered: energy, transport, industry, agriculture, forestry and waste management.

^e To the extent possible, the following sectors should be used: energy, transport, industry/industrial processes, agriculture, forestry/LULUCF, waste management/waste, other sectors (i.e. cross-cutting), as appropriate.

^f Parties may choose to report total emissions with or without LULUCF, as appropriate.

Table 6(c): Information on updated greenhouse gas projections

GHG emissions projections	Unit	GHG emissions and removals								GHG emission projections - Scenarios	
		Base year (1990)	1990	1995	2000	2005	2010	2015	With additional measures		
									2020	2030	
Sector											
Energy	kt CO ₂ eq	25,982.97	25,982.97	27,621.39	31,737.07	32,527.46	28,831.09	24,714.26	22,147.14	24,523.03	
Transport	kt CO ₂ eq	5,135.48	5,135.48	6,271.71	10,788.98	13,121.30	11,528.36	11,830.91	13,071.93	14,701.66	
Industry/industrial processes	kt CO ₂ eq	3,272.17	3,272.17	3,273.64	4,742.75	3,769.00	2,458.44	3,133.28	3,244.54	3,721.24	
Agriculture	kt CO ₂ eq	20,144.82	20,144.82	20,762.83	20,295.16	19,248.76	18,349.23	19,227.36	20,010.18	19,446.59	
Forestry/LULUCF	kt CO ₂ eq	5,796.98	5,796.98	6,709.50	5,938.57	5,203.20	4,169.88	4,313.67	4,637.32	7,549.99	
Waste management/waste	kt CO ₂ eq	1,567.29	1,567.29	1,842.96	1,511.63	1,315.05	524.59	974.16	622.57	499.72	
Other Sectors											
Gases											
CO ₂ emissions including net CO ₂ from LULUCF	kt CO ₂ eq	38,282.71	38,282.71	42,028.68	50,653.38	52,682.33	45,007.95	42,060.01	41,370.57	48,881.10	
CO ₂ emissions excluding net CO ₂ from LULUCF	kt CO ₂ eq	32,840.70	32,840.70	35,793.19	45,192.87	48,027.69	41,630.06	38,392.84	37,380.25	42,001.52	
CH ₄ emissions including CH ₄ from LULUCF	kt CO ₂ eq	15,029.97	15,029.97	15,305.32	14,576.59	13,816.29	12,470.17	13,634.24	13,624.67	13,003.67	
CH ₄ emissions excluding CH ₄ from LULUCF	kt CO ₂ eq	14,803.41	14,803.41	14,996.77	14,292.22	13,511.18	11,980.58	13,263.43	13,256.97	12,631.10	
N ₂ O emissions including N ₂ O from LULUCF	kt CO ₂ eq	8,551.76	8,551.76	8,863.89	8,828.94	7,666.25	7,372.05	7,354.82	7,822.75	7,835.82	
N ₂ O emissions excluding N ₂ O from LULUCF	kt CO ₂ eq	8,423.42	8,423.42	8,698.32	8,635.21	7,422.80	7,069.57	7,079.20	7,543.44	7,537.97	
HFCs	kt CO ₂ eq	1.23	1.23	103.19	456.66	678.41	932.02	1,076.80	838.73	629.57	
PFCs	kt CO ₂ eq	0.12	0.12	97.61	397.76	216.39	46.58	20.50	24.63	32.83	
SF ₆	kt CO ₂ eq	33.88	33.88	79.11	51.76	96.78	33.09	44.49	51.17	57.72	
NF ₃	kt CO ₂ eq	NO	NO	4.37	49.17	28.38	NO	0.96	1.15	1.54	
Other gases											
Total with LULUCF ^f	kt CO ₂ eq	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Total without LULUCF	kt CO ₂ eq	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	

Table 7: Provision of public financial support: Summary information in 2016

Allocation channels	Domestic currency					USD ^b				
	Core/general ^c ₁	Mitigation	Climate-specific ^{d,2}			Core/general ^c ₁	Mitigation	Climate-specific ^{d,2}		
			Adaptation	Cross-cutting ^e	Other ^f			Adaptation	Cross-cutting ^e	Other ^f
2015										
Total contributions through multilateral channels	101,861.00		1,689.00		0					
Multilateral climate change funds ^g	1,420.00		1,200.00		0					
Other multilateral climate change funds ^h										
Multilateral financial institutions, including regional development banks	53,845.00									
Specialized United Nations bodies	46,596.00		489							
Total contributions through bilateral, regional and other channels		1,976.00	22,524.00	9,815.00						
Total	101,861.00	1,976.00	24,213.00	9,815.00	0					
2016										
Total contributions through multilateral channels	147,001.60		2,000.00		2,000.00	564.3				
Multilateral climate change funds ^g	1,420.00		1,500.00		2,000.00					
Other multilateral climate change funds ^h										
Multilateral financial institutions, including regional development banks	51,825.00									
Specialized United Nations bodies	93,756.60		500			564.3				
Total contributions through bilateral, regional and other channels		1,230.00	37,968.00	9,498.00						
Total	147,001.60	1,230.00	39,968.00	9,498.00	2,000.00	564.3				

Note: Explanation of numerical footnotes is provided in the documentation box after tables 7, 7(a) and 7(b).

Abbreviation: USD = United States dollars.

^a Parties should fill in a separate table for each year, namely 2015 and 2016, where 2018 is the reporting year.

^b Parties should provide an explanation of the methodology used for currency exchange for the information provided in tables 7, 7(a) and 7(b) in the documentation box.

^c This refers to support to multilateral institutions that Parties cannot specify as being climate-specific.

^d Parties should explain in their biennial reports how they define funds as being climate-specific.

^e This refers to funding for activities that are cross-cutting across mitigation and adaptation.

^f Please specify.

^g Multilateral climate change funds listed in paragraph 17(a) of the “UNFCCC biennial reporting guidelines for developed country Parties” in decision 2/CP.17.

^h Other multilateral climate change funds as referred to in paragraph 17(b) of the “UNFCCC biennial reporting guidelines for developed country Parties” in decision 2/CP.17.

Table 7(a): Provision of public financial support: contribution through multilateral channels (sheet 1 of 4)

Donor funding	Total Amount				Status	Funding source	Financial instrument	Type of support	Sector
	Core/general		Climate-specific						
	Domestic Currency	USD	Domestic Currency	USD					
2015									
Total contributions through multilateral channels									
Multilateral climate change funds									
1. Global Environment Facility	1,420.00		0.00		Disbursed		Grant	Other (Core / General)	
2. Least Developed Countries Fund			1,000.00		Disbursed	ODA	Grant	Adaptation	Other (Environment)
3. Special Climate Change Fund									
4. Adaptation Fund									
5. Green Climate Fund									Cross-cutting
6. UNFCCC Trust Fund for Supplementary Activities			200.00		Disbursed	ODA	Grant	Adaptation	Cross-cutting
7. Other multilateral climate change funds									
Multilateral financial institutions, including regional development banks									
1. World Bank	8,400.00				Disbursed	ODA	Grant		Agriculture, Cross-cutting
2. International Finance Corporation									
3. African Development Bank									
4. Asian Development Bank									
5. European Bank for Reconstruction and Development	1,820.00				Disbursed	ODA	Grant		
6. Inter-American Development Bank									
7. Other									
International Fund for Agricultural Development	2,000.00				Disbursed	ODA	Grant		
World Health Organisation	1,900.00				Disbursed	ODA	Grant		
OECD	1,050.00				Disbursed	ODA	Grant		
EU - European Development Fund	38,675.00				Disbursed	ODA	Grant		

Table 7(a): Provision of public financial support: contribution through multilateral channels (sheet 2 of 4)

Donor funding	Total Amount				Status	Funding source	Financial instrument	Type of support	Sector
	Core/general		Climate-specific						
	Domestic Currency	USD	Domestic Currency	USD					
Specialized United Nations bodies									
1. United Nations Development Programme									
2. United Nations Environment Programme									
3. Other									
United Nations Development Programme	8,275.00				Disbursed	ODA	Grant		
United Nations Environment Programme	61.00		189.00		Disbursed	ODA	Grant	Adaptation	
UNISDR			300.00		Disbursed	ODA	Grant	Adaptation	Other (DRR)
World Food Programme	2,200.00				Disbursed	ODA	Grant		
UN Convention to Combat Desertification	31.50				Disbursed	ODA	Grant		
UNICEF	7,200.00				Disbursed	ODA	Grant		
UN AIDS	15,700.00				Disbursed	ODA	Grant		
UNHCR	5,800.00				Disbursed	ODA	Grant		
UN FPA	2,800.00				Disbursed	ODA	Grant		
UN WOMEN	1,910.00				Disbursed	ODA	Grant		
UN VOLUNTEERS	595.00				Disbursed	ODA	Grant		
UN OHCHR	2,023.50				Disbursed	ODA	Grant		
2016									
Total contributions through multilateral channels									
Multilateral climate change funds									
1. Global Environment Facility	1,420.00								
2. Least Developed Countries Fund			1,000.00		Disbursed	ODA	Grant	Adaptation	Other (Environment)
3. Special Climate Change Fund									
4. Adaptation Fund									
5. Green Climate Fund			2,000.00						Cross-cutting
6. UNFCCC Trust Fund for Supplementary Activities			500.00		Disbursed	ODA	Grant	Adaptation	Other (Environment)
7. Other multilateral climate change funds									

Table 7(a): Provision of public financial support: contribution through multilateral channels (sheet 3 of 4)

Donor funding	Total Amount				Status	Funding source	Financial instrument	Type of support	Sector
	Core/general		Climate-specific						
	Domestic Currency	USD	Domestic Currency	USD					
Multilateral financial institutions, including regional development banks									
1. World Bank	10,000.00				Disbursed	ODA	Grant		
2. International Finance Corporation									
3. African Development Bank									
4. Asian Development Bank									
5. European Bank for Reconstruction and Development	1,365.00				Disbursed	ODA	Grant		
6. Inter-American Development Bank									
7. Other									
World Food Programme	40,000.00				Disbursed	ODA	Grant		
Food and Agriculture Organisation	460.00				Disbursed	ODA	Grant		Agriculture
Specialized United Nations bodies									
1. United Nations Development Programme									
2. United Nations Environment Programme									
3. Other									

Table 7(a): Provision of public financial support: contribution through multilateral channels (sheet 4 of 4)

Donor funding	Total Amount				Status	Funding source	Financial instrument	Type of support	Sector
	Core/general		Climate-specific						
	Domestic Currency	USD	Domestic Currency	USD					
United Nations Development Programme	7,900.00				Disbursed	ODA	Grant		
United Nations Environment Programme	508.30	564.30			Disbursed	ODA	Grant		
UNISDR			500.00		Disbursed	ODA	Grant	Adaptation	Other (DRR)
UN OCHA	4,500.00				Disbursed	ODA	Grant		
UN CERF	7,000.00				Disbursed	ODA	Grant		
UN Peacebuilding Fund	500.00				Disbursed	ODA	Grant		
UN Industrial Development Organisation	412.30				Disbursed	ODA	Grant		
UN Convention to Combat Desertification	31.20				Disbursed	ODA	Grant		
UN RWA	4,000.00				Disbursed	ODA	Grant		
UNICEF	7,500.00				Disbursed	ODA	Grant		
UN AIDS	2,648.00				Disbursed	ODA	Grant		
UNHCR	7,000.00				Disbursed	ODA	Grant		
UN FPA	2,800.00				Disbursed	ODA	Grant		
UN WOMEN	1,500.00				Disbursed	ODA	Grant		
Commission of the European Union	33,642.50				Disbursed	ODA	Grant		
UN CERF	7,000.00				Disbursed	ODA	Grant		
International Atomic Energy Agency	173.20				Disbursed	ODA	Grant		
The Gavi Alliance	3,000.00				Disbursed	ODA	Grant		
International Fund for Agricultural Development	2,000.00				Disbursed	ODA	Grant		
International Trade Centre	800.00				Disbursed	ODA	Grant		
IOM Geneva	191.10				Disbursed	ODA	Grant		
WTO Advisory Law Centre	350.00				Disbursed	ODA	Grant		
World Health Organization	300.00				Disbursed	ODA	Grant		

Table 7(b) Provision of public financial support: contribution through bilateral, regional and other channels (sheet 1 of 2)

Project/programme/activity	Total Amount		Status	Funding source	Financial instrument	Type of support	Sector	Recipient country or region	Additional Information
	Climate-specific								
	Domestic Currency	USD							
2015									
Total contributions through bilateral, regional and other channels									
Adaptation projects and programmes	14,878.00		Disbursed	ODA	Grant	Adaptation	Agriculture, Water and sanitation, Energy, Other (Climate Research), Other (DRR), Other (Social Protection)	Ethiopia	
Mitigation Projects and Programmes	896.00		Disbursed	ODA	Grant	Mitigation	Energy, Water and sanitation, Other (Bio Fuels)	Ethiopia	
Adaptation Projects and Programmes	3,018.00		Disbursed	ODA	Grant	Adaptation	Agriculture, Water and sanitation, Other (DRR), Other (Social Protection)	Malawi	
Mitigation Projects and Programmes	1,080.00		Disbursed	ODA	Grant	Mitigation	Energy, Forestry, Agriculture	Malawi	
Cross-cutting Projects and Programmes	4,400.00		Disbursed	ODA	Grant	Cross-cutting	Agriculture, Water and sanitation, Other (DRR)	Malawi	
Adaptation Projects and Programmes	550.00		Disbursed	ODA	Grant	Adaptation	Agriculture, Water and sanitation	Mozambique	
Cross-cutting Projects and Programmes	732.00		Disbursed	ODA	Grant	Cross-cutting	Agriculture, Other (Governance)	Mozambique	
Cross-cutting Projects and Programmes	1,588.00		Disbursed	ODA	Grant	Cross-cutting	Agriculture	United Republic of Tanzania	
Adaptation Projects and Programmes	3,328.00		Disbursed	ODA	Grant	Adaptation	Agriculture, Cross-cutting, Other (Infrastructure), Other (Governance), Other (Education)	Viet Nam	
Adaptation Projects and Programmes	150.00		Disbursed	ODA	Grant	Adaptation	Agriculture	Myanmar	
Cross-cutting Projects and Programmes	1,165.00		Disbursed	ODA	Grant	Cross-cutting	Agriculture, Cross-cutting	Zambia	
Adaptation Projects and Programmes	150.00		Disbursed	ODA	Grant	Adaptation	Agriculture	South Africa	
Cross-cutting Projects and Programmes	80.00		Disbursed	ODA	Grant	Cross-cutting	Cross-cutting	South Africa	
Adaptation Projects and Programmes	450.00		Disbursed	ODA	Grant	Adaptation		Zimbabwe	
IIED, WRI, Climate Justice Advocacy	1,850.00		Disbursed	ODA	Grant	Cross-cutting	Cross-cutting	Multi-Country	

Table 7(b) Provision of public financial support: contribution through bilateral, regional and other channels (sheet 2 of 2)

Project/programme/activity	Total Amount		Status	Funding source	Financial instrument	Type of support	Sector	Recipient country or region	Additional Information
	Domestic Currency	USD							
2016									
Total contributions through bilateral, regional and other channels									
Adaptation projects and programmes	15,140.00		Disbursed	ODA	Grant	Adaptation	Agriculture, Energy, Other (Climate Research), Other (DRR), Other (Social Protection), Cross-cutting, Water and sanitation	Ethiopia	
Mitigation Projects and Programmes	910.00		Disbursed	ODA	Grant	Mitigation	Agriculture, Water and sanitation	Ethiopia	
Adaptation Projects and Programmes	6,676.00		Disbursed	ODA	Grant	Adaptation	Other (Social Protection), Agriculture, Forestry, Other (DRR)	Malawi	
Mitigation Projects and Programmes	320.00		Disbursed	ODA	Grant	Mitigation	Energy	Malawi	
Cross-cutting Projects and Programmes	4,166.00		Disbursed	ODA	Grant	Cross-cutting	Agriculture, Water and sanitation, Other (DRR)	Malawi	
Adaptation Projects and Programmes	3,897.00		Disbursed	ODA	Grant	Adaptation	Agriculture, Water and sanitation, Other (Nutrition), Other (DRR), Cross-cutting	Mozambique	
Cross-cutting Projects and Programmes	219.00		Disbursed	ODA	Grant	Cross-cutting	Agriculture	Mozambique	
Adaptation Projects and Programmes	2,140.00		Disbursed	ODA	Grant	Adaptation	Agriculture, Other (Nutrition)	United Republic of Tanzania	
Cross-cutting Projects and Programmes	1,000.00		Disbursed	ODA	Grant	Cross-cutting	Agriculture	United Republic of Tanzania	
Adaptation Projects and Programmes	2,868.00		Disbursed	ODA	Grant	Adaptation	Agriculture, Other (Education), Other (Nutrition), Cross-cutting	Viet Nam	
Cross-cutting Projects and Programmes	84.00		Disbursed	ODA	Grant	Cross-cutting	Cross-cutting, Other (Gender Equality)	Viet Nam	
Adaptation Projects and Programmes	190.00		Disbursed	ODA	Grant	Adaptation	Water and sanitation, Cross-cutting	Myanmar	
Adaptation Projects and Programmes	1,227.00		Disbursed	ODA	Grant	Adaptation	Agriculture	Zambia	
Cross-cutting Projects and Programmes	1,110.00		Disbursed	ODA	Grant	Cross-cutting	Agriculture, Cross-cutting	Zambia	
Adaptation Projects and Programmes	250.00		Disbursed	ODA	Grant	Adaptation	Cross-cutting, Agriculture	South Africa	
Adaptation Projects and Programmes	707.00		Disbursed	ODA	Grant	Adaptation	Agriculture, Cross-cutting	Zimbabwe	
Cross-cutting Projects and Programmes	233.00		Disbursed	ODA	Grant	Cross-cutting	Cross-cutting	Zimbabwe	
Adaptation Projects and Programmes	1,749.00		Disbursed	ODA	Grant	Adaptation	Water and sanitation, Agriculture, Cross-cutting, Other (Nutrition), Other (Social Protection)	Uganda	
Cross-cutting Projects and Programmes	680.00		Disbursed	ODA	Grant	Cross-cutting	Water and sanitation, Other (Education), Cross-cutting	Uganda	
Adaptation Projects and Programmes	1,686.00		Disbursed	ODA	Grant	Adaptation	Agriculture, Water and sanitation, Other (Nutrition), Other (Education)	Kenya	
Cross-cutting Projects and Programmes	96.00		Disbursed	ODA	Grant	Cross-cutting	Cross-cutting	Kenya	
Adaptation Projects and Programmes	280.00		Disbursed	ODA	Grant	Adaptation	Cross-cutting	Sierra Leone	
Adaptation Projects and Programmes	213.00		Disbursed	ODA	Grant	Adaptation	Cross-cutting	Liberia	
Adaptation Projects and Programmes	945.00		Disbursed	ODA	Grant	Adaptation	Agriculture	Sudan	
IIED, WRI, Climate Justice Advocacy, Agri support	1,910.00		Disbursed	ODA	Grant	Cross-cutting	Cross-cutting	Multi-Country	

Table 8: Provision of technology development and transfer support (sheet 1 of 2)

Recipient country and/or region	Targeted area	Measures and activities related to technology transfer	Sector	Source of the funding for technology transfer	Activities undertaken by	Status	Additional information
Ethiopia	Mitigation	Enhancing integrated Watershed management with climate smart Agriculture in Gergera Watershed	Agriculture	Public	Public	Implemented	Working with Government institutions and farmers to strengthen integrated watershed management approaches through building capacity to use climate smart Agriculture practices and to enhance watershed planning, management and ecosystem regeneration and conservation.
Ethiopia	Adaptation	Improving Food and Nutrition Security and Climate Resilience through Adoptive Research in SNNPR	Agriculture	Public	Public	Implemented	This project contributes to poverty reduction and improved food security, nutrition, and climate resilience in seven woredas, or districts, of the region. Operational research in the agricultural sector is a form of farmer participatory research and extension that places greater emphasis on on-farm trials and farmer validation of technologies. Introduction of new crops and varieties contributes to diversity of the farming system and contributes to food security and resilience to climate change. This project also tackles the seed supply challenge by facilitating access to improved varieties of seed.
Ethiopia	Mitigation	Support for rural livelihoods through promotion and dissemination of improved Cook Stoves in Tigray and SNNPR	Energy	Public	Public	Implemented	Support for rural livelihoods that are climate smart through promotion and dissemination of improved Cook Stoves in Tigray and SNNPR . The overall objective is to improve the livelihood of poor, rural households and to contribute to regional development and Climate Resilient Green Economy implementation in SNNPR and Tigray
Ethiopia	Adaptation	Improving Food and Nutrition Security and Climate Resilience through Adoptive Research in Tigray	Agriculture	Public	Public	Implemented	The overall goal of the programme is to contribute to food and nutrition security, gender equity and building climate resilient economy through adaptation, evaluation and dissemination of improved agricultural technologies. Operational research in the agricultural sector is a form of farmer participatory research and extension that places greater emphasis on on-farm trials and farmer validation of technologies. Introduction of new crops and varieties contributes to diversity of the farming system and contributes to food security and resilience to climate change. This project also tackles the seed supply challenge by facilitating access to improved varieties of seed
Malawi	Adaptation	Root and Tuber Crops for Agricultural Transformation in Malawi (RTC-ACTION Malawi)	Other (Agroforestry), Agriculture	Public	Public	Implemented	Root and Tuber Crops for Agricultural Transformation programme aims to contribute towards climate-smart agriculture, i.e. agriculture that sustainably increases productivity (food security) and resilience (climate change adaptation) through the scaling up of roots and tuber particularly those crops that are better adapted to the future climate related scenarios, and ranges of precipitation and temperature. Innovative technologies are used for seed storage that can be developed by farmers themselves. This project was designed, to strengthen the capacity of government departments, to be closely aligned with Malawi's National Adaptation Plans and Agriculture Sector Wide Approach Programme (ASWAP).

Table 8: Provision of technology development and transfer support (sheet 2 of 2)

Recipient country and/or region	Targeted area	Measures and activities related to technology transfer	Sector	Source of the funding for technology transfer	Activities undertaken by	Status	Additional information
Malawi	Mitigation and Adaptation	Adoption of Climate-Smart Agriculture principles and practices under smallholder farmer conditions in the context of climate change	Agriculture	Public	Public	Implemented	To improve sustainable crop production, productivity and marketing through adoption of Climate-Smart Agriculture principles and practices under smallholder farmer conditions in the context of climate change. Climate-smart agriculture practices can help shield farmers from the adverse effects of climate change and variability and also improve farm yields and household incomes, resulting in stronger and more resilient communities besides delivering environmental benefits. The project specifically aims at: increasing adoption of CSA practices in smallholder farming systems; promoting agricultural diversification; promoting sustainable land and water management practices; providing improved access to stable and profitable markets for legumes; and increasing adoption of energy saving technologies
Malawi	Mitigation	Accelerated Uptake of Improved Cookstoves	Energy	Public	Public	Implemented	Accelerating Uptake of Improved Cookstoves - The overall objective of this programme is to contribute to the national target of having 2 million cook stoves adopted in Malawi by 2020, through improved access to stove technologies and technical support and by accessing carbon financing services through Concern Universal and other organisations so that local and national stakeholders better understand carbon certification and markets.
Malawi	Adaptation	Building Community Resilience Programme in Chikwawa	Other (DRR)	Public	Public	Implemented	he overarching objective of the programme is to build of the capacity of local authorities and communities to be better prepared to respond to extreme weather events (particularly flooding) through early warning systems, evacuation preparedness and improved local measures to reduce the impact of flooding on the communities. Work includes strengthening the District's capacity to plan emergency response, and to communicate with vulnerable communities by linking information from highland communities with lowlying communities to improve early warning and put in place Districts emergency response measures to reduce risks to the communities in Chikwawa.
United Republic of Tanzania	Adaptation	MVIWATA: Strengthening farmers voices through lobbying and networks - improving capacity of farmers to adopt adaptive technologies	Agriculture	Public	Public	Implemented	This programme supports the Network of Small-Scale Farmers' Groups in Tanzania. The focus of this programme is the strengthening of farmer groups and networks at all levels including through capacity building, economic empowerment and advocacy. Climate Change is contributing to increased food insecurity, conflicts over land use and struggle for land between "investors" and small, local producers. This programme builds the knowledge and training of farmers in climate change and introduces adaptive technologies to improve natural resource management.
Viet Nam	Adaptation	Pilot of community-based operation and maintenance of communal infrastructure	Agriculture	Public	Public	Implemented	Improved capacity of communities of the poor and ethnic minorities in the Central Highlands of Vietnam to identify local adaptation needs through improved planning and maintenance of local infrastructure.

Table 9. Provision of capacity-building support

Recipient country / region	Targeted area	Programme or project title	Description of programme or project
Ethiopia	Adaptation	Improving smallholder food security, nutrition and resilience in Tigray - Bureau of Agriculture	The goal of the project is to enhance food security, improved nutrition and resilience of vulnerable communities through the introduction of climate smart agricultural technologies to smallholder farmers by supporting the capacity of government authorities
Malawi	Multiple Areas	Agriculture Sector-Wide Approach Support Project (ASWAP SP MDTF)	Agriculture Sector Wide Approach Support Project (ASWAP SP MDTF). The objectives of this programme are to improve the effectiveness of investments aimed at food security and sustainable agricultural growth, and strengthen the natural resource base in agricultural lands, through a doubling of the area under sustainable land management as a basis for securing ecosystem services and sustainable agricultural productivity. By supporting conservation agriculture and agro-forestry, this project protects and enhances sinks and thus contributes to climate change mitigation and combats land degradation. By supporting and researching agricultural weather-based risk management, early warning systems and sustainable water management this project also supports long term adaptation to climate change. Risk management and early warning systems also contribute to Disaster Risk Management.
United Republic of Tanzania	Adaptation	Agriculture Value Chain Development Programme, focusing on sunflower maize and pulses	The aims of the programme are to promote better access to and use of agricultural knowledge, technologies, improved marketing systems and infrastructures. The programme promotes sustainable agriculture practices, and promotes drought resilient crops, water conservation and improved irrigation and improved supply chains and supports climate resilience.
Zambia	Multiple Areas	Local Development Programme in Northern Province	The goal of this programme is to reduce the poverty and vulnerability in isolate rural communities in northern province in Zambia. The programme promotes conservation agriculture practices, agroforestry and drought resistant crops, water conservation and improved irrigation and the identification and adoption of suitable technologies that supports climate resilience agriculture. The strategy adopted is based on detail climate scenario analysis and planning and the introduction of well-adapted technology to short-term climate variability and is a pre-condition for adaptation to more frequent extreme events and long-term climate changes.
United Republic of Tanzania	Multiple Areas	Technoserve / small-scale cocoa farmers in two regions of Tanzania	Cocoa value chain: developing and building the capacity for a high quality cocoa value chain improving sustainable production and market access
United Republic of Tanzania	Multiple Areas	SNV: Oil seeds value chain project - improving producer association and oil seed value chain and markets	The programme promotes edible oilseeds such as sunflower and sesame seeds to support improved household nutrition and food security in poor communities. Sunflower and sesame seeds were chosen for this project for their potential for increased processing capacity, income and employment, and for being climate smart crops.
United Republic of Tanzania	Multiple Areas	Cocoa value chain - developing a high quality cocoa value chain improving production and market access	Through support for Technoserve work with small-scale cocoa farmers in two regions of Tanzania build a cocoa sector: The aim of this project is to stimulate growth of the agricultural economy and enhance long-term resilience of the poorest households by improving productivity of cocoa trees through re-planting and improving valuechains it is expected to lead to increased productivity due to improved soil fertility management. The project also aims to build the capacity of the of agriculture extension system to apply the project methodologies in the wider region. Climate change is recognised and incorporated as a cross cutting issue in this project. The project includes an early objective to increase capacity for mitigation and adaptation at local level. Farmers will also receive training in improved farming techniques and water management and irrigation for conservation of water resources thus contributing both to protection of bio-diversity and combatting desertification. As the primary aim of this project is to stimulate growth of the agricultural economy with climate change adaptation as an important sub-component.
Viet Nam	Adaptation	Improvement of livelihood of poor and ethnic minorities in Central Highlands	The aim of the project is to contribute to poverty reduction through the improvement of livelihood of the poor and ethnic minorities in the Central Highlands through the adoption of sustainable coffee production technologies and pro - poor market access (CPMA) in poorest districts, communes and villages and of ethnic minority people. The project will help by providing necessary technical assistance and capacity development support in planning and adopting technologies considered crucial to sustain coffee production and adapt to climate change
Viet Nam	Adaptation	From university to community - preparing a generation of professionals in sustainable development	From university to community preparing a generation of professionals in sustainable development works to provide support to train 200 students in 10 participating universities
Mozambique	Multiple Areas	Gorongosa National Park restoration project - northern buffer zone	The overall goal of the project is to reduce the threats of the Park biodiversity by attracting communities living and hunting in the park to a buffer zone with basic social services and while addressing at the same time interventions aimed at building the capacity, productivity and resilience of small-scale agricultural production systems of food insecure households, a situation that is aggravated by the serious drought affecting the area.
Uganda	Adaptation	WRI support for adaptation finance tracking	Developing the capacity of civil society groups and Local Government to track adaptation financing to the local and its use to address climate change impacts at community
Multi-country	Multiple Areas	IIED Support to integrate climate change into development programmes	Development of the Climate Change and Development Learning Platform to better integrate climate risk into development planning and programmes. The support provides for capacity building for the Least Developed Countries Group in the UNFCCC, and Irish Aid Partners in 9 key partner countries.