HM Government

The UK's Sixth National Communication and First Biennial Report under the UNFCCC

December 2013

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The UK's Sixth National Communication and First Biennial Report under the United Nations Framework Convention on Climate Change

Prepared by the Department of Energy and Climate Change

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Foreword by the Secretary of State for Energy and Climate Change

This is the UK's Sixth National Communication and the First Biennial Report under the United Nations Framework Convention on Climate Change.

Earlier this year, the IPCC's Fifth Assessment Report confirmed that scientists are more certain than ever of humankind's dangerous interference with the climate. But working together to keep global temperature rise to no more than 2 degrees Celsius above pre-industrial levels can help to avoid the most dangerous effects of climate change.

Together with all our international partners we are in the process of agreeing, by 2015, a new legally-binding deal on climate change. It's clear that any effective solution will involve every country on the planet. And honest and transparent reporting on the progress we are each making individually will be key to this. That's why I am proud to lay out in this document the strong progress the UK has made.

When the Coalition Government took office in 2010, we confirmed our commitment to using a wide range of levers to cut carbon emissions, decarbonise the economy and support the creation of new green jobs and technologies. Since then, we have brought forward a full programme of measures to fulfil our joint ambitions for a low carbon economy.

The Energy Bill now before Parliament will enable the biggest reforms to our electricity market since privatisation. By creating a new framework of long-term contracts for low carbon electricity, and a mechanism for maintaining sufficient capacity to keep the lights on, we are aiming to bring on the £110 billion of new investment needed in our electricity infrastructure this decade. To date, the Green Investment Bank has committed £714m of public money to projects in a range of green sectors, including waste, offshore wind and energy efficiency, helping to mobilise an additional £1.9 billion of finance from the private sector.

And these policies are working. The actions we have already taken mean the UK's greenhouse gas emissions are significantly below the level needed to achieve our Kyoto target. In 2011 we estimated that the UK's greenhouse gas emissions were 26% below 1990 levels, compared to our target of a 12.5% reduction over the 2008-2012 period. These policies also put us on track, to 2022, to meet our domestic commitments under the Climate Change Act – the world-leading framework which requires the UK to reduce its emissions by at least 80% by 2050, via a series of legally-binding carbon budgets.

These policies demonstrate that the ambitious international deal we're working for can be delivered, on the ground, around the world. The 2050 calculator, developed to show how the UK can transition to a low-carbon economy, has now gone global – with 13 international versions underway to illustrate that the low-carbon transition can be achieved in economies as diverse as South Korea and South Africa.

To tackle the challenges of dangerous climate change, we will need to continue and strengthen this action – both at home and abroad. But when countries meet in Paris in 2015, we will know that a global deal to decarbonise our economies can work: because we are seeing it take shape today, including through the policies described in this Communication.

Edward Davey MP

Executive summary

This report covers the UK's Sixth National Communication and First Biennial Report under Article 12 of the United Nations Framework Convention on Climate Change (UNFCCC), under Article 7 of the Kyoto Protocol and under decision 2/CP.17 of the Conference of the Parties under the UNFCCC. This report provides a comprehensive overview of climate change related activity in the UK – including the progress made at home and abroad to reduce greenhouse gas emissions, and to adapt to the effects of a changing climate.

The UK's first Biennial Report is attached in Annex 1 and the related Common Tabular Format forms Annex 2. Annex 3 of the National Communication is the UK Report on national activities with respect to the GCOS Implementation Plan. A summary table outlining the location of supplementary information required under Article 7, paragraph 2, of the Kyoto Protocol within this National Communication is provided in Annex 8.

The National Communication contains eight chapters:

Chapter 1: National circumstances

- The UK population in 2011 was 63 million, with nearly 84% of the population resident in England. The UK population is predicted to rise to over 70 million by 2030.
- The UK covers over 24 million hectares. Around 70% of this is used for agricultural use.
- The UK Budget 2013 forecast is for the UK GDP to grow by 1.2% in 2013 and 1.8% in 2014.
- The UK has experienced 8 of the 10 warmest years on record since 1990, with 2006 the warmest year to date. By 2080, UK daily minimum temperatures are set to rise by up to 4 ºC or more, depending on the region and the future emissions.

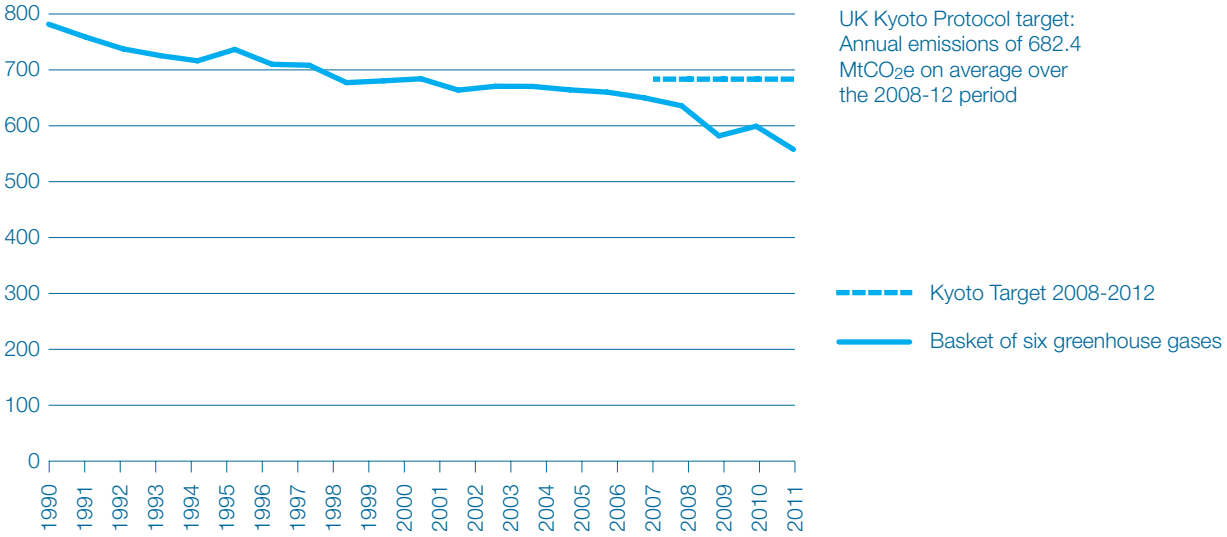
Chapter 2: Greenhouse gas emissions inventory

- In 2011, UK greenhouse gas (GHG) emissions on a UNFCCC basis were 553.2 million tonnes of carbon dioxide equivalent ($MtCO_2e$) – 29.1% lower than 1990 levels.[1]
- The Kyoto Protocol requires that UK GHG emissions are reduced by 12.5% below base year levels over the 2008-12 period. In 2011, UK's GHG emissions were 29.2% below Kyoto Protocol base-year levels.

[1] Greenhouse gas emissions are expressed throughout this document as million tonnes of carbon dioxide equivalent ($MtCO_2e$). Gases other than CO_2 are expressed in terms of carbon dioxide equivalent by multiplying their emissions by their global warming potential (GWP).

- Between 1990 and 2011 CO_2 emissions including LULUCF fell by 22.4%. Methane (CH_4) emissions fell by 57.6% and nitrous oxide (N_2O) emissions fell by 49.0%.
- Between 1995 and 2011, hydrofluorocarbons (HFCs) emissions fell by 4.4%, perfluorocarbons (PFCs) emissions fell by 29.6%, and sulphur hexafluoride (SF_6) emissions fell by 51.0%.
- The reduction in GHG emissions since 1990 has been mainly driven by restructuring in the energy supply industry (concerted move away from coal and oil generation towards use of gas), energy efficiency, pollution control measures in the industrial processes sector and other policies that reduced emissions of non-CO_2 GHGs, most notably the increase in landfill methane capture and oxidation.

Figure 1: UK emissions of GHGs, 1990–2011, $MtCO_2e$



Source: 2011 Final UK greenhouse gas emissions.

Chapter 3: Policies and measures

- The UK has a strong policy portfolio delivering GHG emissions reductions in the electricity sector, in industry, and in homes, offices and buildings. The devolved administrations have made strong progress on their mitigation programmes and continue to work closely with the UK government and each other on developing innovative and effective mitigation policies and measures.
- Since its introduction in 2002, the renewable obligation (RO) has succeeded in tripling the level of renewable electricity from 2.9% of total UK generation to 11.3% in 2012. In March 2012 total capacity under the RO was almost 12,500 MW, with over 30 TWh of renewable generation, and savings of 15.1 $MtCO_2e$.
- The Energy Bill currently before Parliament will build on the success of the RO, and go further – enabling the biggest reforms to our electricity market since privatisation. EMR will help incentivise investment in low carbon electricity generation to ensure the UK meets its decarbonisation and security of supply goals, while minimising costs to consumers. EMR provides support for low carbon technologies in the short to medium term, working towards a long term vision of a competitive market where all technologies participate on a level playing field without direct financial support.
- To complement the support provided for large-scale low-carbon generation, the Feed-in-Tariffs scheme encourages deployment of small-scale (up to 5MW), low-carbon electricity generation, particularly by organisations, businesses, communities and

individuals that have not traditionally engaged in the electricity market. Over 470,000 installations (2.2 GW capacity) were registered on either the central feed-in tariff register or the microgeneration certification scheme by the end of August 2013.

- Half of the UK's carbon emissions currently come from the energy used to generate heat. The renewable heat incentive financial support scheme for renewable heat has an important role to play in the UK's transition to a low carbon economy. This policy could result in cumulative savings of 5 $MtCO_2e$ to 2015, increasing to 39 $MtCO_2e$ to 2020.
- A world first, the Green Deal energy efficiency programme is designed to deliver energy efficiency improvements across Great Britain, and to boost long term investment and growth in the energy efficiency products and service sectors. It is already helping consumers to cut waste and the cost of their bills, whilst reducing their energy demand and carbon emissions.
- The Energy Company Obligation (ECO) is a statutory obligation placed on the main energy suppliers to meet a series of targets relating to carbon savings and reducing home heating costs up to 2015. On 2 December 2013, Government announced proposals to extend the scheme to 2017.

Chapter 4: Projections of GHG emissions in a scenario with policy measures

- In 2011, UK emissions of the basket of six greenhouse gases covered by the Kyoto Protocol[2] were estimated to be 553.2 million tonnes of carbon dioxide equivalent ($MtCO_2e$), 29.2% lower than the 1990 level of 775 $MtCO_2e$. UK emissions of the basket are projected to fall to 438 $MtCO_2e$ (43% below the 1990 level) by 2020 and 399 $MtCO_2e$ by 2030 (48% below the 1990 level).
- Emissions of CO_2, CH_4 and N_2O are projected to be 39%, 63% and 52% respectively, below 1990 levels by 2020. Emissions of the fluorinated greenhouse gases (HFCs, PFCs and SF_6) are collectively projected to be 32% below their 1990 level in 2020.
- Since the Fifth National Communication, the UK has announced further policies to help meet its EU effort sharing, renewable energy, and energy efficiency targets, as well as the domestic carbon budgets set under the 2008 Climate Change Act.[3,4] These policies include a major reform of the Electricity Market, the Renewable Heat Incentive for business and new measures to improve the energy efficiency of domestic buildings (the Green Deal and ECO).
- Policies adopted in the period between 2009 and 2013 are projected to deliver emissions savings of 122 $MtCO_2e$ by 2020 and 143 $MtCO_2e$ by 2030 and these savings are included in the projections. The UK's most recent national projections indicate that the UK is on track to meet its first three carbon budgets.
- In 2011, the government set its fourth carbon budget for 2023-27, capping emissions to an annual equivalent of 390 $MtCO_2e$ in 2025. A range of future policy options to meet this target was identified.[5]

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2 The basket of greenhouse gases covered by the Kyoto Protocol consists of six gases: carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride.

3 http://www.legislation.gov.uk/uksi/2009/1259/article/1/made

4 http://www.legislation.gov.uk/ukpga/2008/27/contents

5 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48080/1685-ia-fourth-carbon-budget-level.pdf

Chapter 5: Vulnerability assessment, climate change impact, and adaptation measures

- The UK has made a strong start on adaptation and this is already making us better equipped to cope with higher temperatures, increased rainfall and the other potential changes.
- The UK's first Climate Change Risk Assessment (CCRA) was published in January 2012 and sets out the severity and likelihood of a range of potential impacts in the short, medium and long term. This was followed by the National Adaptation Programme (NAP), published in July 2013. The NAP sets out the UK government's response to the climate change impacts identified in the CCRA.
- Climate adaptation policy is a devolved matter. Scotland, Wales and Northern Ireland have established their own adaptation programmes while Defra leads for adaptation policy in England and UK reserved matters. The UK Administrations are committed to working closely together to share best practice and develop UK wide initiatives where appropriate.
- There are numerous examples of adaptation in practice in the UK. These include reforming the way we abstract water to cope with changes in availability, increasing the interconnectivity of the natural environment which will help build its resilience to climate change and factoring the need for adaptation into planning policy. In Scotland, the Scottish Forestry Strategy sets out three key actions to improve understanding, maintain preventative measures and increase the role of forestry in environmental protection. Meanwhile the Heatwave Plan for Wales increases Welsh resilience to extreme heat and in Northern Ireland the Department for Agriculture and Rural Development Strategic Plan 2012-2020 contains a number of actions to make their agriculture sector more resilient to climate change.
- The UK also supports adaptation in developing countries. We are providing up to £150 million to the International Fund for Agricultural Development's Adaptation for Smallholder Agriculture Programme, while in Bangladesh we are investing £73 million in the Chars Livelihoods Programme between 2009 and 2016.

Chapter 6: Financial assistance and support for technologies

- In 2010, the UK government announced the £2.9 billion International Climate Fund (ICF). The purpose of the fund is to support international poverty reduction by helping developing countries grow in a low carbon way, address deforestation and adapt to climate change. In 2013, a further £969 million was announced, increasing the fund to £3.87 billion from 2011/12 to 2015/16.
- The UK delivered in full its Fast Start Finance pledge, which it committed to at the UN Conference on Climate Change (COP 15) in Copenhagen in 2009. This was achieved by providing over £1.5 billion over between 2010 and 2012.
- In 2011, the UK government launched the Prosperity Fund to help tackle climate change, strengthen energy security and promote an open global economy with a particular focus on emerging economies. Funding for 2013/14 is £19.6 million, over half of which is spent on climate projects.

Chapter 7: Research and systematic observation

- The UK continues to be a world-leader in many aspects of climate research and observations of the climate system. It continues to be very active in both fields, both independently and with international partners.

Research

- The new Met Office Hadley Centre climate programme, jointly funded by DECC and Defra, will strengthen national climate capability by developing improved understanding of the climate system and the next generation of state-of-the-art climate and Earth system models in partnership with the UK academic community.
- Publication of the UK Climate Change Risk Assessment and the National Adaptation Programme has informed UK adaptation policy. The Committee on Climate Change's Adaptation Sub-Committee reported on managing the land in a changing climate, and the preparedness for flood risk to people and property and availability of water for households and businesses.
- The UK has been focused on improvement of climate information for a range of audiences. For example, Climate Service UK is a new initiative led by the Met Office, which will provide business and society with information to help make them more resilient to climate variability and change.
- The Living with Environmental Change (LWEC) partnership has set up a Task Force on Climate Mitigation. It is exploring the global and regional impacts of a range of emissions scenarios, the technical and economic feasibility of achieving such pathways, and how results can be used to stimulate action. LWEC has developed Climate Change Impacts Report Cards to build up a picture of historical and future impacts resulting from climate change.
- Defra has developed the Sustainable Pathways for Low Carbon Energy Research Programme to address evidence for mitigation policy needs.
- The Health Protection Agency (Public Health England from 1 April 2013) set up a new programme on Climate Change and Extreme Events and published an authoritative report on the Health Effects of Climate Change in the UK 2012 – Current evidence, recommendations and research gaps.

Systematic observations

- A group of experts has been set up to oversee co-ordination of UK GCOS activities, the "Coordinating Climate Observations Group" (CCOG).
- In 2012 the British Standards Institution (BSI) published a new national standard for the acquisition and management of meteorological precipitation data from a rain-gauge network.

Chapter 8: Education, training and public awareness

- The Award winning 2050 calculator is a simple, user-friendly model of the UK's energy system, launched in 2010. It allows a wide variety of people to explore the full range of options for reducing GHG emissions to the year 2050 and is based on rigorous scientific evidence.
- The Met Office recognises both the need and appetite for increased and informative communication on climate change and has developed a range of information, videos, blogs, and engagement at: http://www.metoffice.gov.uk/climate-guide.
- Climate Change, and broader sustainability issues, feature in the educational curricula of the UK and its devolved administrations.
- Green Fund provides support students on a range of different types of sustainability projects and approaches designed by the students' unions themselves to resolve key local issues.

Chapter 1: National circumstances relevant to greenhouse gas emissions and removals

1.1 Key developments

- The UK population in 2011 was 63 million, with nearly 84% of the population resident in England. The UK population is predicted to rise to over 70 million by 2030.
- The UK covers over 24 million hectares. Around 70% of this is used for agricultural use.
- In March 2013 the area of woodland in the UK was estimated to be 3.1 million hectares. Of this total, 1.4 million hectares (45%) was in Scotland, 1.3 million hectares (42%) was in England, 0.3 million hectares (10%) was in Wales and 0.1 million hectares (4%) was in Northern Ireland.
- Since 1990, the UK has experienced 8 of the 10 warmest years on record, with 2006 being the warmest year on record. By 2080, UK daily minimum temperatures are set to rise by up to 4ºC, or more, depending on the region and future emissions
- The UK Budget 2013 forecast is for the UK GDP to grow by 1.2% in 2013 and 1.8% in 2014. The government is delivering an ambitious programme of supply-side reform. The UK Budget 2013 sets out further action the government will take to help UK businesses create jobs and to help people buy their own home.
- In the last 10 years, UK energy production has declined at an average rate of 7.8% per year; natural gas production has declined at the fastest rate, down 9.3% per year, followed by petroleum down 9.1%, coal down 5.5%, and primary electricity down 1.7% per year.
- Bioenergy and waste has grown by an average 8.7% per year over this same time period, though in 2012, it accounted for only 5.2% of the UK's energy. The decrease in production in the UK is a result of a number of oil and gas fields becoming exhausted, as well as increased maintenance activity.
- The UK's long term strategy to reduce transport emissions includes the Renewable Transport Fuels Obligation (RFTO), which requires 5% of transport fuel sold in the UK to come from renewable sources by 2013-14.
- In 2012/13 households in England produced 22.6 million tonnes of waste, continuing the year-on-year fall seen since 2007/8. In 2012/13, 43.2% of household waste was recycled, the highest recycling rate recorded for England. Local Authorities recycled, composted or reused 10.7 million tonnes of the waste they collected.

- Despite the UK's long history of urbanisation, some areas are sparsely populated, including the Highlands of Scotland, and parts of Wales and northern England. In 2011 there were around 28 million dwellings in the UK, of which 23 million were in England. Most common are semi-detached houses (30%), followed by terraced houses (25%), detached houses (23%), and purpose built flats (17%).
- In 2012, the total population of cattle and calves was around 9.9 million, virtually unchanged on 2011. The total number of pigs in the UK in 2012 was around 4.9 million, an increase of 0.9% on 2011. The total number of sheep and lambs in the UK increased by 1.8% between 2011 and 2012 to 32.2 million.

1.2 Introduction

The UK has international targets for reducing greenhouse gas (GHG) emissions. The Kyoto Protocol requires that UK GHG emissions are reduced by 12.5% below base year levels over the 2008-12 period. In 2011, UK's GHG emissions were 29% below base year levels. This chapter presents a brief description of the UK's national circumstances and how changes in national circumstances affect GHG emissions over time.

The National Communication and the Biennial Report detail the action the UK is taking to fulfil its commitments under the Framework Convention on Climate Change and the Kyoto Protocol. In particular, Chapter 3 discusses policies put in place by the Devolved Administrations, the Ministerial Departments (listed below) and other government departments. These include policies from the Department for Business, Innovation and Skills (BIS), the Department for Transport (DfT), the Department for Communities and Local Government (CLG) and the Department for International Development (DfID).

1.3 Government profile

Her Majesty's Government (HMG) is the central government of the United Kingdom (UK). HMG has responsibility for developing and implementing policy and for drafting laws.

The UK consists of England, Scotland, Wales and Northern Ireland, with aspects of government devolved to the democratically accountable governments within each, namely the:

- Scottish government[6]
- Welsh government[7]
- Northern Ireland Executive.[8]

While the UK Government has overall responsibility for ensuring that a programme is put in place to deliver the UK's Kyoto target and its domestic carbon budgets[9], all the administrations will play a part in meeting these targets. The approach taken by each administration will differ, drawing on the range of policies at their disposal.

6 http://home.scotland.gov.uk/home.

7 http://wales.gov.uk/?lang=en.

8 http://www.northernireland.gov.uk/.

9 https://www.gov.uk/government/policies/reducing-the-uk-s-greenhouse-gas-emissions-by-80-by-2050/supporting-pages/carbon-budgets.

HMG is split into 24 ministerial departments and 21 non-ministerial departments. Each department focuses on a different aspect of government policy, including:

- The Department of Energy & Climate Change (DECC) which works to make sure the UK has secure, clean, affordable energy supplies and promote international action to mitigate climate change.
- The Department for Environment, Food and Rural Affairs (Defra), which is the government department responsible for policy and regulations on environmental, food and rural issues including domestic adaptation.
- Her Majesty's Treasury (HMT), which is the UK government's economic and finance ministry, maintaining control over public spending, setting the direction of the UK's economic policy and working to achieve strong and sustainable economic growth.

Further information about the UK government can be found at: https://www.gov.uk.

1.4 Population profile

This section discusses demographic characteristics of the UK, to provide context on the population-related drivers that affect the UK's GHG emissions. Unless stated otherwise, the following statistics have been produced from data collected by the Office for National Statistics,[10] who produce the official population estimates for the UK and its constituent countries.

The total population of the UK was estimated to be 63.3 million in mid-2011, which was 6 million more (11%) than in mid-1990. There was a further estimated increase between mid-2011 and mid-2012 of 420,000 as a result of 254,400 more births than deaths and 165,600 more migrants arriving to the UK than emigrants leaving. Work-related reasons and formal study are the two most common reasons for migrating to the UK.

Table 1 shows that the population of the UK is increasing and ageing with the median age in the UK increasing from 35.8 in 1990 to a projected 39.9 in 2012. The population aged greater than 64 years increased from 15.7% in 1990 to 16.5% in 2011 and 17% in 2012. The male to female ratio of the UK population has remained steady between 1990 and 2011 at approximately 49% to 51%.

Table 1: Mid-year population estimates, UK, 1990-2012

	Total population (thousands)	Male population (thousands)	Female population (thousands)	Median age (years)	Percentage of population aged less than 16 years	Percentage of population aged 16 to 64	Percentage of population aged more than 64 years
1990	57,238	27,819	29,419	35.8	20.2	64.0	15.7
2000	58,886	28,691	30,196	37.6	20.3	63.9	15.8
2010	62,262	30,643	31,619	39.7	18.6	64.8	16.6
2011	63,285	31,097	32,188	39.8	18.8	64.7	16.5
2012	63,705	31,315	32,390	39.9	18.8	64.2	17.0

Source: Mid-year population estimates, Office for National Statistics

The UK is expected to see a continued growth in population, as shown in Table 2. The population is projected to increase by 4.9 million to 67.2 million from 2010 to 2020 – this increase is equivalent to an average annual rate of growth of 0.8%.

[10] http://www.ons.gov.uk/ons/index.html.

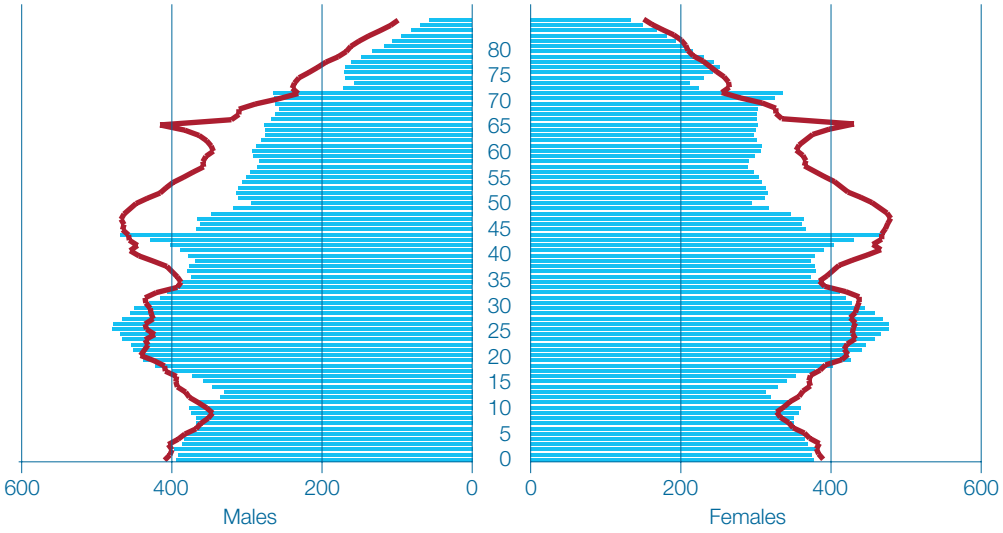
If past trends continue, the UK population will continue to grow, reaching 71.4 million by 2030. This is due to natural increase (more births than deaths) and because it is assumed there will be more immigrants than emigrants.

Table 2: Population projections in the UK by country, 2010 to 2030

					Millions
	2010	2015	2020	2025	2030
United Kingdom	62.3	64.8	67.2	69.4	71.4
England	52.2	54.5	56.6	58.6	60.4
Wales	3	3.1	3.2	3.2	3.3
Scotland	5.2	5.4	5.5	5.6	5.7
Northern Ireland	1.8	1.9	1.9	2.0	2.0

Source: Office for National Statistics

Figure 2: Population pyramid for the UK, mid-2011 (red line) compared with mid-1990 (blue bars)



Source: Office for National Statistics

Each line in Figure 2 represents a single year of age. The length of the line relates to the number of people of that age in the population. The size and composition of the population is determined by the pattern of births, deaths and migration which have taken place in previous years. The main details illustrated by the pyramid for mid-2012 include the following:

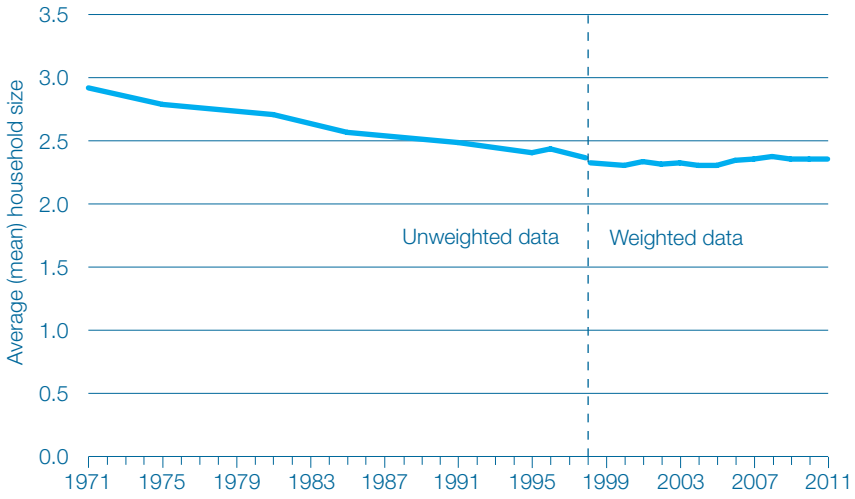
- The peaks and wide areas of the pyramid reflect the high numbers of births in the years after the Second World War and during the baby boom of the 1960s.
- The sharp narrowing of the pyramid for people aged around 10 years is a consequence of low numbers of births just after the turn of the century. The increasing broadening of the base of the pyramid is due to a higher number of births in recent years.
- Females outnumber males at older ages, reflecting the higher life expectancy of females.

Another driver of GHG emissions in the domestic sector is the number of households and their associated level of comfort and lifestyle. In the UK, the number of households has increased by 17% from 22.6 million in 1990 to 26.4 million in 2011, and 27.1 million in 2012.

Figure 3 shows average household size between 1971 and 2011. Over the 40 years between 1971 and 2011 the average size of a household in Great Britain has reduced – from 2.91 persons in 1971 to 2.35 persons in 2011. As Figure 3 shows, average household size fell most rapidly between 1971 and 1991, and continued to decline at a slower rate, throughout the 1990s, since when it has changed little. Since 2004 the average household size has steadily increased, albeit slightly.

The overall decline in average household size has resulted from a large increase in the proportion of one-person households, which almost doubled between 1971 and 1998 (increasing from 17% in 1971 to 29% in 1998). Since 1998 the proportion of one-person households has remained stable, with 31% of households in 2011 comprising of one-person. Households containing one adult aged 16 to 59 years tripled from 5% in 1971 to 13% in 1998. Since 1998 there has been little change in this proportion, which has ranged between 13 and 16%. In 2011, 14% of households contained one adult aged 16 to 59 years. The proportion of households containing one adult aged 60 and over has remained stable over the forty years since 1971. In 2011 17% of households contained one adult aged 60 and over.

Figure 3: Average household size, Great Britain, 1971-2011



Source: General Lifestyle Survey, Office for National Statistics

1.5 Geographic profile

The UK lies between latitude 49ºN and 61ºN and longitude 8ºE and 2ºW, positioned in the north western part of Europe. Crown dependencies are self-governing and make up part of the UK, these are: Jersey; Guernsey; and Isle of Man. Overseas territories are under the jurisdiction and sovereignty of the UK but do not form part of it.

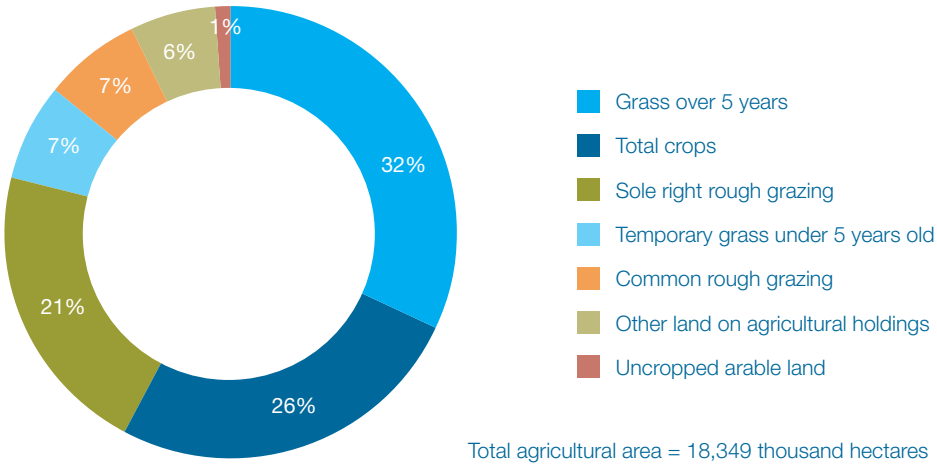
There are fourteen overseas territories:

- Anguilla
- Bermuda
- British Antarctic Territory
- British Indian Ocean Territory
- British Virgin Islands

- Cayman Islands
- Falkland Islands
- Gibraltar
- Montserrat
- Pitcairn Islands
- Saint Helena, Ascension and Tristan da Cunha
- South Georgia and the South Sandwich Islands
- Sovereign base areas of Akrotiri and Dhekelia
- Turks and Caicos Islands.

In 2012, around 70% (17.1 million hectares) of the total UK land area was used for agriculture, Figure 4 shows UK land use data for the total agricultural area at June 2012.[11] Between 2007 and 2011 the area under crops increased by 5% while the area of uncropped arable land fell by 74%, reflecting the removal of "set aside" land during this period. The area of temporary grassland (less than 5 years old) increased by 9% between 2007 and 2011.

Figure 4: Agricultural land use in the UK, 2012



Source: Agriculture in the UK 2012, Department for Environment Food and Rural Affairs

1.6 Climate profile

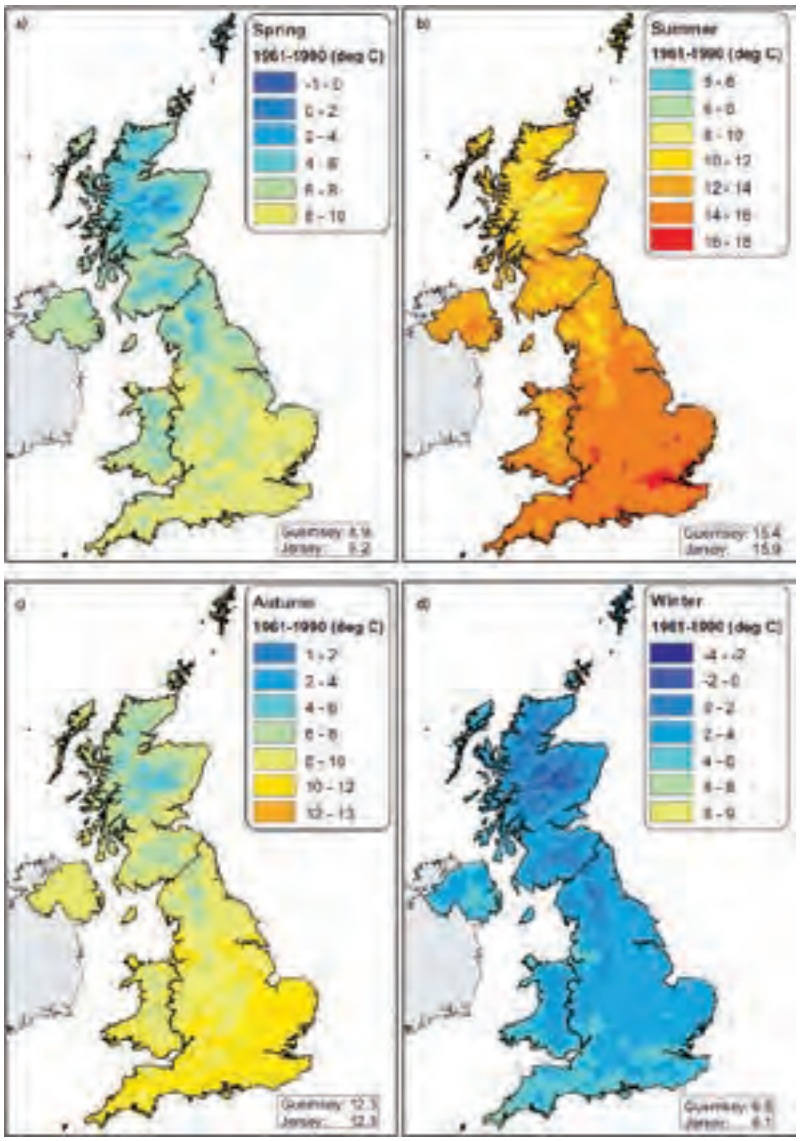
The UK's climate is maritime: moist and temperate, with a moderate annual temperature range. Average annual precipitation in the UK typically ranges from approximately 800 mm to 1400 mm. The UK climate is heavily influenced by its proximity to the Atlantic Ocean and the Gulf Stream/ North Atlantic Drift which brings warm water into high northern latitudes. Prevailing winds are westerly, thus UK regional climates vary with distance from the Atlantic as well as topography. Continental influences are most strongly seen in the southeast of the country.

Variations in the strength and position of the jet stream strongly influence UK weather. Sometimes the jet stream is directed close to or over the country, bringing extended periods of stormy, wet weather. At other times, a blocked pattern steers the jet stream away to the north or to the south, bringing generally settled, dry conditions, either warmer or colder than average. Space heating is required in most buildings throughout the winter months and the use of air conditioning in the summer months is increasing. In the UK, GHG emissions are strongly influenced by weather conditions. In winter, cooler-than-average temperatures increase demand

[11] Agriculture in the UK 2012 https://www.gov.uk/government/publications/agriculture-in-the-united-kingdom-2011

for space heating; and in summer, warmer-than-average temperatures increase demand for space cooling. Figure 5 shows the average daily mean temperature for the UK.[12]

Figure 5: Average (1961-1990) daily temperature (°C) by season, UK



Source: The climate of the UK and recent trends, UKCP09

1.6.1 UK Climate trends[13]

1.6.1.1 Temperature

Central England Temperature (CET) is the longest-compiled temperature series in the world, beginning in 1659. Figure 6 shows the temperature difference for each year when compared to the 1961-1990 mean CET.[14]

Eight of the ten warmest years recorded have been since 1990, with 2006 being the warmest year on record. It is likely that there has been a significant influence from human activity on the recent warming of CET.

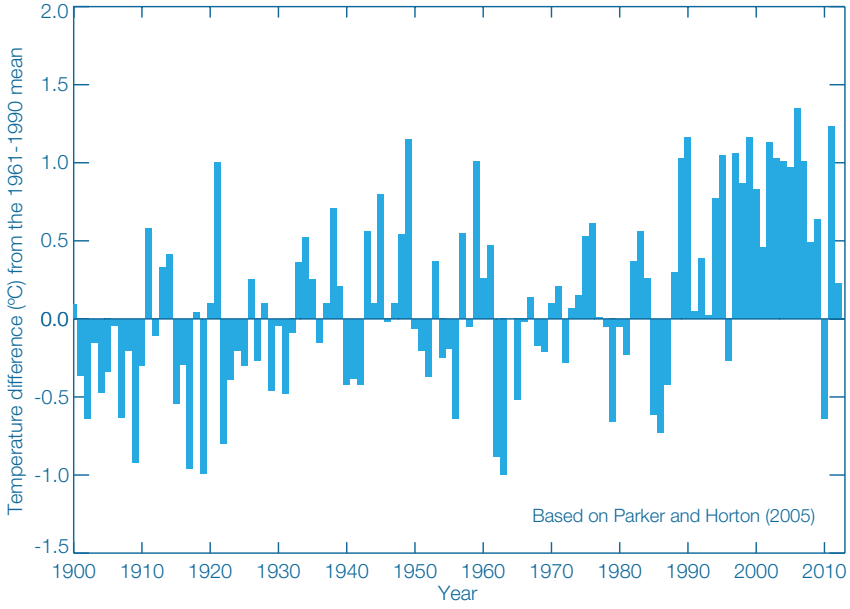
[12] UKCP09: The climate of the UK and recent trends http://ukclimateprojections.defra.gov.uk/22544

[13] Met Office climate summary datasets http://www.metoffice.gov.uk/climate/uk/summaries/datasets

[14] Met Office Hadley Centre Central England Temperature (HadCET) dataset http://www.metoffice.gov.uk/hadobs/hadcet/

The coldest year recorded since 1990 was 2010, this was particularly cold compared to other years since 1990 which have been relatively warm when compared to the 1961-1990 mean CET. The effect of this cold year on emissions can be seen in Figure 30, which shows an increase in total UK GHG emissions for 2010.

Figure 6: Mean Central England Temperature Annual Anomalies, 1900 to 2012



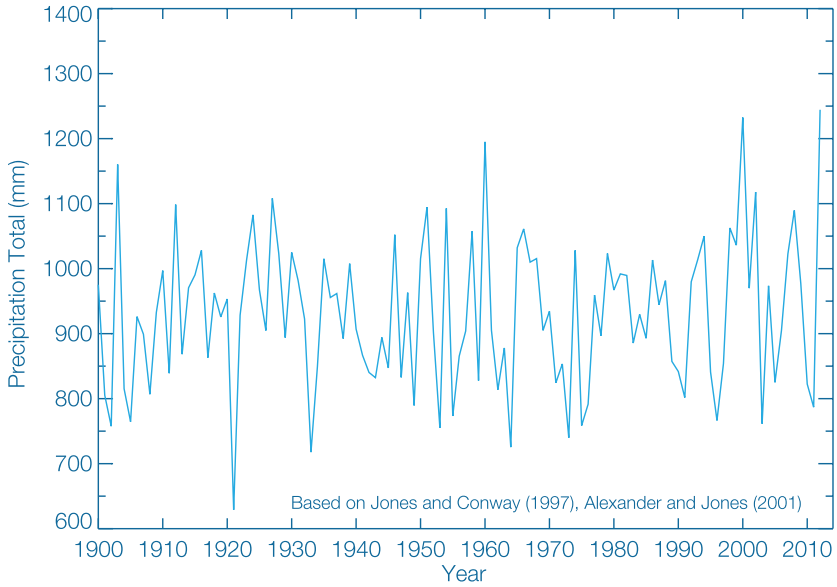
Source: Met Office

1.6.1.2 Precipitation

The UK regional precipitation series is the longest instrumental series of this kind in the world and is presented in Figure 7 by total precipitation for each year.[15]

Five of the ten wettest years recorded have been since 1990. 2000 and 2012 were the wettest years on record.

Figure 7: Average annual precipitation, UK, 1900–2012



Source: Met Office

[15] UK regional precipitation series http://www.metoffice.gov.uk/hadobs/hadukp/

1.6.1.3 Sea level

Sea level around the UK rose on average by about 1mm/yr in the 20th century, corrected for land movement. The rate for the 1990s and 2000s has been higher, up to 3mm/yr, which is closer to the global average for these years. Sea-surface temperatures around the UK coast have risen by about 0.7ºC over the past three decades.

1.6.2 UK climate projections[16]

Climate projections are based on climate modelling conducted by the Met Office Hadley Centre. The projections below are summer, winter and annual mean changes by the 2080s (relative 1961-1990 baseline) under the medium emissions scenario and a 50% probability level. Also available in the full report are 10% (very likely to be exceeded) and 90% (very likely not to be exceeded) probabilities.

1.6.2.1 Temperature

The projections indicate that all areas of the UK warm during this century, more so in summer than in winter. For the medium scenario changes in summer mean temperatures are greatest in parts of southern England (up to 4.2ºC) and least in the Scottish islands (just over 2.5ºC). This is shown in Figure 8[14] below.

Mean daily maximum temperatures increase throughout the UK everywhere. Increases in the summer average are up to 5.4ºC in parts of southern England and 2.8ºC in parts of northern Britain. Increases in winter are 1.5ºC to 2.5ºC across the country.

Changes in the warmest day of summer range from +2.4ºC to +4.8ºC, depending on location, but with no simple geographical pattern.

Mean daily minimum temperature increases on average in winter by about 2.1ºC to 3.5ºC depending on location. In summer it increases by 2.7ºC to 4.1ºC, with the biggest increases in southern Britain and the smallest in northern Scotland.

1.6.2.2 Precipitation

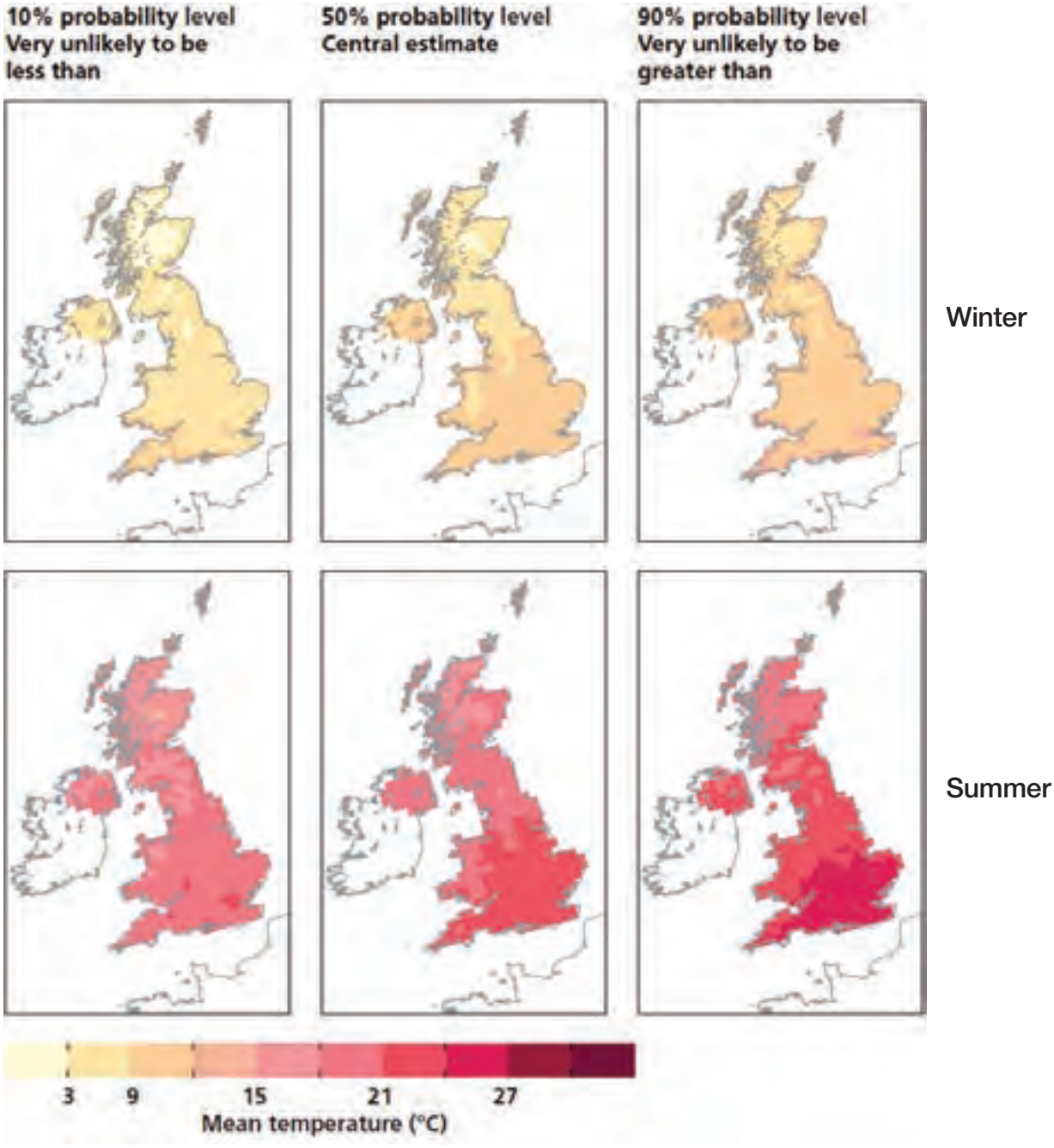
Central estimates of annual precipitation amounts show very little change across the UK. The biggest changes in precipitation in winter are seen along the western side of the UK, with increases up to +33%. Decreases of a few percent are seen over parts of the Scottish highlands.

The biggest changes in precipitation in summer are seen in parts of the far south of England, with precipitation down to about –40%. Changes close to zero are seen over parts of northern Scotland.

Changes in the wettest day of the winter range from zero in parts of Scotland to +25% in parts of England. Changes in the wettest day of the summer range from –12% in parts of southern England to +12% in parts of Scotland.

[16] UKCP09: UK Climate Projections science report
http://ukclimateprojections.defra.gov.uk/media.jsp?mediaid=87893&filetype=pdf

Figure 8 – 10, 50 and 90% probability levels of the projected summer and winter seasonal mean temperature by the period of the 2080s under the Medium emissions scenario



Source: UK Climate Projections, UKCP09

1.6.2.3 Other projections

Relative humidity decreases by around –9% in summer in parts of southern England and by less elsewhere. In winter changes are a few percent or less everywhere.

Summer-mean cloud amount decreases, by up to –18% in parts of southern England (giving up to an extra +20 Wm^{-2} of downward shortwave radiation) but increase by up to +5% in parts of northern Scotland. Changes in cloud amount are small in winter.

It is very unlikely that an abrupt change to the Atlantic Ocean Circulation (Gulf Stream) will occur this century.

1.7 Economy and industry profile

The UK is currently the world's seventh largest economy at $2.4 trillion in 2011,[17] the tenth largest exporter of goods ($475 billion in 2012) and second largest exporter of services ($284 billion in 2012).[18]

Gross domestic product (GDP) is a measure of economic activity which captures the value of goods and services that the UK produces during a given period. GDP statistics are generally presented in real terms (also known as chained volume or constant prices) as they are adjusted to account for changes in the price level.

Real GDP has grown considerably since 1990 as shown in Figure 9.[19] This can be attributed to a range of factors, including: population growth, which increases the amount of available labour; investment in capital, which improves labour productivity; and technological improvement, which increases how much the economy can produce (productive potential).

GDP in the UK grew steadily from 2000 until early 2008, when a financial market shock affected UK and global economic growth. Up until that point, services in the UK had continued to grow steadily, while production output had been broadly flat over the same period. Construction activity grew strongly in the early part of the decade and although there was a temporary decline in the mid-2000s, this was reversed by the end of 2007. The deterioration in economic conditions during 2008 had a large effect on the construction and production industries, but the effect on the services industries was less pronounced.

Economic growth resumed towards the end of 2009, but at a slower rate than the period prior to 2008, as demand was subdued by inflation outstripping nominal wage growth, leading to a fall in the real income of households. The services industries grew steadily, if slowly, during this period; activity in these industries is now slightly above the level previously seen in early 2008. By contrast, production and construction activity grew in 2010 but did not sustain this growth, with continued long-term economic uncertainty – exacerbated by the euro area sovereign debt crisis – particularly affecting construction in 2012. Although there has been growth across all industrial groupings in 2013, activity in the production industries remains slightly below the trough recorded in 2009. The increase in GDP since then is overwhelmingly attributable to services.

Coming out of the economic downturn in 2008-09, the rate of GDP growth has been slower compared with the early-2000s, owing to weaknesses in the domestic and global markets. Services have continued to grow steadily from 2009, and activity in these industries is now approximately at the level previously seen in early 2008. Production began to decrease from the start of 2011 following a mild recovery in 2010, as increased inflation and slower wage growth began to reduce households' real income. Compounding this subdued domestic demand was the development of the euro area sovereign debt crisis, which affected business sentiment in the EU, a key export market for the UK. Construction activity saw a more marked increase than that of production in 2010. Despite the positive signs during 2010, construction has trended downwards from late 2011.

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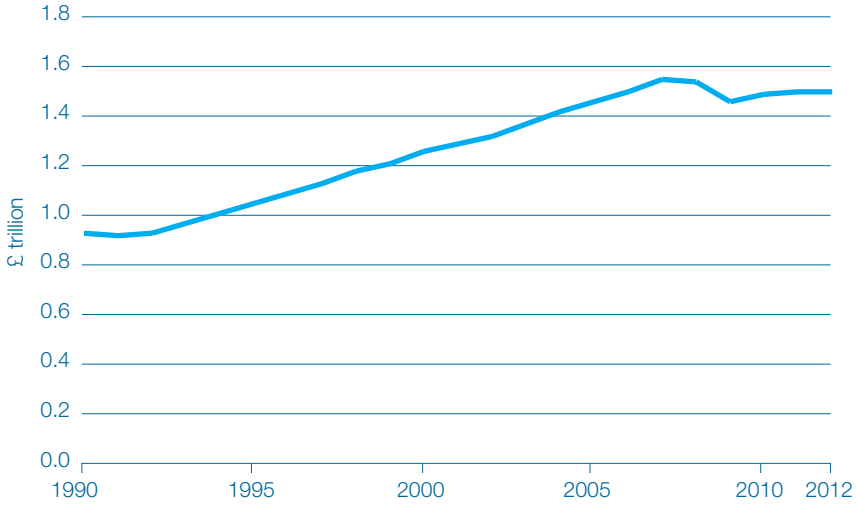
[17] United Nations Statistics Division http://unstats.un.org/unsd/snaama/selbasicFast.asp

[18] United Nations conference on trade and development statistics: Exports and imports of goods and services, annual, 1980-2012 http://unctad.org/en/Pages/Statistics.aspx

[19] Long-term profile of Gross Domestic Product (GDP) in the UK http://www.ons.gov.uk/ons/rel/elmr/explaining-economic-statistics/long-term-profile-of-gdp-in-the-uk/sty-long-term-profile-of-gdp.html

Figure 9: UK Real GDP 1990-2012



Source: Office for National Statistics

The chained volume measure of GDP grew by 0.2% in 2012 as shown in Table 3. Total expenditure can be decomposed into components. This table shows what effect the change in each component would have if all other components had remained unchanged. Of the six components, there was an equal split, with three having a positive, and three a negative contribution. The strongest positive influence came from the households and government, with large negative contributions from net trade and changes in inventories.

Table 3: Contributions to annual growth in the chained volume measure of GDP, UK, 2012

		Change in GDP
Component	**£ million**	**Percentage points**
Households and non-profit institutions serving households final expenditure	10,201	0.7
General government final expenditure	9,357	0.6
Gross fixed capital formation	1,056	0.1
Change in inventories	-5,204	-0.3
Net trade	-9,326	-0.6
Other*	-3,523	-0.2
Total	**2,561**	**0.2**

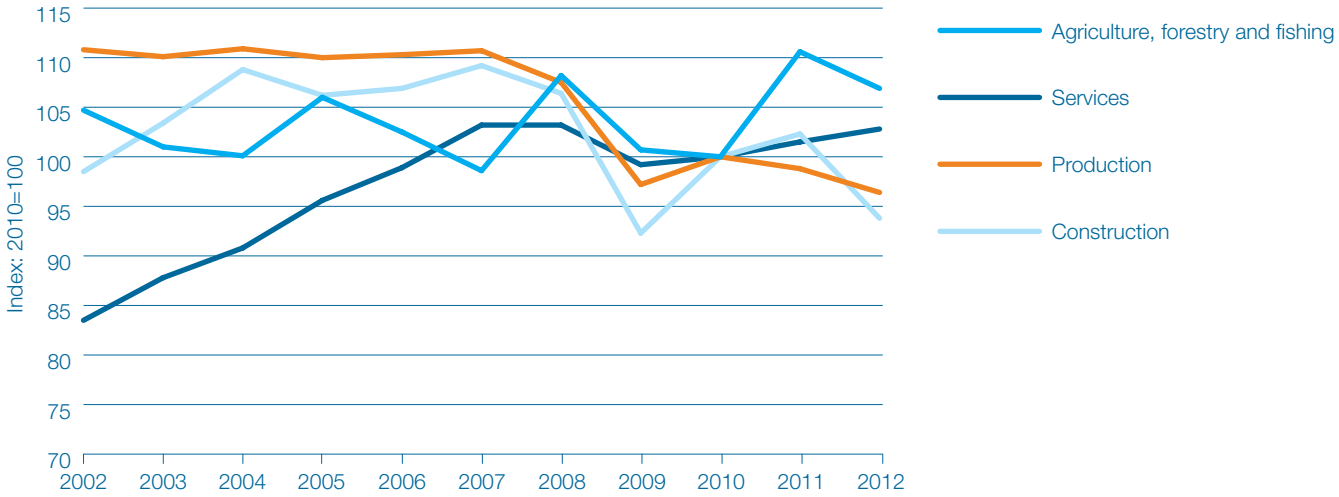
Source: United Kingdom National Accounts, The Blue Book 2013 Edition Release

*Comprises acquisition of valuables and the statistical discrepancy between the expenditure measure and the average measure of GDP.

Figure 10 shows gross valued added (GVA) at basic prices by industry using 2010, the latest base year available. The UK is a services-oriented economy, with total services contributing 78% of UK GVA in 2012. Within the services sector, the sources of UK output are diverse; financial services accounts for 11% of GVA; distribution, transport, hotels and restaurants for 23.5%; information and communication services for 8.5%; real estate services 13.5%; professional and support services for 15%; government, health and education for 24%.[20] The other contributions to GVA in 2012 come from manufacturing, mining, utilities, agriculture and construction.

[20] Industrial Analyses, United Kingdom Nation Accounts, The Blue Book, 2013 edition http://www.ons.gov.uk/ons/rel/naa1-rd/united-kingdom-national-accounts/the-blue-book--2013-edition/chapter-02--the-industrial-analyses-at-a-glance-from-table-2-1.html

Figure 10: UK Gross Value Added at basic prices by industry, UK, 2002-2012



Source: Industrial Analyses, United Kingdom Nation Accounts, The Blue Book, 2013 edition, Office for National Statistics

Table 4: Number of VAT and/or PAYE enterprise by broad industrial grouping, UK, 2011-2013

Industrial Grouping	2011		2012		2013	
	Count (thousands)	Percentage	Count (thousands)	Percentage	Count (thousands)	Percentage
Agriculture, forestry & fishing	139	6.7	139	6.5	144	6.6
Production	131	6.3	133	6.2	136	6.3
- Mining, quarrying & utilities	8	0.4	9	0.4	10	0.5
- Manufacturing	123	5.9	124	5.8	126	5.8
Construction	262	12.6	264	12.3	257	11.9
Wholesale and retail; repair of motor vehicles	357	17.2	361	16.8	358	16.5
- Motor trades	66	3.2	68	3.2	68	3.1
- Wholesale	104	5.0	104	4.8	103	4.8
- Retail	187	9.0	189	8.8	188	8.7
Transport & storage (inc. postal)	66	3.2	67	3.1	67	3.1
Accommodation & food services	127	6.1	131	6.1	129	6.0
Information & communication	147	7.1	159	7.4	166	7.7
Finance & insurance	43	2.1	46	2.1	46	2.1
Property	74	3.6	77	3.6	80	3.7
Professional, scientific & technical	330	15.9	352	16.4	366	16.9
Business administration and support services	141	6.8	144	6.7	143	6.6
Public administration and defence	3	0.1	4	0.2	5	0.2
Education	31	1.5	33	1.6	35	1.6
Health	83	4.0	88	4.1	89	4.1
Arts, entertainment, recreation and other services	145	7.0	151	7.0	146	6.7
Total	**2,081**		**2,149**		**2,168**	

Source: Inter-Departmental Business Register (IDBR), Office for National Statistics
Note: Count given to the nearest thousand

Table 4 gives a broad overview of the number and type of industrial enterprises in the UK for 2011, 2012 and 2013.[21] In 2013 the professional, scientific and technical sector accounted for the largest number of businesses, with 16.9% of all enterprises registered. The second largest number of enterprises come from wholesale, retail and repair of motor vehicles, with 16.5%% of all enterprises registered. The third largest sector was construction, however, this fell from 12.3% in 2012 to 11.9% in 2013.

The professional, scientific and technical sector had the largest growth between 2012 and 2013, an increase of 14,000 businesses. This was followed by the information and communication sector which increased by 7,000 businesses in 2013. Construction had the largest fall in businesses with a fall of 6,000.

The government's economic strategy set out in the June Budget 2010 is designed to protect the economy through the recent period of global uncertainty and provide the foundations for recovery. This strategy is restoring the public finances to a sustainable path and the deficit has been reduced by a third over the three years from 2009-10. The UK is seen as a relative safe haven, with low market interest rates helping to keep interest payments lower for families, businesses and the taxpayer. This strategy has helped the government to equip the UK to compete in the global race to build a stronger economy and a fairer society. The UK has the fourth lowest corporation tax rate in the G20 and will reduce the rate by an additional percentage point in April 2015 to 20%, the joint lowest in the G20; it has risen to eighth in the 2012 World Economic Forum Global Competitiveness Report. The 2012 KPMG Annual Survey of Tax Competitiveness looked at six key competitor economies and found that out of these the UK was the most commonly cited as being in the top three.

Three key factors, first set out in the Office for Budget Responsibility's (OBR) November 2011 Economic and fiscal outlook, have resulted in a more subdued and uneven recovery than expected and continued to weigh on the UK economy through 2012:

- Evidence has accumulated that suggests the impact of the financial crisis on GDP and underlying productivity has been greater than expected.
- The euro area sovereign debt crisis and global uncertainty have damaged confidence and reduced external demand.
- Commodity price driven inflation since 2011 has reduced real incomes and raised business costs.

The Budget 2013 forecast is for the UK GDP to grow by 1.2% in 2013 and 1.8% in 2014. The government is delivering an ambitious programme of supply-side reform to equip the UK to succeed. Budget 2013 sets out further action the government will take to help UK businesses create jobs and to help people buy their own home.[22]

1.8 Energy profile

This section provides a summary of the UK energy system looking at trends in production, consumption, imports and exports, and the price of energy. Energy Supply accounted for around 35% of the UK's GHG emissions in 2011, representing a reduction of nearly 30% since 1990.

[21] UK Business: Activity, Size and Location – 2013 http://www.ons.gov.uk/ons/rel/bus-register/uk-business/2013/stb---uk-business--activity--size-and-location---2013.html#tab-Business-counts-by-broad-industry

[22] HM Treasury Budget 2013 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/221885/budget2013_complete.pdf

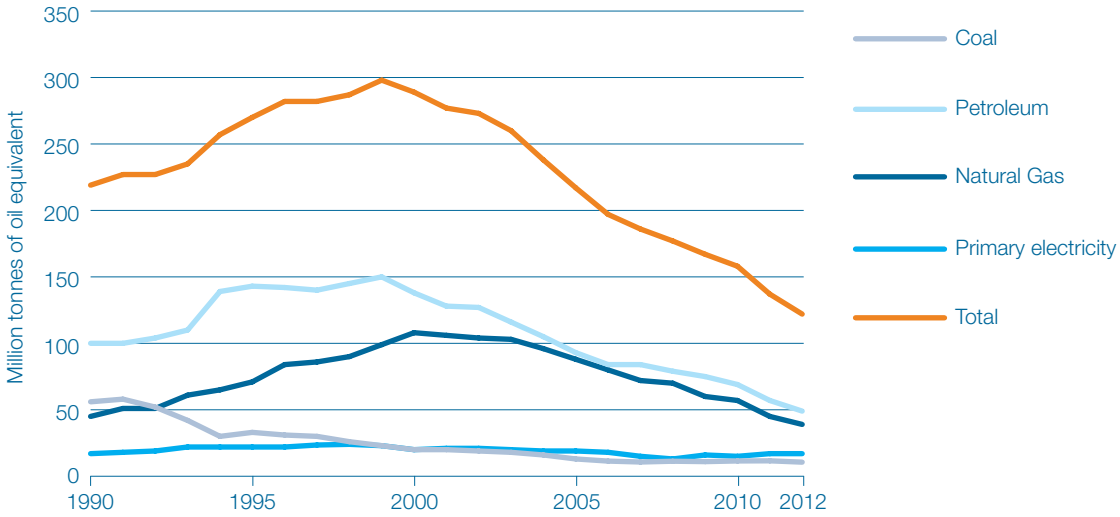
Trends in the production of primary fuels in the UK are illustrated in Figure 11.[23] The chart shows that total energy production in the UK has fallen in each of the last 13 years; this fall was driven by a sharp decrease in primary oil and gas production. In 2012, total energy production fell to 122 million tonnes of oil equivalent (mtoe), a decrease of 44% compared to 1990 production, and 59% lower than when output peaked at 298 mtoe in 1999.

Over the earlier period 1990 to 2000, UK production increased rapidly, mainly due to the growth of oil and gas. Production reached record levels for natural gas in 2000, a year after record levels were reached for overall energy and petroleum.

In the last 10 years, UK energy production has declined at an average rate of 7.8% per year; natural gas production has declined at the fastest rate, down 9.3% per year, followed by petroleum down 9.1%, coal down 5.5%, and primary electricity down 1.7% per year. Bioenergy and waste has grown by an average 8.7% per year over this same time period, though in 2012, it accounted for only 5.2% of the UK's energy. The decrease in production in the UK is a result of a number of oil and gas fields becoming exhausted, as well as increased maintenance activity.

In 1990, primary oil (crude oil and natural gas liquids) accounted for 46% of total production, natural gas 21%, coal 26%, with primary electricity (consisting of nuclear, wind and natural flow hydro) a further 8%. In 2012 this altered, with 40% of total production coming from primary oil, 32% from natural gas, 14% from primary electricity, 9% from coal and 5% from renewables (bioenergy and waste only).

Figure 11: Production of primary fuels, UK, 1990-2012



Source: Digest of United Kingdom Energy Statistics, Department of Energy and Climate Change

Import dependency is calculated by dividing net imports by adjusted primary supply, where an addition is made for energy supplied to marine bunkers. UK import dependency is shown in Figure 12.[24]

In the 1970s, the UK was a net importer of energy. Following development of oil and gas production in the North Sea, the UK then became a net exporter of energy in 1981. Output fell back in the late 1980s following the Piper Alpha disaster, with the UK regaining a position as a net exporter in the mid 1990s. North Sea production peaked in 1999, and the UK returned to

[23] Digest of United Kingdom Energy Statistics
https://www.gov.uk/government/collections/digest-of-uk-energy-statistics-dukes

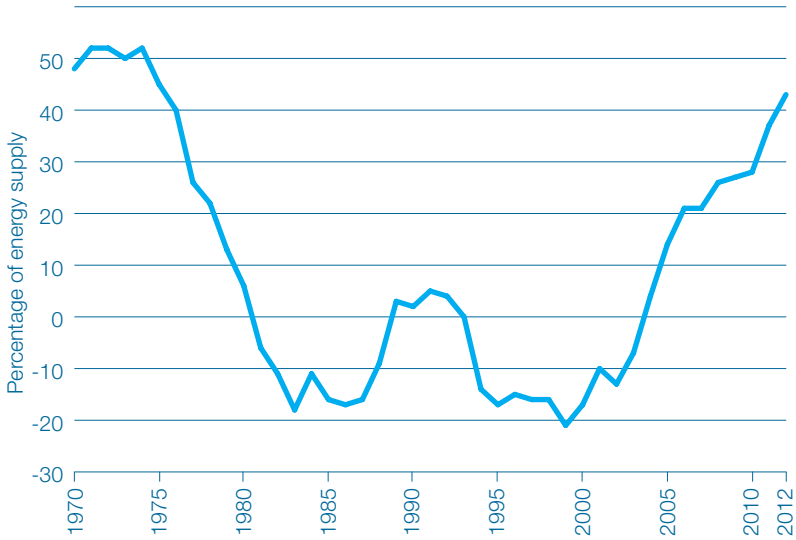
[24] UK Energy in Brief, DECC
https://www.gov.uk/government/collections/uk-energy-in-brief

being an energy importer in 2004. The UK remains a net exporter of oil products, though the level of net imports of crude oil result in the UK being a net importer of oil.

In 2012, 43% of energy used in the UK was imported, up sharply from the 2010 level as North Sea oil and gas output fell following adverse weather conditions as well as a number of maintenance issues. The import dependency ratio is at its highest level since 1976.

Latest comparable data from Eurostat, for 2011, show that the UK had the seventh lowest level of import dependency in the EU, behind Denmark, which remains a net exporter, Estonia, Romania, Czech Republic, the Netherlands and Poland.

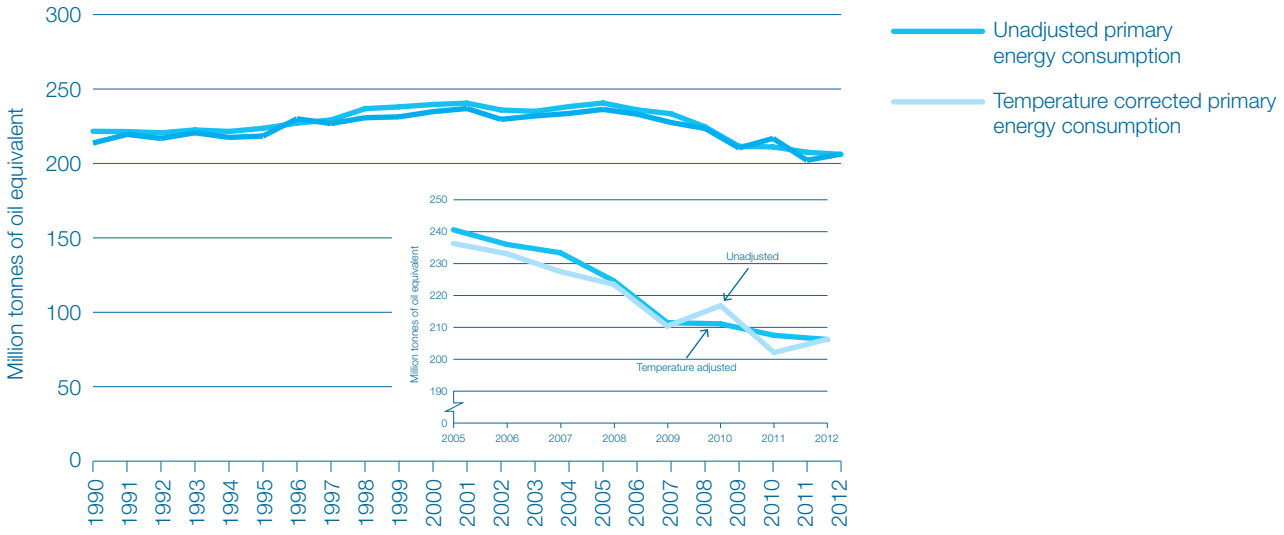
Figure 12: UK import dependency, 1970-2012



Source: UK Energy in Brief, Department of Energy and Climate Change.

In 2012, the total UK level of primary energy consumption (fuels obtained directly from natural sources) was 206.3 mtoe. In 2011, energy consumption was 202.1 mtoe – the lowest level of UK primary energy consumption for over 25 years. The level of primary energy consumption in 2012 was 3% lower than in 1990. Figure 13 shows how primary energy consumption has changed in the UK since 1990 for both the unadjusted and temperature corrected series.[25]

Figure 13: UK total primary energy consumption unadjusted and temperature corrected 1990 to 2012



Source: Energy Consumption in the UK, Department of Energy and Climate Change

[25] Energy Consumption in the UK. DECC https://www.gov.uk/government/collections/energy-consumption-in-the-uk

On a temperature-corrected basis (to remove the impact a hot or cold year has on energy consumption) primary energy consumption in 2012 was at the lowest seen in the period 1990 to 2012, at 206.1 mtoe, 7% lower than in 1990.

Energy supply will always equal energy demand, and so far in this section we have discussed energy supply in the UK, which can be calculated as:

energy production + imports – export + stock change.

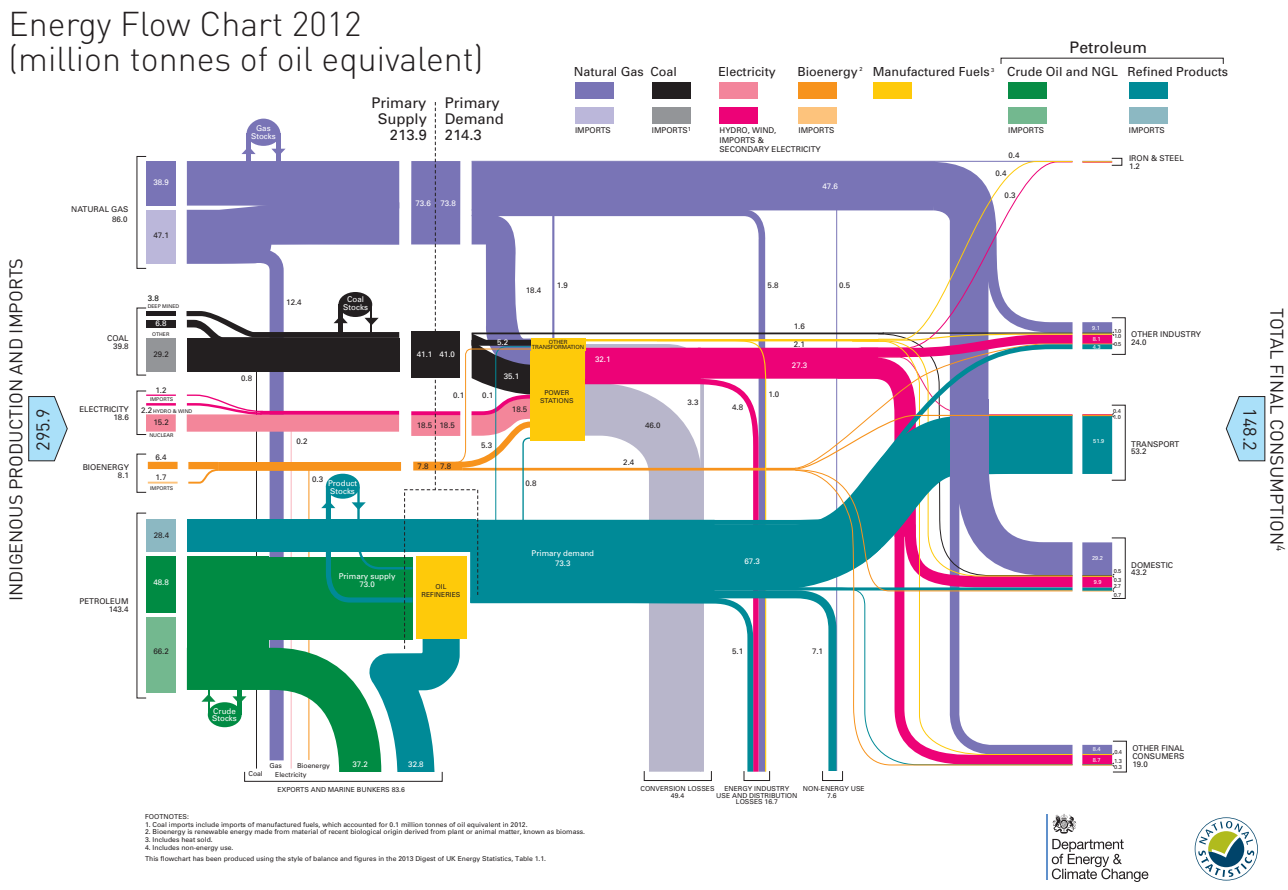
In the final part of this section demand is discussed, which can be calculated as:

final consumption including non-energy use + energy used by the energy industry + transformation losses.

In 1990, 8% of UK energy supply was from low carbon sources, this had increased to 12% in 2012.

The energy flow chart for 2012 in Figure 14 illustrates the flow of primary fuels from the point at which they become available from home production or imports, to their eventual final uses.[26] They are shown in their original state and after conversion into different types of energy by the secondary fuel producers. The flows are measured in million tonnes of oil equivalent, with the widths of the bands approximately proportional to the size of the flow they represent.

Figure 14: Energy Flow Chart 2012, UK, 2012



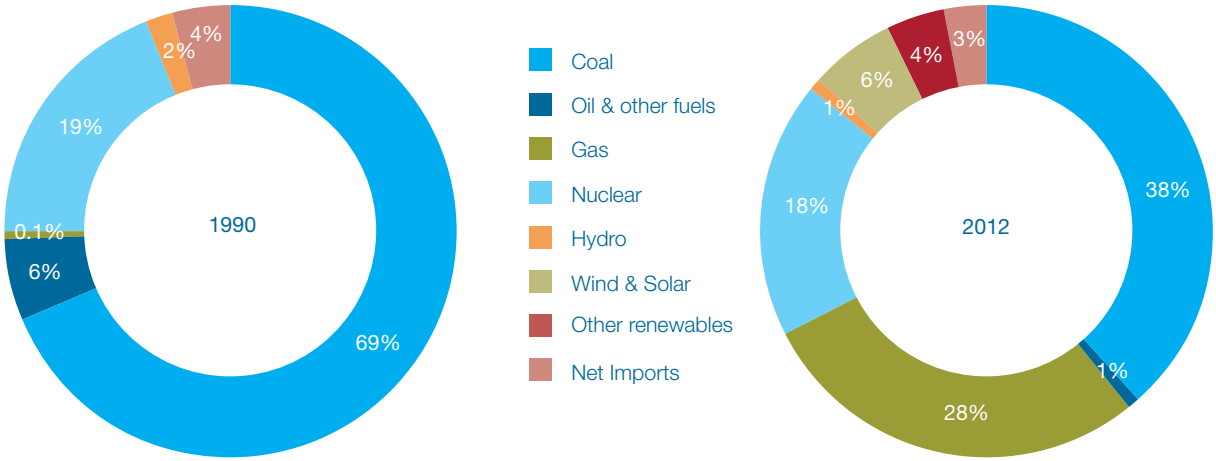
Source: Energy Flow Chart, Department of Energy and Climate Change

[26] Energy Flow Chart, DECC: https://www.gov.uk/government/collections/energy-flow-charts

A number of transformations occur to get from primary energy sources to usable fuel with crude oil refined into various petroleum products. The majority of coal is burnt in power stations to generate electricity which is then consumed by final users. In 2012, just over a third of energy supplied was used to generate electricity.

Between 1990 and 2012, supply of electricity rose by 15% from 308.7 TWh to 353.9 TWh. Electricity supplied from gas increased from less than 1% to 28%. Electricity supplied from coal fell from 69% to 38%. The share of net imports fell from 4% to 3%. Figure 15 shows electricity supplied by fuel for 1990 and 2012, to show how the fuel mix in electricity supplied has changed.[27]

Figure 15: Electricity supplied by fuel type, UK, 1990 and 2012



Source: Digest of United Kingdom Energy Statistics, Department of Energy and Climate Change

Table 5 shows inland energy consumption for 1990, 2011 and 2012. Between 1990 and 2011, primary energy consumption fell 5% to 202.1 mtoe, this was driven by a 52% (34.5 mtoe) fall in coal consumption and a 13% (10.1 mtoe) reduction in petroleum consumption.[28] Over this period natural gas inland energy consumption increased by 26.1 mtoe. Primary energy consumption was 2.1% higher in 2012 than in 2011. Consumption rose as a result of the colder weather in 2012, where the average daily temperature was 9.8°C, 1.0°C colder than in 2011.

Table 5: Inland energy consumption (mtoe) – 1990, 2011 and 2012

	1990	2011	2012
Coal	66.9	32.4	41.1
Petroleum	77.2	67.1	65.9
Natural gas	51.2	77.3	73.1
Nuclear electricity	16.3	15.6	15.2
Hydro electricity	0.4	1.8	2.2
Net electricity imports	1.0	0.5	1.0
Bioenergy & waste	0.7	7.3	7.8
Total	**213.6**	**202.1**	**206.3**

Source: UK Energy in Brief, Department of Energy and Climate Change

[27] Digest of United Kingdom Energy Statistics
https://www.gov.uk/government/collections/digest-of-uk-energy-statistics-dukes

[28] UK Energy in Brief, DECC
https://www.gov.uk/government/collections/uk-energy-in-brief

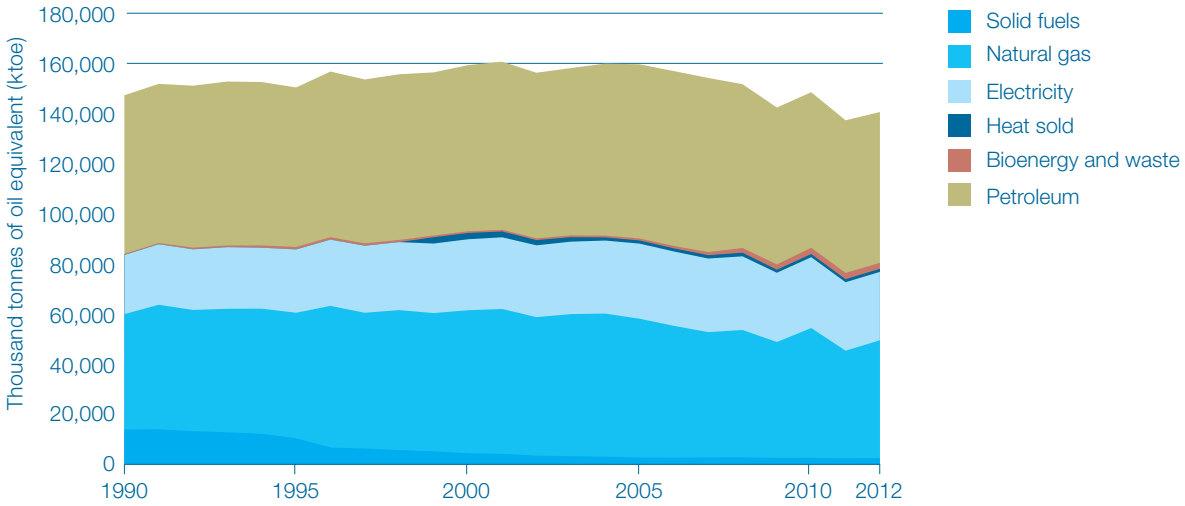
Figure 16 shows final energy consumption in the UK from 1990 to 2012 by fuel type.[29] Final energy consumption in 2012 in the UK was 140.6 mtoe – this was the second lowest level of final energy consumption over the period 1990 to 2012. Final energy consumption in 2011, at 137.3 mtoe was the lowest level of consumption. An 8% decrease seen between 2010 and 2011 was driven by a 17% reduction in gas consumption, resulting from a milder winter in 2011 requiring less fuel for heating purposes compared with the cold winter in 2010. This was reversed between 2011 and 2012, when more gas was used in the winter heating season as temperatures were cooler.

Between 1990 and 2012, final energy consumption in the UK decreased by 5%, from 147.3 mtoe to 140.6 mtoe. This fall of 6.7 mtoe, was created from a reduction in the consumption of solid fuels of 11.4 mtoe and a reduction in petroleum 3.1 mtoe; alongside increases in electricity (3.7 mtoe), bioenergy and waste (1.9 mtoe), heat sold (1.2 mtoe) and natural gas (1.0 mtoe).

In 1990 final energy consumption from petroleum was 43% of total final energy consumption in the UK, increasing slightly to 44% in 2011. Over the same period, electricity increased from 16% to 20%, with solid fuels falling from 9% to 2%. In 2011, bioenergy and waste made up 2% of final UK energy consumption.

From 2005, a general declining trend in final energy consumption was driven by improvements in energy efficiency. However, in the last 4 years a number of one-off effects have driven down the series – namely the recession into 2009, reduced consumption, particularly cold weather in 2010 and 2012 resulted in an increase in demand, whilst warmer weather in 2011 caused consumption to fall back. The cold weather of 2012 saw final energy consumption increase by 2% between 2011 and 2012.

Figure 16: Final energy consumption by fuel, UK, 1990-2012



Source: Energy Consumption in the UK, Department of Energy and Climate Change

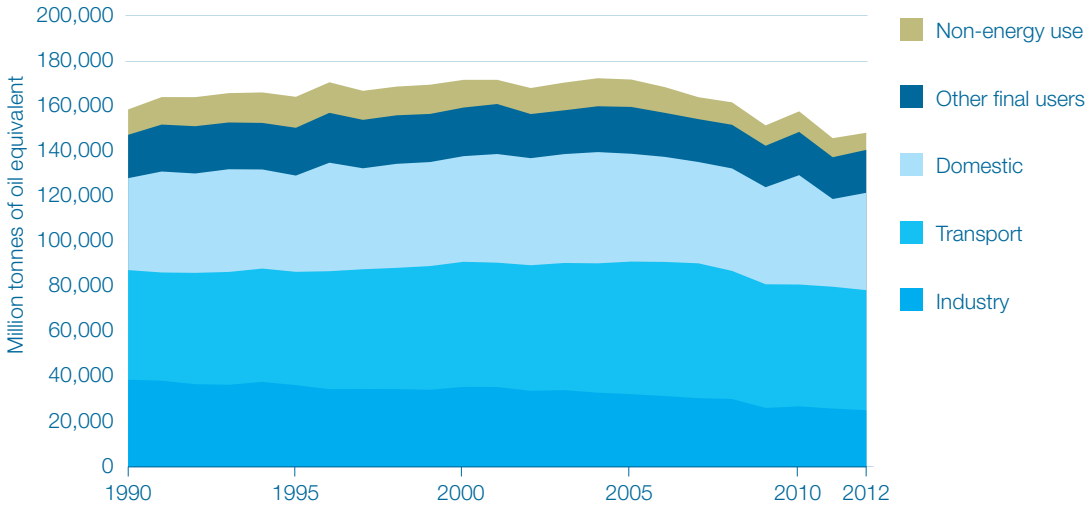
Figure 17 shows the changing levels of energy consumption (including non-energy use) in the UK by sector.[30] In 1990 total final UK consumption was 158,520 thousand tonnes of oil equivalent. The transport sector was responsible for 31% of total final energy consumption, the domestic sector a further 26%, with industry consumption responsible for 24% and other final users 12%. However, by 2012 total UK consumption had declined by 7% to 148,198 thousand tonnes of oil equivalent. During this period, consumption from transport had risen to 36% of the

[29] Energy Consumption in the UK. DECC https://www.gov.uk/government/collections/energy-consumption-in-the-uk

[30] Energy Consumption in the UK. DECC https://www.gov.uk/government/collections/energy-consumption-in-the-uk

UK total, domestic consumption had increased to 29% of UK consumption, with industrial consumption decreasing to 17% of total UK consumption and other final users increasing to 18%.

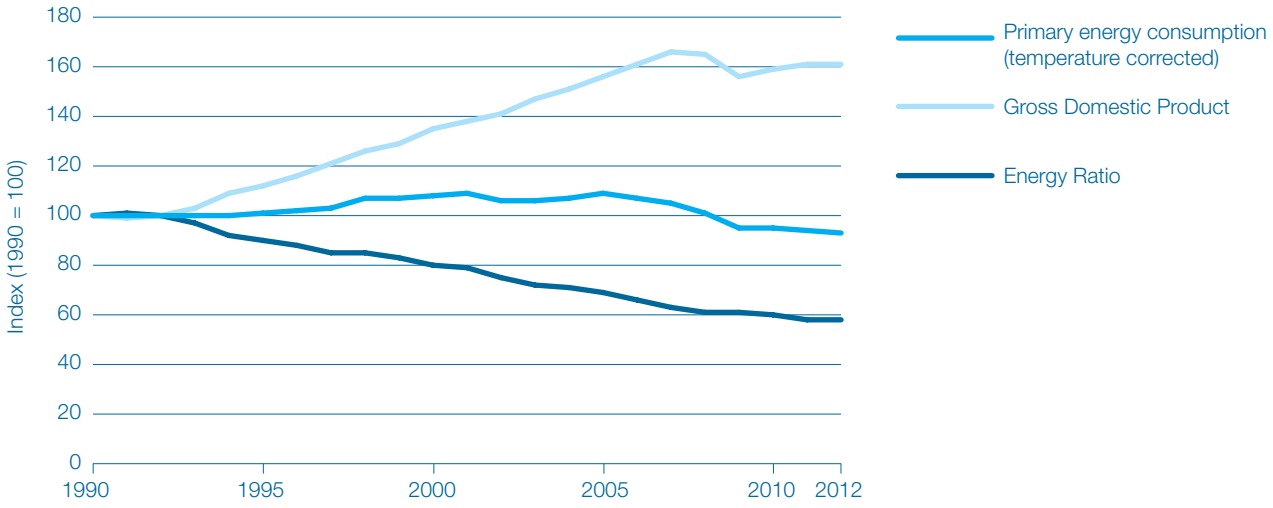
Figure 17: Final energy consumption by sector, UK, 1990-2012



Source: Energy Consumption in the UK, Department of Energy and Climate Change

The relationship between energy consumption and economic activity at the aggregate level can be gauged by comparing a country's temperature corrected inland primary energy consumption with its gross domestic product (GDP). The energy ratio is calculated by dividing temperature corrected primary energy consumption by GDP at constant (2010) prices. The energy ratio has fallen steadily, at around 2.5% per year since 1990, though since 2005 the rate has fallen at 2.6% per year as shown in Figure 18.[31]

Figure 18: Energy ratio, UK, 1990-2012



Source: Energy Sector Indicators, Department of Energy and Climate Change

The downward trend in the ratio can be explained by a number of factors:

- Improvements in energy efficiency (including the impact of the EU Emissions Trading System, Climate Change Agreements and the Carbon Reduction Commitment)
- Fuel switching in generation (from gas to coal)

[31] Energy Sector Indicators, Department of Energy and Climate Change: https://www.gov.uk/government/publications/uk-energy-sector-indicators-2013

- A decline in the relative importance of energy intensive industries
- The fact that some uses, such as space heating, do not increase

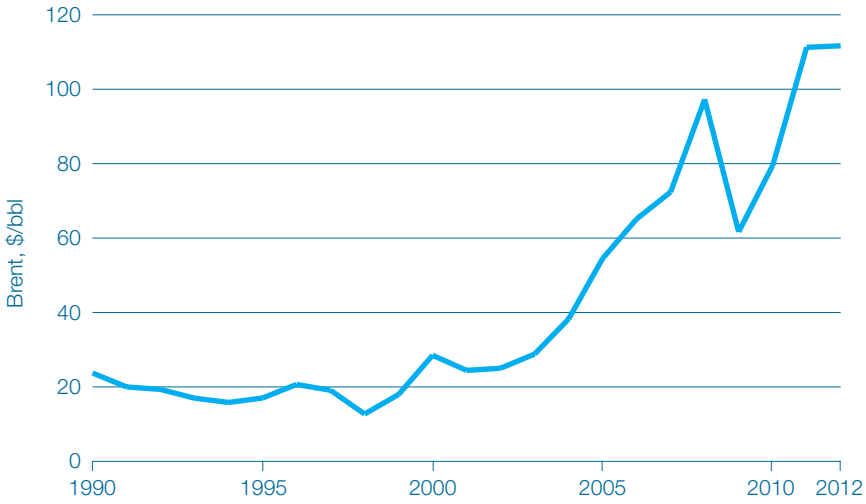
Latest International Energy Authority data shows that the energy ratio is falling in all G8 countries. The UK is estimated to have the lowest energy ratio in the G8.

A key driver of energy use in the UK is price. UK energy prices are influenced by a number of factors, both local and global. Prices of primary fuels (gas, coal, oil) will obviously affect the price of secondary fuels (electricity, road fuels), but can also themselves be affected by the price of the other primary fuels.

The price of crude oil is the main driver in the cost of all energy. Petroleum products such as petrol are made from crude oil, and as such, changes in the price of oil will be reflected in the cost of these products. However, gas prices have historically been linked to oil, and as initially oil and then gas have formed a major input to electricity generation, the price of electricity has also been driven by oil prices.

Figure 19 shows the Brent spot crude prices from 1990 to 2012. In 1990 the Brent spot price was 23.73 $/bbl, in 2012 this was nearly five times higher at to 111.67 $/bbl. The 2012 average was a high over the 1990 to 2012 period, whilst the average 1998 average price was a low at 12.72 $/bbl.[32]

Figure 19: Spot crude prices, 1990-2012



Source: BP Statistical review

1.9 Transport profile

Transport accounted for around 22% of the UK's GHG emissions in 2011, representing a reduction of 2% since 1990.[33] Road transport is the most significant source of emissions in this sector and in particular the changes seen in passenger cars heavily influence the Transport category.

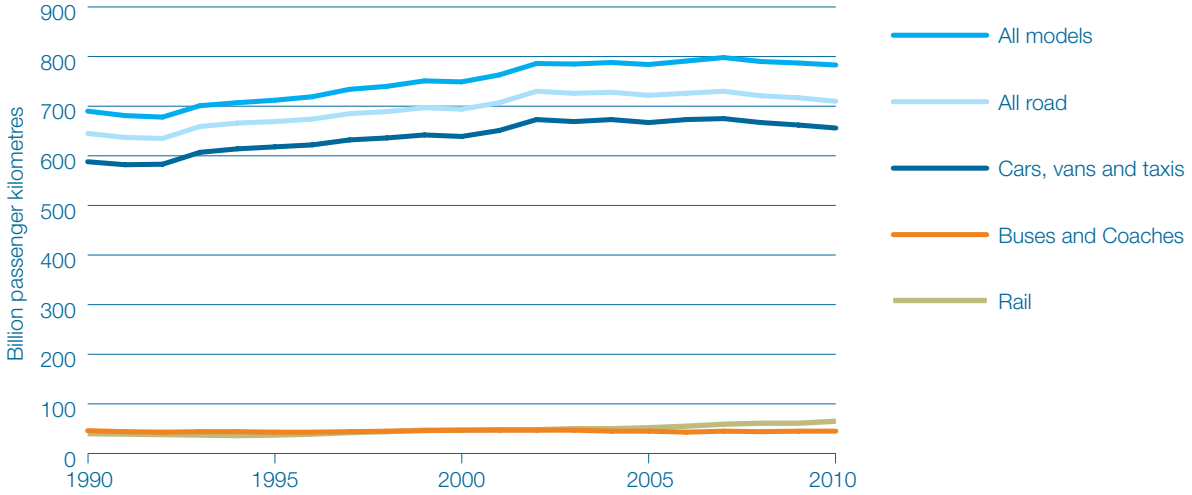
Between 1990 and 2011 there has been an increase in the total distance travelled (passenger kilometres) in the UK. This increase is driven mainly by an increase in the distance travelled by road, and in particular by cars, vans and taxis although there have been small falls since 2007 as shown in Figure 20.[34]

[32] BP Statistical Review http://www.bp.com/content/dam/bp/pdf/statistical-review/statistical_review_of_world_energy_2013.pdf

[33] The figure quoted is for emissions by source and does not include memo items such as international aviation and shipping.

[34] Transport Statistics Great Britain 2012, https://www.gov.uk/government/publications/transport-statistics-great-britain-2012

Figure 20: Passenger Transport by Mode, 1990 – 2011



Source: Transport Statistics Great Britain 2012, Department for Transport

The number of licensed vehicles in Great Britain has increased from about 25 million in 1990 to nearly 35 million in 2012. Vehicles in the private and light goods taxation class (which is mainly made up of private cars and light vans) accounted for about 89% of all the licensed vehicles in 2012.

Most of the increase in new registrations has been in the private and light good vehicles tax class. New registrations in the other tax classes have remained fairly steady with most years between 290,000 and 440,000 new vehicle registrations. It is likely that the significant decrease in new registrations since 2008 was caused by the recession and the ongoing economic climate. New car and light van registrations were helped by the Vehicle Scrappage Scheme which ran between May 2009 and March 2010.

Both Vehicle Excise Duty (VED) and the Company Car Tax System[35] rewards motorists for selecting fuel-efficient cars by being linked to the vehicles' carbon emissions. Reforms to VED mean that for cars with the very lowest carbon emissions the rate is reduced to zero. Motorists can save thousands of pounds on their company car tax bill if they choose clean, low-carbon vehicles.

Due to the increased manufacture of more fuel efficient cars, new cars sold in the UK are approximately 30% more fuel efficient for petrol and approximately 20% more fuel efficient for diesel than they were a decade ago.[36]

In 2012, transport accounted for 39% of all final energy consumption in the UK. Road transport accounted for 27% of final energy consumption with aviation accounting for 9%. The direct use of petroleum accounted for 98% of transport energy consumption.[37]

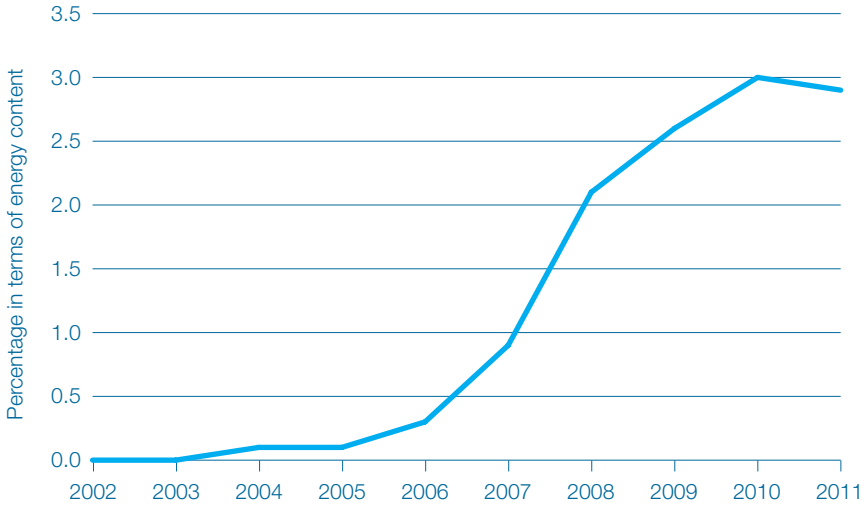
Energy from renewable sources made up around 3.1% of transport energy consumption in 2012 up from 0.3% in 2005. Almost all transport renewable energy consumption is in the form or biofuels blended into petrol and road diesel. As shown in Figure 21 biofuels made up 2.4% of road transport energy consumption in 2012, up from 0.2% in 2005.

[35] Vehicle Certification Agency (VCA) website www.vca.gov.uk/fcb/index.asp

[36] Average new car fuel consumption: Great Britain, annual https://www.gov.uk/government/statistical-data-sets/env01-fuel-consumption

[37] Transport energy and environment statistics https://www.gov.uk/government/collections/energy-and-environment-statistics

Figure 21: Biofuels as a proportion of all road transport fuels, 2002–2011

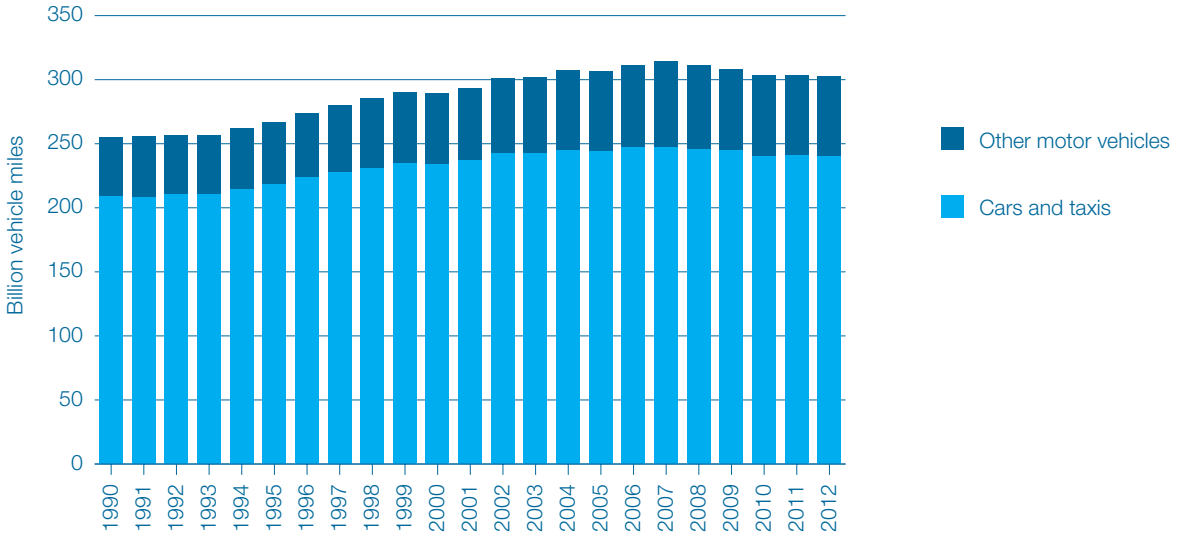


Source: Department for Transport

The UK's long term strategy to reduce transport emissions includes the Renewable Transport Fuels Obligation (RFTO), which requires 5% of transport fuel sold in the UK to come from renewable sources by 2013-14.[38] In 2011 the RFTO was amended to introduce mandatory sustainability criteria which biofuels must meet for those fuels to be eligible for renewable transport fuel certificates. The amendment also introduced double rewards for some fuel types including those made from waste materials such as used cooking oil. The percentage of fuel required to come from renewables was reduced to 4.75% to take account of the inclusion of a wider group of vehicles.

As can be seen in Figure 22 car traffic decreased slightly (0.2%) between 2011 and 2012, from 240.7 to 240.3 billion vehicle miles.[39] In the last ten years, traffic volumes for all vehicle types have decreased (for example, cars and taxis: -1.0%; heavy good vehicles: -11.9%) except for light goods vehicles which have increased by over a fifth (21.5%).

Figure 22: Road Traffic by vehicle type (cars and all motor vehicles), 1990–2012



Source: Department for Transport

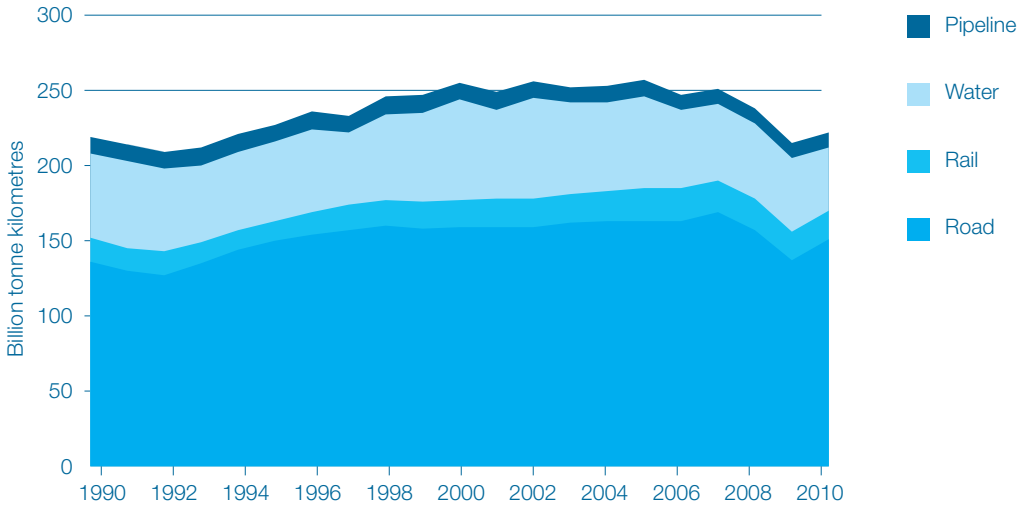
[38] Dft Renewable Transport Fuels Obligation https://www.gov.uk/renewable-transport-fuels-obligation

[39] Transport energy and environment statistics https://www.gov.uk/government/collections/energy-and-environment-statistics

Government forecasts suggest that road traffic will return to the growth trend evident before the recession. Forecasts from the National Transport Model suggests that by 2035 road traffic will be 44% higher than in the level in 2010. The greatest growth is in light goods van traffic which is forecast to be 88% higher than in 2010. The only forecast decrease is a small decrease in bus and coach traffic of 1% between 2010 and 2035. Despite this increase in traffic, CO_2 emissions are forecast to decline by around 9% from 2010 levels, reflecting fleet fuel efficiency improvements and use of biofuels.

Figure 23 shows that in 2010, the level of domestic freight moved was at broadly the same level as in 1990, at around 222 billion tonnes kilometres.[40] Since the late-1980s, more than 60% of goods moved have been transported by road. The amount travelling this way rose to 151 billion tonne kilometres in 2010 from 137 billion tonne kilometres in 2009, an increase of 10%. Goods moved by rail have increased slowly since the mid-1990s to account for around 9% of all goods moved in 2010. In recent years, rail freight has also accounted for around 5% of goods lifted, compared with 9% in 1980/81. Goods moved by pipeline have remained fairly stable over the last 25 years, at between 10 and 12 billion tonne kilometres.

Figure 23: Domestic goods moved by mode: Great Britain, 1990-2010,



Source: Department for Transport and Office of Rail Regulation

1.10 Waste

In 2011 GHG emissions from waste contributed to 3% of total UK emissions; representing a decrease of 64% since 1990. Approximately 82% of emissions from this sector are attributable to landfill CH_4.

Consistent with the EU Landfill Directive, the government and the devolved administrations have published waste strategies aiming to reduce the quantity of waste produced and to increasingly recover value from it. The strategies also set targets for reducing the amount of waste sent to landfill and to increase the amount of recycling or composting. These targets will further reduce the level of methane emissions from the waste sector in the UK.

In 2011/12 households in England produced 22.9 million tonnes of waste, continuing the year on year fall seen since 2007/8. The last data for commercial and industrial data from 2009 also shows a significant decrease with 47.9 million tonnes, a decrease of 29% since the previous survey in 2002/3. (The industrial sector accounts for 24.1 million tonnes and the commercial sector 23.8 million tonnes.)

[40] Transport energy and environment statistics https://www.gov.uk/government/collections/energy-and-environment-statistics

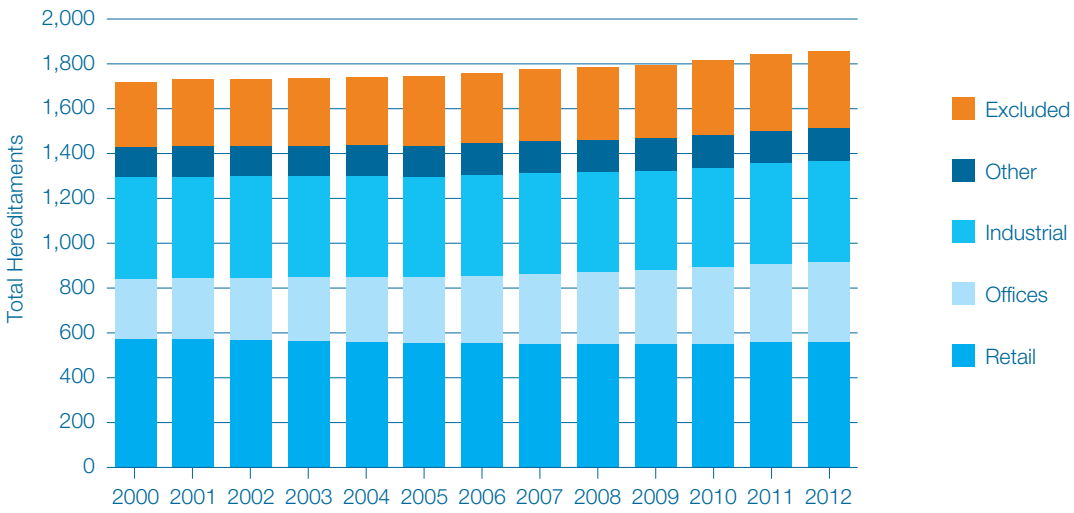
In 2011/12, 43% of household waste was recycled, the highest recycling rate recorded for England, Local Authorities recycled, composted or reused 10.7 million tonnes of the waste they collected. This amounted to more than was landfilled for the first time since records began, although an increase in incineration may have partly accounted for the change in landfill.

A total of 25.0 million tonnes, or 52%, of commercial & industrial waste was recycled or reused in England in 2009, compared to 42% in 2002/3. A total of 11.3 million tonnes, or 24%, of commercial & industrial waste was sent to landfill in 2009, compared to 41% in 2002/3. Small enterprises, with between 0 and 49 employees, produced 16.6 million tonnes of C&I waste in England, in 2009, or 35% of total commercial & industrial waste[41].

1.11 Building stock and urban structure profile

Despite the UK's long history of urbanisation, some areas are sparsely populated, including the Highlands of Scotland, and parts of Wales and northern England. In 2011 there were around 28 million dwellings in the UK, of which 23 million were in England.[42] Most common are semi-detached houses (30%), followed by terraced houses (25%), detached houses (23%), and purpose built flats (17%).[43] The number of households in England is projected to increase by 10% between 2011 and 2021.[44] This reflects, amongst other things, the increasing number of people living on their own. In Scotland the number of households is projected to increase by around 23% between 2010 and 2035.[44]

Figure 24: Total non-domestic properties for England and Wales, 2000-2012



Source: Business floorspace statistics, Valuation Office Agency

Note 1: Hereditament is the legal name for the unit of non-domestic property that is, or may become, liable to national non-domestic rates, and thus appears on the rating lists.

Note 2: Categories are assigned where the floorspace data met certain criteria, where the criteria is not met the hereditament is put in an excluded category.

[41] Commercial and industrial waste generation and management
https://www.gov.uk/government/publications/commercial-and-industrial-waste-generation-and-management

[42] Dwelling stock
https://www.gov.uk/government/statistical-data-sets/live-figures-on-dwelling-stock-including-vacants

[43] 2011 Census
http://www.ons.gov.uk/ons/guide-method/census/2011/index.html

[44] Household projections
https://www.gov.uk/government/statistical-data-sets/live-tables-on-household-projections

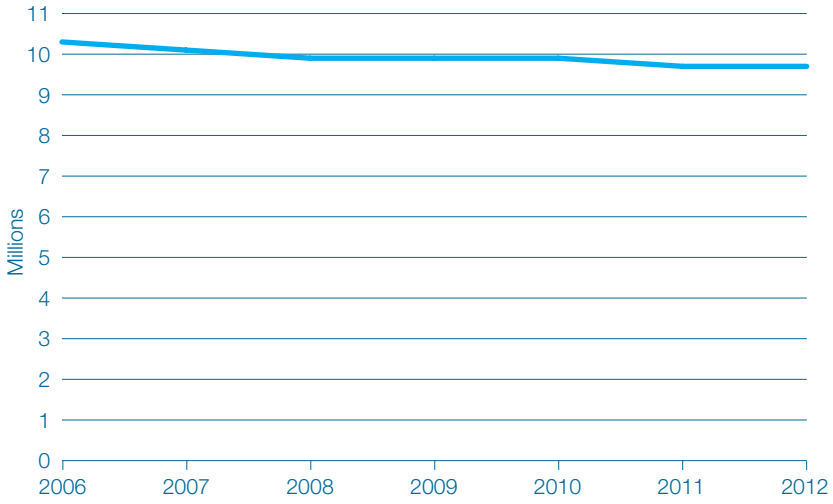
The total non-domestic properties in England and Wales have remained relatively stable in the years 2007-2011as shown in Figure 24, however there have been noticeable increases (approximately 15%) in the offices category.[45]

1.12 Agriculture profile

The total area of agricultural land in the UK in 2012 was around 18.3 million hectares. About 6.3 million hectares of this was arable (including uncropped land), of which around half was under cereal production. 11.1 million hectares is currently under grass, (temporary, permanent and sole right rough grazing). The remainder was common rough grazing, other land (roads, paths, buildings, etc.) or farm woodland.[46]

The total number of cattle and calves in the UK increased by 0.5% to just over 9.7 million between December 2011 and December 2012. This reversed the trend of declining cattle numbers since 2005 at this time of year. The UK's dairy herd remained static at 1.8 million and the UK's beef herd continues to shrink, falling by 0.8% to 1.6 million. Total cattle numbers in the UK during the period 2006-2012 are shown in Figure 25.[47]

Figure 25: Total Cattle in the UK, December 2006-December 2012



Source: Farming Statistics, Department for Environment, Food and Rural Affairs

The total number of pigs in the UK decreased by 2.4% since December 2011 to just over 4.2 million, which is the smallest pig herd as at 1 December since 2000 (the first year for which figures are readily available). The total number of breeding pigs in the UK increased by 2.% to just over 500,000 animals in December 2012. Total pig numbers in the UK during the period 2002-2012 are shown in Figure 26.[48]

The total number of sheep and lambs in the UK increased by 4.4% between December 2011 and December 2012 to just under 23.0 million. The UK's female breeding flock increased by 0.4% to 14.3 million over the same period. Larger increases were seen in other sheep and lambs

[45] Business floorspace statistics, Valuation Office Agency http://www.voa.gov.uk/corporate/statisticalReleases/120517_CRLFloorspaceReleaseNotes.html#Glossary

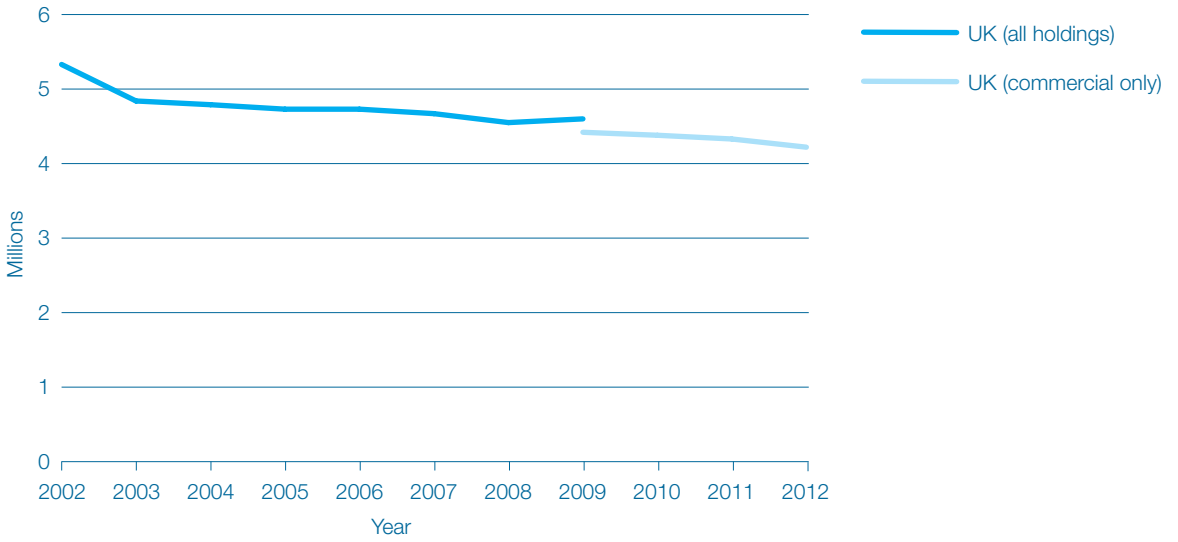
[46] Agriculture in the UK 2012 https://www.gov.uk/government/publications/agriculture-in-the-united-kingdom-2011

[47] Farming statistics: livestock populations at 1 December 2012 – UK and England https://www.gov.uk/government/publications/farming-statistics-livestock-populations-at-1-december-2012-uk-and-england

[48] Farming statistics: livestock populations at 1 December 2012 – UK and England https://www.gov.uk/government/publications/farming-statistics-livestock-populations-at-1-december-2012-uk-and-england

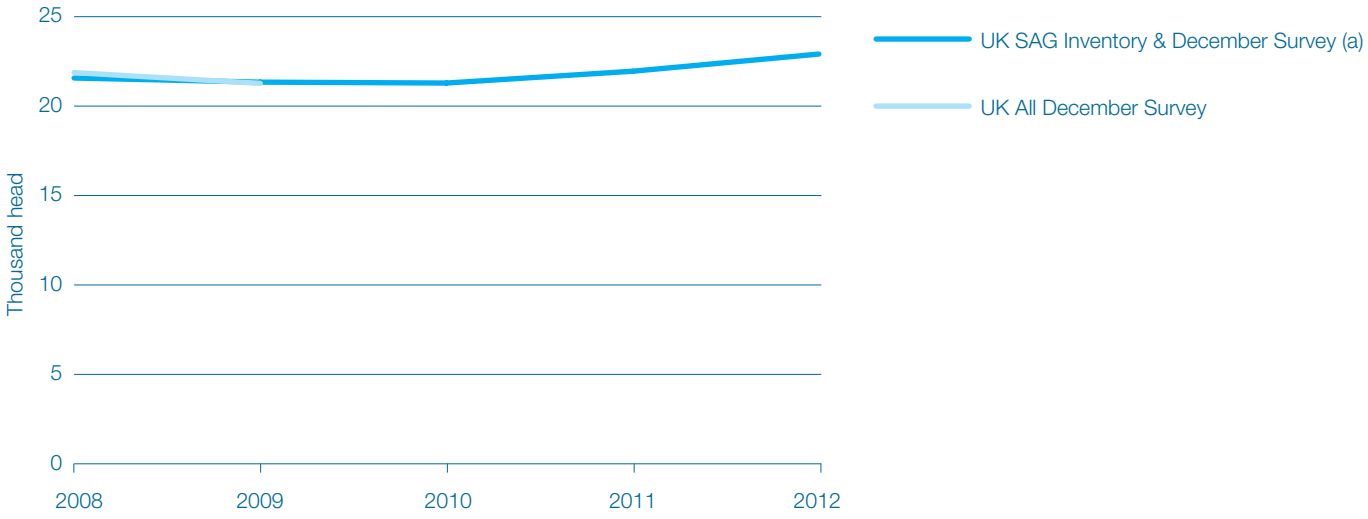
for the UK rising 11.7%. Livestock numbers have an impact on GHG emissions due to enteric fermentation. Total sheep and lamb numbers in the UK during the period 2008-2012 are shown in Figure 27.[49]

Figure 26: Total pig numbers in the UK, December 2002-December 2012



Source: Farming Statistics, Department for Environment, Food and Rural Affairs

Figure 27: Total sheep and lambs in the UK, December 2008-December 2012



Source: Farming Statistics, Department for Environment, Food and Rural Affairs

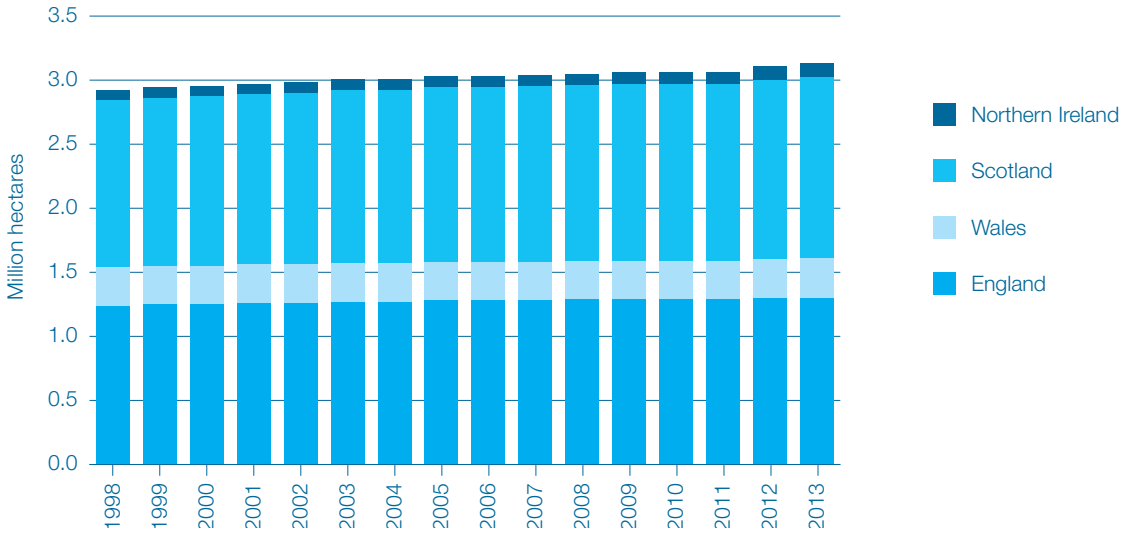
1.13 Forestry profile

The area of woodland in the UK at 31 March 2013 is 3.1 million hectares. Of this total, 1.4 million hectares (45%) is in Scotland, 1.3 million hectares (42%) is in England, 0.3 million hectares (10%) is in Wales and 0.1 million hectares (4%) is in Northern Ireland.[50] This has changed relatively little over the period 2007 to 2011 as can be seen in Figure 28. State forests account for 0.9 million hectares.

[49] Farming statistics: livestock populations at 1 December 2012 – UK and England https://www.gov.uk/government/publications/farming-statistics-livestock-populations-at-1-december-2012-uk-and-england

[50] Forestry Statistics 2013 http://www.forestry.gov.uk/forestry/infd-7aqdgc

Figure 28: Area of woodland, 1998-2013



Source: Forestry Statistics 2013, Forestry Commission

Around 1.6 million hectares of the total UK woodland is made up predominantly of conifer species, the remainder being broadleaved.

The total area of new planting and restocking in the UK was 23.9 thousand hectares in 2012-13. Restocking accounted for 55% of this total. Broadleaved species accounted for 83% of the new planting area but just 26% of the restocked area in 2012-13.

A total of 10.1 million green tonnes of softwood was produced in the UK in 2012. UK hardwood production totalled 0.5 million green tonnes in 2012. Softwood availability in the UK is projected to increase to an annual average of 15.9 million green tonnes over the five year period 2017 to 2021 and 18.3 million green tonnes from 2027 to 2031.

Apparent consumption of wood in the UK amounted to 43.2 million m^3 wood raw material equivalent in 2012, made up of 10.1 million m^3 UK production, 39.6 million m^3 imports and 6.5 million m^3 exports.

This sector can act as both a source and a sink for GHG emissions.

Chapter 2:
Greenhouse gas inventory information

2.1 Key developments

- In 2011, UK greenhouse gas (GHG) emissions on a UNFCCC basis were 553.2 million tonnes of carbon dioxide equivalent ($MtCO_2e$) – 29.1% lower than 1990 levels.
- The Kyoto Protocol requires that UK GHG emissions are reduced by an average 12.5% below base year levels over the five-year period 2008-12. In 2011, UK's GHG emissions were 29.2% below Kyoto Protocol base-year levels.
- Between 1990 and 2011, carbon dioxide (CO_2) emissions including LULUCF fell by 22.4%; methane (CH_4) emissions fell by 57.6%; and nitrous oxide (N_2O) emissions fell by 49.0%.
- Between 1995 and 2011, Hydrofluorocarbons (HFCs) emissions fell by 4.4%; Perfluorocarbons (PFCs) emissions fell by 29.6%; and sulphur hexafluoride (SF_6) emissions fell by 51.0%.
- The reduction in GHG emissions since 1990 has been mainly driven by restructuring in the energy supply industry (concerted move away from coal and oil generation towards use of gas); energy efficiency; pollution control measures in the industrial processes sector and other policies that reduced emissions of non-CO_2 GHGs, most notably the increase in landfill methane capture and oxidation.

2.2 Introduction

This chapter presents information on UK GHG inventory, covering emission estimates for the period 1990-2001, and the National System established to produce and quality assure the UK GHG Inventory. The UK is obliged to produce an annual GHG inventory, containing an estimate of all anthropogenic GHG emissions across the UK, in order to meet its commitments under the UNFCCC and the Kyoto Protocol. A concise summary of the National System is contained within this chapter, a further more detailed summary can be found in the UK's National Inventory Report (NIR), submitted to the United Nations Framework Convention on Climate Change (UNFCCC) in 2013.[51]

[51] UK Greenhouse Gas Inventory, 1990–2011, Annual report for submission under the UN Framework Convention on Climate Change, April 2013: http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/6598.php.

The GHG inventory covers the six direct GHGs under the Kyoto Protocol. These are collectively known as the 'basket' of GHGs and are:

- Carbon dioxide (CO_2)
- Methane (CH_4)
- Nitrous oxide (N_2O)
- Hydrofluorocarbons (HFCs)
- Perfluorocarbons (PFCs)
- Sulphur hexafluoride (SF_6).

The direct GHGs have different impacts on the atmosphere and are therefore assigned a global warming potential (GWP). The GWP is a means of providing a simple measure of the relative effects of the emissions of the various gases when compared with CO_2 which has a GWP of 1. Once the emissions of GHGs are converted into their GWP equivalents, they can be summed and presented as carbon dioxide equivalent emissions, referred to as CO_2e. Table 2(c) in the UK's first Biennial report (Annex 1) contains a list of respective GWPs for each gas.

The Kyoto Protocol to the UNFCCC was established in 1997 in response to the threat of dangerous climate change. The UK's target under the Kyoto Protocol is a reduction in emissions of 12.5% during the first commitment period (2008-2012) against base year emissions. The UK's base year for assessing emissions of CO_2, CH_4, and N_2O is 1990. The UK has chosen to use 1995 as the base year for emissions of the fluorinated gases: HFCs, PFCs and SF_6. This is in line with most other EU member states, and in accordance with Article 3.8 of the Kyoto Protocol. The UK also uses the inventory to track progress against legally binding domestic targets which are further discussed in Chapter 3 – Policies and measures. These domestic targets include the UK reducing GHG emissions by at least 80% by 2050.

The UK instrument of ratification of the Convention and Kyoto Protocol extends the coverage of these instruments to Overseas Territories (OTs) and Crown Dependencies (CDs) that are territories under the jurisdiction and sovereignty of the United Kingdom though not part of it. The OTs covered are Gibraltar, Bermuda, Cayman Islands, Falkland Islands and Montserrat. The CDs covered are Guernsey, Jersey and the Isle of Man. Emissions from each OT and CD are calculated individually and added to the UK total.

This chapter shows trends in UK GHG emissions between 1990 and 2011, disaggregating overall emissions by gas, by source and end-use sector. The by-source basis includes emissions from the energy supply industry as a particular sector, whereas the end-user basis reallocates these emissions to the sectors that make use of the energy supplied. The inventory is also spatially disaggregated to provide geographical breakdown to England and the three devolved administrations (Scotland, Wales and Northern Ireland), and to 406 local authorities[52] that make up the United Kingdom.

Land use, land-use change and forestry (LULUCF) emissions and removals are reported in the UK's GHG inventory in accordance with the rules for reporting this sector under the UNFCCC. The UNFCCC reporting basis includes an estimate of all anthropogenic sources minus sinks from the LULUCF sector.

Common Reporting Format Tables used for reporting GHG emissions estimates to the UNFCCC are included as Annex 3. A narrower definition of LULUCF emissions and removals is used to assess progress against the Kyoto target which includes only mandatory activities

[52] Local Authority is a designation of local government used in the United Kingdom.

under Article 3.3 of the Kyoto Protocol, and forest management, which the UK has chosen as an activity under Article 3.4 of the Kyoto Protocol. In the first commitment period of the protocol, the UK decided not to account for cropland or grazing land management or re-vegetation under Article 3.4. For the second commitment period the UK may elect to account for cropland and grassland management
(re-vegetation activities do not occur in the UK).

For calculation of the Kyoto Protocol Base Year deforestation emissions in 1990 are included in the base year total, as required by Article 3.7 of the Kyoto Protocol and subsequent decisions of the COP (Conference of the Parties).

2.3 National system for preparing the UK GHG inventory

This section provides a summary of the national system the UK uses for preparing its GHG inventory. Section 1.2 of the National Inventory Report (NIR) presents the full details of the institutional arrangements the UK has for inventory preparation.[53]

The UK's GHG inventory is compiled under contract to DECC[54] by a consortium led by the environment consultancy Ricardo-AEA.[55] Ricardo-AEA also compiles the UK's Air Quality Pollutant Inventory, used for reporting emissions to other international agreements, including the Gothenburg Protocol and the UNECE Convention on Long Range Trans boundary Air Pollution. The majority of the underlying information is held on common databases and this helps ensure consistency between these inventories. Emissions estimates from the energy supply sector, industrial processes sector and waste management sector are produced under the Ricardo-AEA contract. Emissions from the agricultural sector are provided by Rothamsted Research under contract to Defra and emissions and removals in the LULUCF sector are produced on behalf of DECC by the Centre for Ecology and Hydrology (CEH).

The GHG inventory is compiled annually according to Intergovernmental Panel on Climate Change (IPCC) Guidelines and Good Practice Guidance (IPCC, 1996, 2000 and 2003) and with regard to the 2006 Guidelines (IPCC, 2006).[56] Methodological improvements take account of new data sources, updated guidance from IPCC, relevant work by organisations such as CORINAIR (the European inventory system for certain air pollutants) and specific research programmes sponsored by government Departments including DECC, Defra and Department for Transport (DfT) together with the Devolved Administrations. All methodological improvements are applied back to 1990 to ensure a consistent time series.

The UK operates an established national system for GHG emissions estimation, reporting and archiving. There are a wide range of activities that take place as part of this system. These activities include: collecting and processing data from a wide range of sources; selecting appropriate emissions factors and estimation methods according to IPCC guidance; compiling the inventory; managing all aspects of inventory Quality Assurance (QA) and Quality Control (QC) including the Quality Control of raw and processed data and data management tools; documentation and archiving; prioritisation of methodology and data improvements; and completing uncertainty assessments. The methodologies and data sources used to create the GHG inventory are summarised in Section 1.4 of the NIR.

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[53] 2011 UK National Inventory Report (NIR): http://naei.defra.gov.uk/reports/reports?report_id=747.

[54] Department of Energy & Climate Change, 3 Whitehall Place, London, SW1A 2AW, Tel: +44 (0)3000604000, email: climatechange.statistics@decc.gsi.gov.uk

[55] Ricardo-AEA, The Gemini Building, Fermi Avenue, Harwell, Didcot, OX11 0QR, Tel: +44 (0)123575300, email: enquiry@ricardo-aea.com

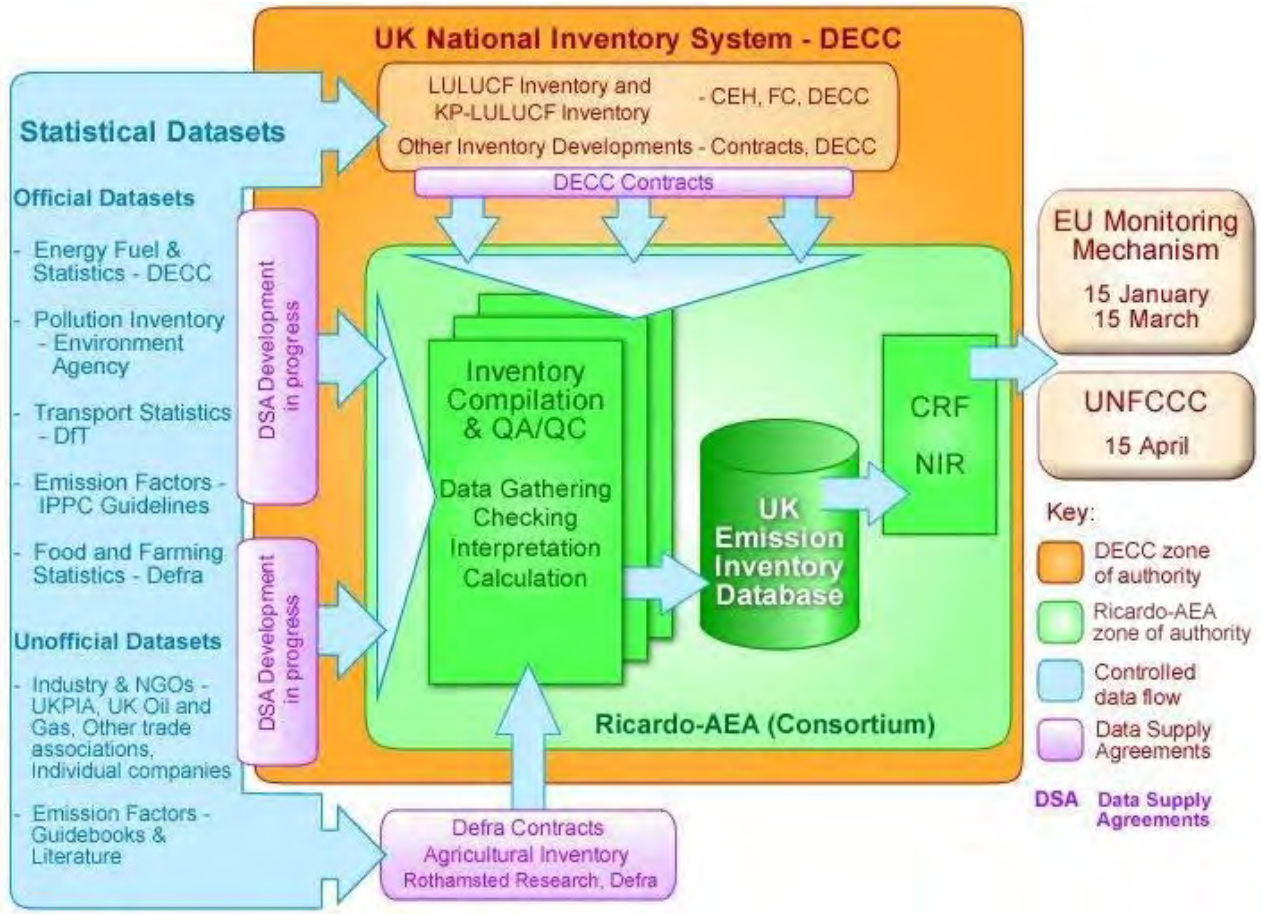
[56] IPCC Guidelines: http://www.ipcc-nggip.iges.or.jp/public/index.html.

The NIR, including Common Reporting Format (CRF) tables, is reported to the UNFCCC, and to the EU Monitoring Mechanism (EUMM), by the deadlines set. Further details are provided in Section 1.4 of the NIR, and in subsequent chapters and appendices of the NIR. The national system ensures that the UK will be able to engage with the expert review process under Article 8 of the Kyoto Protocol.

Data are collected on an annual basis from national statistics, industry, trade associations and data associated with industrial pollution reporting and emissions trading. Emissions factors are reviewed on an annual basis, and if necessary updated. A consistent time series of emissions and removal estimates is maintained by recalculations to previous years of the time series where necessary if methods or data have been updated. Each sector specific chapter of the NIR provides details of the process for the recalculation of previously submitted inventory data, and the effects of these recalculations. Chapter 10 of the NIR provides a summary which explains and justifies any re-calculations across the inventory. These approaches are fully compliant with the requirements of the Kyoto Protocol and IPCC good practice.

Figure 29 shows the main elements the UK National Inventory System, including provision of data to the European Union under the terms of the EU Monitoring Mechanism.

Figure 29: Main elements for the preparation of the UK GHG inventory



Source: UK National Inventory Report.

The complexity (or tier) of the methods used to estimate emissions (and removals) of GHGs is prioritised. Higher tier methods of calculation and country specific emissions factors are used for key source categories in the inventory. The UK inventory mainly uses higher tier methods, and makes extensive use of country specific emissions factors.

The GHG inventory is subject to a range of review procedures. These include an annual internal pre-submission review, where the latest GHG inventory is presented and discussed at the National Inventory Steering Committee (NISC). The inventory is also reviewed each year by the UNFCCC either during centralised, desk or in-country reviews, and in addition, is reviewed by the compilers of the EU GHG inventory. Any recommendations made as part of these reviews are used to help guide the development of the inventory. Chapter 10 of the NIR provides brief details of improvements to the NIR and the inventory in response to FCCC reviews.

DECC has been appointed as the Single National Entity with responsibility for the overall management and strategic development of priority improvements in the UK's GHG inventory. The latest NIR provides the contact details for the Single National Entity. Ricardo-AEA is the delegated Inventory Agency with responsibility for the planning, preparation and reporting of the UK GHG inventory. Ricardo-AEA is responsible for the quality and delivery of datasets to DECC and reporting in DECC's behalf. DECC has established the NISC, an inter-departmental committee responsible for prioritising improvements and the approval of the national inventory data prior to submission to the European Union (EU) through the European Commission (EC) and the UNFCCC each year, as well as guiding the development of the inventory.

DECC has an inventory Improvement programme, a process for prioritising improvement needs, clarifying and consulting with stakeholders via the NISC and contracting the improvement work, where needed, via a framework contract with key inventory experts . The improvement programme aims to ensure completeness of the inventory and reduce its uncertainty. The programme is informed by assessments of uncertainty in the inventory, the identification of key categories, the procedures to ensure quality, and the outcomes of reviews. Section 1.7 of the NIR provides details of the uncertainty analyses; Section 1.5 provides a description of the key categories and the processes to identify them; and, Section 1.6 provides a description of the QA/QC system, and the inventory improvement programme.

The NIR provides some of the additional reporting required under Article 7, paragraph 2 of the Kyoto Protocol. Other sources of information required under Article 7, paragraph 2 are summarised in Annex 8.

The UK National Registry[57] is operated and maintained by the Environment Agency[58] on behalf of DECC.

The National Registry conforms to the technical standards for data exchange between registry systems as outlined in the Independent Assessment Report (IAR).[59] This also shows the measures that are taken to safeguard data and a description of the database structure. Procedures and security measures are employed to minimise discrepancies and prevent unauthorised changes or errors. Further information can be found in the Standard Assessment Reports (SIAR). Results of test procedures can also be found in these reports.

Information on the registry is publicly available on the environment agency website.[60] Section 14 of the NIR contains further information on the changes in the National Registry. As part of a wider government initiative for the publication of data, registry information will be in transition from its current location to a new '.gov' website. During this time, information will continue to be available where possible.

[57] https://ets-registry.webgate.ec.europa.eu/euregistry/GB/index.xhtml

[58] Environment Agency, PO Box 544, Rotherham, S60 1BY, Tel: +44 (0)3708506506, email: ethelp@environment-agency.gov.uk

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

[60] http://www.environment-agency.gov.uk/business/topics/pollution/137208.aspx

2.4 Geographical coverage

2.4.1 Geographical coverage used for National and International reporting

The UK inventory provides data to assess progress with the UK's commitments under the Kyoto Protocol, the UK's contribution to the EU's target under the Kyoto Protocol and progress towards domestic targets to reduce GHG emissions.

Geographical coverage for these three purposes differs to some extent, because of the following:

- The Kyoto commitment extends coverage to emissions from the Crown Dependencies of Jersey, Guernsey and the Isle of Man, and the Overseas Territories that have ratified the Convention and Kyoto Protocol (the Cayman Islands, the Falkland Islands, Bermuda, Montserrat and Gibraltar). This is the geographical coverage which is reported to the UNFCCC.
- The UK's commitments under the EU's Kyoto Protocol target only include the parts of the UK which are also parts of the EU (the UK and Gibraltar, excluding all Crown Dependencies and other Overseas Territories).
- The carbon budgets and targets under the UK Climate Change Act 2008 apply only to the UK excluding the UK's Crown Dependencies and Overseas Territories.

Table 6 shows the total GHG emissions estimates associated with the geographical coverages of the United Kingdom, Crown Dependencies and Overseas Territories including net emissions/removals from LULUCF.[61] Together these total the overall emissions estimates submitted to the UNFCCC.[62]

Table 6: UK GHG emissions by geographical coverage, $MtCO_2e$

	1990	1995	2000	2005	2010	2011
United Kingdom	27,819	29,419	35.8	20.2	64.0	15.7
Crown Dependencies	1.8	2.0	2.0	1.7	1.7	1.7
Overseas Territories (excluding Gibraltar)	1.7	1.6	1.8	2.1	2.1	2.2
Gibraltar	0.2	0.2	0.2	0.2	0.3	0.2
Total	774.8	715.6	677.9	659.3	594.1	553.1
Change from 1990	0.0%	-7.6%	-12.5%	-14.9%	-23.3%	-28.6%

Source: 2011 Final UK greenhouse gas emissions.

2.5 Geographical coverage used in this report

This report presents emissions estimates based on UNFCCC coverage. Tables 6, 7 and 8 present emissions estimates consistent with this coverage. Figure 30 shows the trend in emissions reported under the Kyoto Protocol; the geographical coverage is on a UNFCCC basis but the total emissions differ slightly. This arises due to differences in reporting of Land Use, Land Use Change and Forestry under the UNFCCC and the Kyoto Protocol. Under the UNFCCC, all emissions and removals from this sector are included, whereas under the Kyoto

[61] UK National statistics: 2011 Final UK greenhouse gas emissions https://www.gov.uk/government/publications/final-uk-emissions-estimates

[62] UK National Statistics publications have a geographical coverage that includes the United Kingdom and Crown Dependencies.

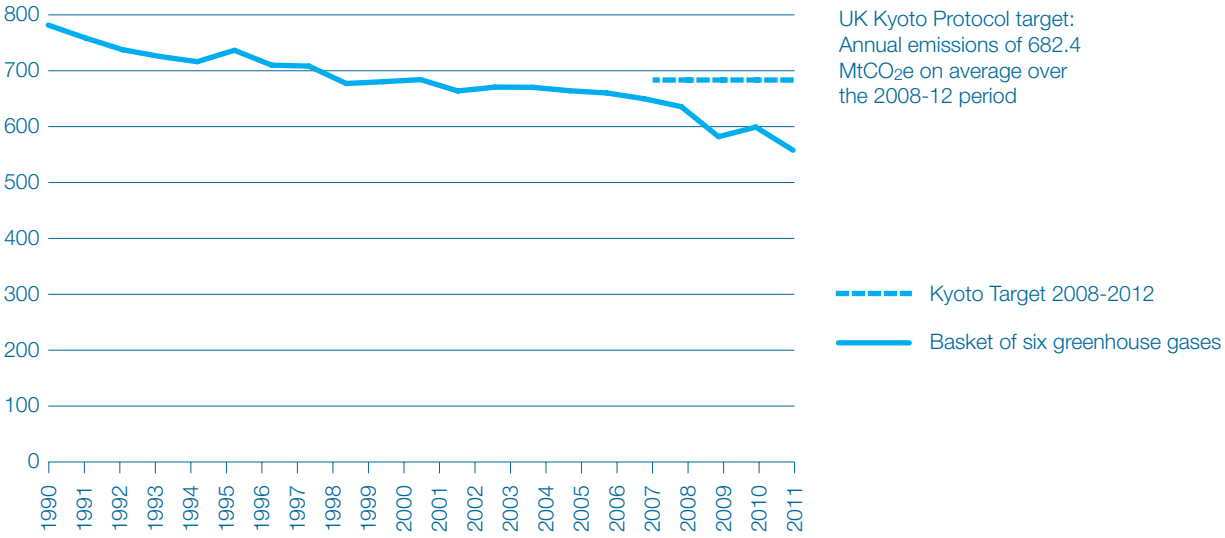
Protocol, only selected emissions and removals are included. This report does not further discuss these reporting differences, but the executive summary of the UK NIR contains more information. Emissions both including and excluding LULUCF are provided in Annex 3.

2.6 GHG emissions trends

Figure 30 shows the trend in emissions between 1990 and 2011 for the basket of six GHGs covered by the Kyoto Protocol along with the emissions reduction target relating to the first commitment period under the Kyoto Protocol. Annual GHG emissions for 2011 were an estimated 29.2% below the fixed base year[63] emission. This has been driven by a number of factors such as the move away from coal-fired generation towards the use of natural gas and renewable sources, tighter regulation of landfills, increased utilisation of landfill CH_4 in gas flares and engines and abatement technology in adipic acid and nitric acid manufacture.

Information on individual gases is contained in sections below and Annex 3 contains tables summarising the UK's GHG emissions. More details can be found in the UK's annual GHG inventory, published in April 2013.[64]

Figure 30: UK emissions of GHGs, 1990–2011



Source: 2011 Final UK greenhouse gas emissions.

Notes: The Kyoto Protocol target line is calculated from a fixed base-year figure, as defined in the UK's Initial Report[65]

2.7 GHG emissions inventory by gas

Table 7 shows historical data for CO_2 and the other GHGs. This includes the full UNFCCC coverage of the UK, its Crown Dependencies and Overseas Territories. Further detailed information and analysis can be found in the UK NIR.

The sections that follow summarise the main factors affecting the historical trend by gas. Percentages and data quoted in these sections refer to the full UNFCCC geographical coverage unless otherwise specified. Annex 3 has more detailed data available for all years from 1990-2011.

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63 The Base Year for emissions of carbon dioxide, methane and nitrous oxide is 1990. The Base Year for emissions of fluorinated gases (F-gases) is 1995. The Fixed Base Year is taken from the UK's Initial Report under the Kyoto Protocol. This report was submitted in 2006, based on emissions reported in the 1990-2004 Greenhouse Gas Inventory, and was subject to official review in 2007. For the purposes of calculating achievement of the Kyoto Protocol target emissions occurring in this base year are now fixed, in $MtCO_2e$.

64 2011 UK National Inventory Report (NIR): http://naei.defra.gov.uk/reports/reports?report_id=747.

65 http://unfccc.int/files/national_reports/initial_reports_under_the_kyoto_protocol/application/pdf/report_final.pdf

Table 7: UK GHG emissions (UNFCCC coverage), $MtCO_2e$

	1990	1995	2000	2005	2010	2011
Carbon dioxide	593.5	555.3	554.8	556.1	499.9	460.7
Methane	99.2	85.2	65.0	48.5	43.0	42.1
Nitrous oxide	68.3	58.0	46.5	41.2	35.9	34.8
Hydrofluorocarbons	11.4	15.3	9.3	12.1	14.4	14.7
Perfluorocarbons	1.4	0.5	0.5	0.3	0.2	0.3
Sulphur hexafluoride	1.0	1.2	1.8	1.1	0.7	0.6
Total GHG emissions by sources minus removals by sinks	774.8	715.6	677.9	659.3	594.1	553.1
Total GHG emissions including only mandatory Article 3.3 LULUCF activities and forest management cap under Article 3.4 LULUCF (Kyoto Protocol definition)	769.7	711.0	675.2	659.0	594.0	552.6
Change from Kyoto Protocol fixed base year levels (for row above)	-1.3%	-8.8%	-13.4%	-15.5%	-23.8%	-29.2%
Fixed Base Year[53]	779.9					

Source: 2011 Final UK greenhouse gas emissions.

2.7.1 Carbon dioxide

Carbon dioxide had the largest share of UK greenhouse gas emissions in 2011, making up 83% of the inventory. Net CO_2 emissions (all anthropogenic sources minus removals by sinks) in 1990 were estimated to be 590.5 $MtCO_2e$, or an estimated 77% of the UK's total emissions of GHGs. By 2011, CO_2 emissions estimates had been reduced by 23% to 457.2 $MtCO_2e$, contributing an estimated 83% of UK GHG emissions in that year.

The main source of CO_2 is from combustion of fossil fuels. Power station emissions have contributed the most to decreases in CO_2 (by an estimated 59 $MtCO_2e$, across the period) primarily due to the move away from coal-fired generation towards the use of natural gas and renewable sources. Industrial combustion emissions have decreased due to lower fuel use, in part due to improvements in energy efficiency and fuel-switching to gas.

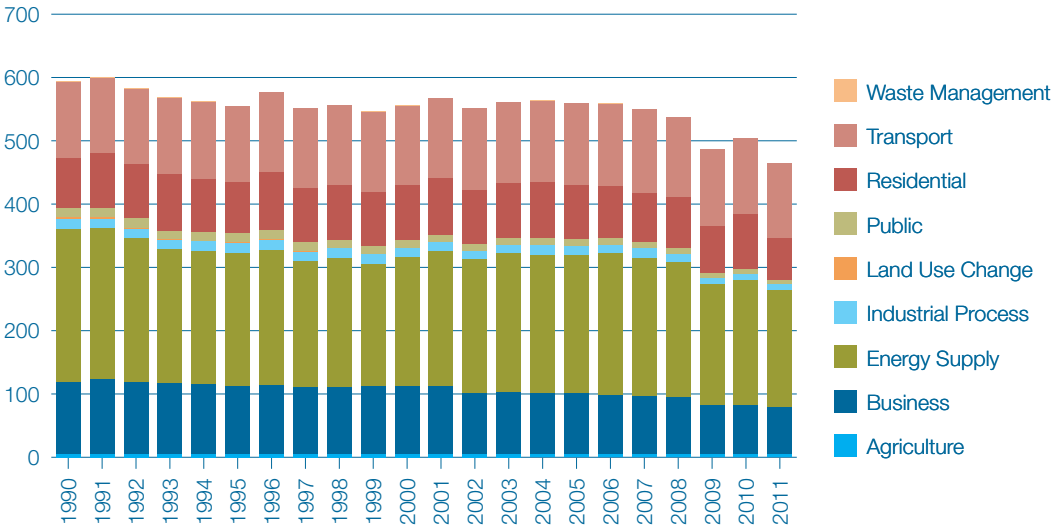
In the LULUCF sector estimates take account of changes in carbon stocks in forests and soils, based on land use and soil survey data, and on annual planting data from the Forestry Commission. CEH also uses the inventories of woodlands in Great Britain (England, Scotland and Wales), which the Forestry Commission has undertaken at 15-20 year intervals since 1924. Data from the most recent is available to DECC, and is being used to improve inventory estimates for this sector. The final dataset will be published by the Forestry Commission in 2015.

Figure 31 shows the contribution of each sector to the emissions of CO_2 between 1990 and 2011.

2.7.2 Methane

Methane is the second largest share of the UK's GHG emissions by gas. Estimated emissions of CH_4 in 1990 were 98.6 $MtCO_2e$, contributing an estimated 13% of the UK's total emissions of GHGs. By 2011 CH_4 emissions estimates had been reduced by 58% to 41.7 $MtCO_2e$, contributing an estimated 8% of UK GHG emissions in that year.

Figure 31: Carbon dioxide emissions by source, 1990-2011, $MtCO_2e$



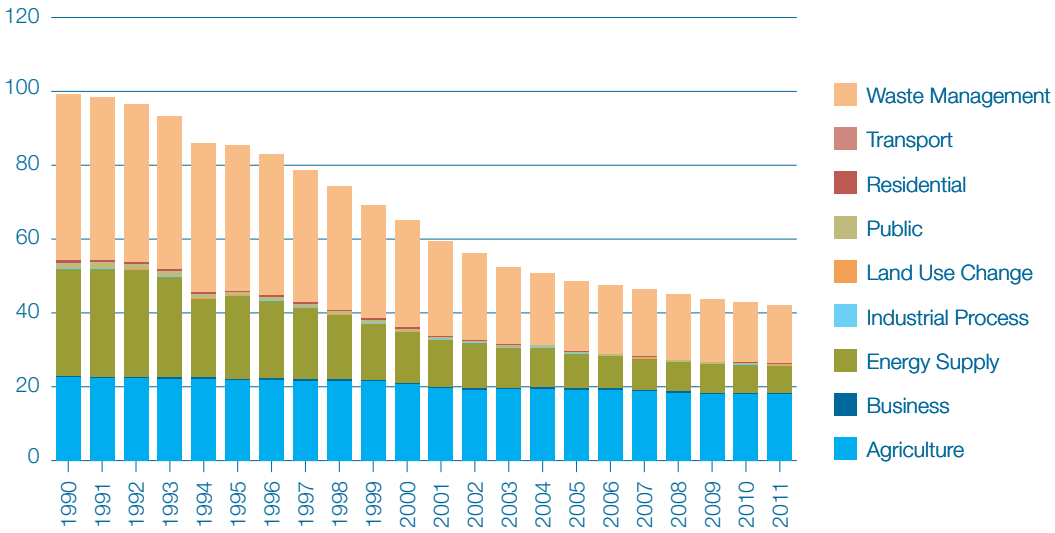
Source: 2011 Final UK greenhouse gas emissions.

The major sources of CH_4 include the anaerobic degradation of landfill waste, enteric fermentation and waste management in the agriculture sector, leakage of natural gas from the distribution network, and emissions due to coal mining. The overall trend in CH_4 emissions is a relatively steady decline driven by large reduction in landfill emissions. Emissions estimates have decreased by 29 $MtCO_2e$ since 1990, due to tighter regulation of landfills and increased utilisation of landfill CH_4 in gas flares and engines.

Mitigation actions in the energy supply sector (including replacing UK gas distribution infrastructure and the using of CH_4 from working and abandoned coal mines) and a reduction in livestock numbers have reduced CH_4 emissions.

Figure 32 shows the contribution of each sector to the emissions of CH_4 between 1990 and 2011.

Figure 32: Methane emissions by source, 1990-2011, $MtCO_2e$



Source: 2011 Final UK greenhouse gas emissions

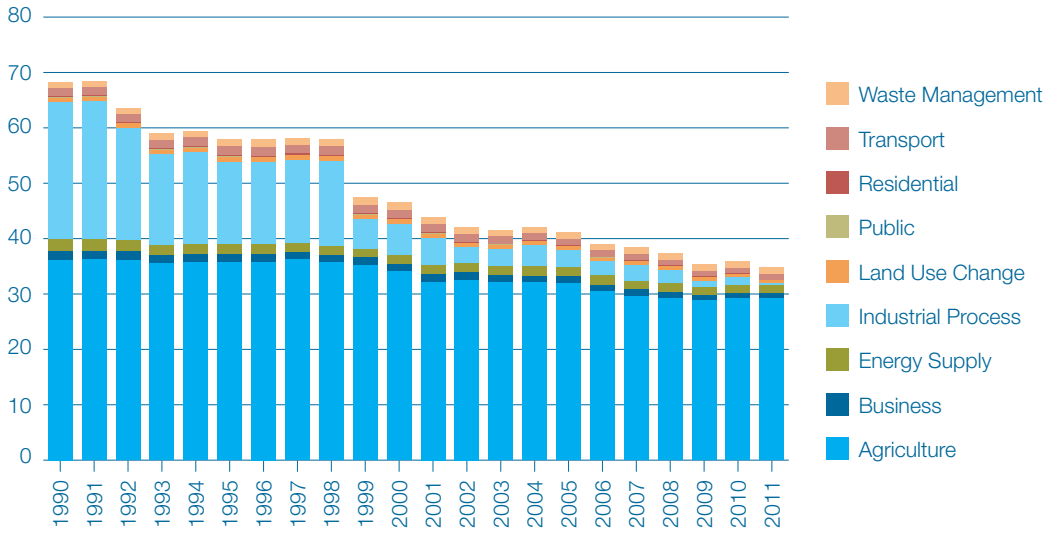
2.7.3 Nitrous oxide

Nitrous oxide emissions contributed 68.2 $MtCO_2e$ or an estimated 9% of the UK's total GHG emissions in 1990. By 2011 N_2O emissions estimates had been reduced by approximately 49% to 34.7 $MtCO_2e$, contributing an estimated 6% of UK GHG emissions in that year.

The industrial processes sector was a major source of N_2O emissions in the 1990s. Emissions from this sector have declined significantly following the introduction of abatement technology in adipic acid and nitric acid manufacture and due to plant closures. The largest source of N_2O in 2011 is agricultural soils, accounting for an estimated 78% of total N_2O emissions. Agricultural soil emissions have declined by an estimated 19% since 1990 due to improvements in farm management practices.

Figure 33 shows the contribution of each sector to the emissions of N_2O between 1990 and 2011.

Figure 33: Nitrous oxide emissions by source, 1990-2011, $MtCO_2e$



Source: 2011 Final UK greenhouse gas emissions.

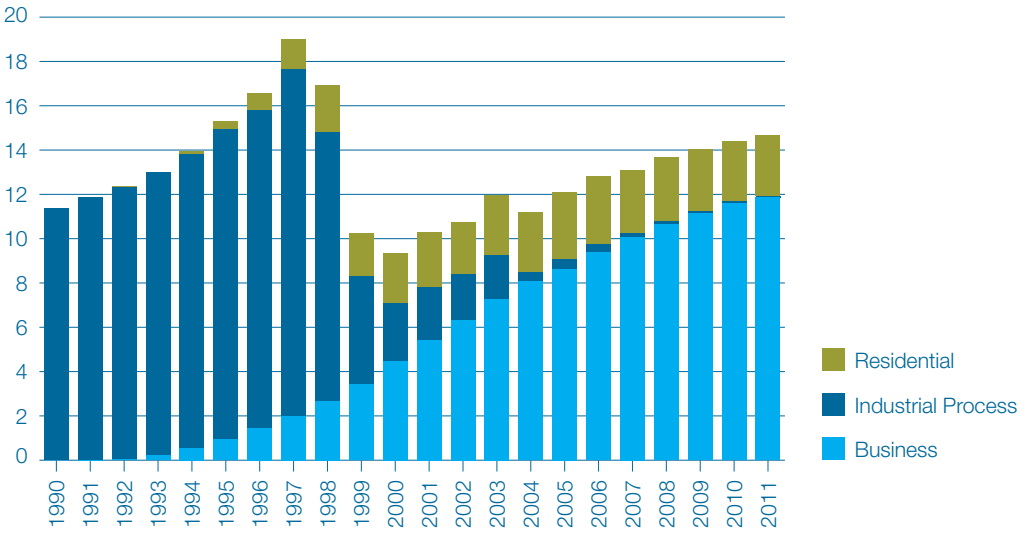
2.7.4 Fluorinated gases (hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride)

Emissions of the fluorinated or industrial gases are small in absolute terms, but their significance is increased by high Global Warming Potential (GWP) values, see Table 2(c) in the UK's first Biennial report (Annex 1). For the purpose of accounting under the Kyoto Protocol, the UK has chosen to use 1995 as the base year for emissions of HFCs, PFCs and SF_6. This is in line with the approach adopted by the majority of EU member states. Emissions estimates of the F-gases totalled 15.6 $MtCO_2e$ in 2011. Since 1995 the overall decrease in their emissions has been an estimated 8.5%, due mainly to the fall in emissions from F-gas manufacture, due to the installation of abatement equipment at two of the three manufacturers. Emissions from certain end-use sectors, such as refrigeration, are continuing to grow.

Since 1990, emissions of HFCs are estimated to have increased by 29%. The largest contribution to this sector in 2011 arises from refrigeration and air conditioning equipment. In 2011, these contributed an estimated 77% to the overall emissions of HFCs. Emissions from this category arise due to leakage from refrigeration and air conditioning equipment during its manufacture and lifetime. Emissions from aerosols contribute the next largest percentage (estimated to be 19%) to overall HFCs emissions. In this category, it is assumed that all the fluid is emitted in the year of manufacture. This category contains mainly industrial aerosols and also metered dose inhalers. Emissions from manufacture of HFCs and HCFCs have decreased by an estimated 99% since 1990, due to plant closures and the installation of abatement equipment.

Figure 34 shows the contribution of each sector to the emissions of HFCs between 1990 and 2011.

Figure 34: Hydrofluorocarbons emissions by source, 1990-2011, $MtCO_2e$

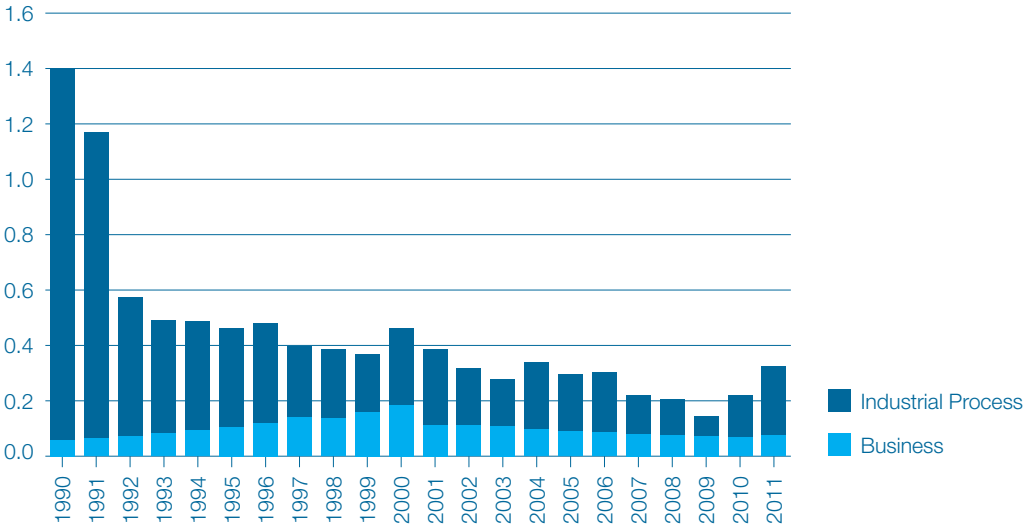


Source: 2011 Final UK greenhouse gas emissions.

Perfluorocarbons emissions have declined by an estimated 77% since 1990. The main source of PFCs emissions is aluminium production. During the process of aluminium smelting, PFCs are formed as a by-product. Since 1990, emissions arising from aluminium production have decreased an estimated 88% due to significant improvements in process control and an increase in the rate of aluminium recycling.

Figure 35 shows the contribution of each sector to the emissions of PFCs between 1990 and 2011.

Figure 35: Perfluorocarbons emissions by source, 1990-2011, $MtCO_2e$

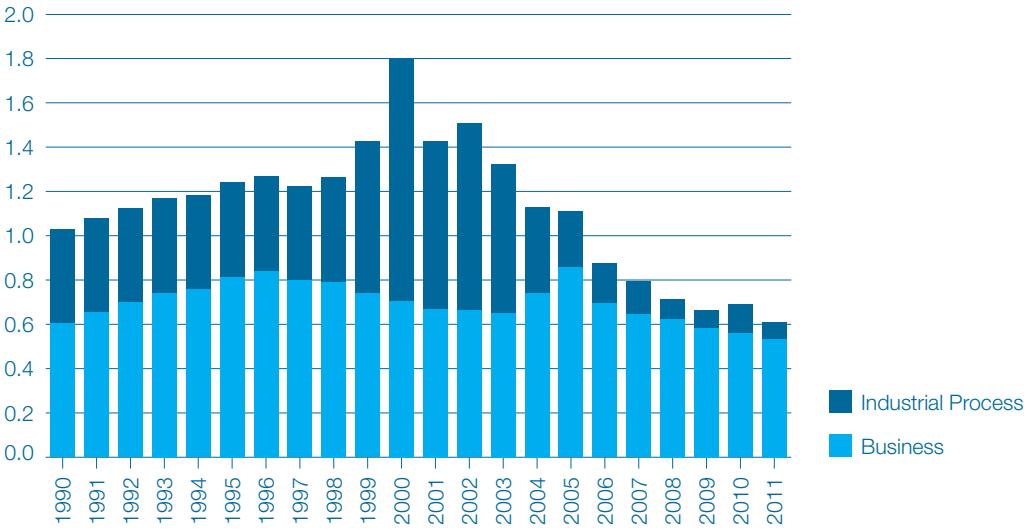


Source: 2011 Final UK greenhouse gas emissions.

The use of SF_6 in magnesium foundries contributed around 12% towards total SF_6 emissions in 2011, and total emissions from magnesium foundries has decreased by an estimated 83% due to declining production. The electronics industry and sports shoes industry account for 88% of emissions and have not changed significantly since 1990.

Figure 36 shows the contribution of each sector to the emissions of SF_6 between 1990 and 2011.

Figure 36: Sulphur hexafluoride emissions by source, 1990-2011, $MtCO_2e$



Source: 2011 Final UK greenhouse gas emissions.

2.8 Sectoral emissions – by source

Table 8 shows the contribution to UK GHG emissions of different sectors by emissions source. By-source reporting shows emissions from the energy supply industry separately to the other sectors. Annex 3 contains more detailed data available for all years from 1990-2011.

Table 8: GHG emissions by source (UNFCCC coverage), $MtCO_2e$

Sector	1990	1995	2000	2005	2010	2011
Agriculture	64.0	62.8	59.4	55.7	51.4	51.4
Business	115.4	110.3	114.0	108.3	92.0	89.2
Energy Supply	273.1	234.8	219.3	228.5	205.3	192.1
Industrial Process	54.7	45.1	24.7	18.8	11.7	10.2
Land Use Change	4.0	3.3	0.4	-2.6	-3.7	-3.3
Public	13.1	12.8	11.5	11.1	8.4	7.1
Residential	80.9	82.5	90.4	88.1	90.2	69.9
Transport	122.2	122.6	127.2	131.0	120.8	119.1
Waste Management	47.5	41.5	30.9	20.5	18.0	17.4
Total GHG emissions by sources minus removals by sinks	774.8	715.6	677.9	659.3	594.1	553.1
Change from 1990	0.0%	-7.6%	-12.5%	-14.9%	-23.3%	-28.6%

Source: 2011 Final UK greenhouse gas emissions.

Energy supply was responsible for an estimated 183 $MtCO_2e$ or 39.8% of net CO_2 emissions in 2011. Overall, between 1990 and 2011, there has been a 14% increase in the amount of electricity generated. The restructuring of the energy supply industry in the mid-1990s led to a significant decrease in emissions to 1999, as there was a strong move away from coal and oil generation towards use of gas. Between 1999 and 2006 emissions increased, due to the volatile and high gas price and the corresponding switching from gas to coal. However between 2006 when CO_2 emissions from the energy supply sector peaked and 2011, emissions have again shown a decline, down an estimated 18% on 2006. This decrease has resulted from a combination of changes in mix of fuel being used for generation, together with greater efficiency due to improvements in technology.

Further details for each sector can be found in the UK NIR describing factors such as a detailed source description, methodology and sources contributing to the sector.

2.9 Sectoral emissions – by end-user

Table 9 shows GHG emissions on an end-user basis. The by-source basis reports emissions from the energy supply industry separately to its own category. Emissions by end-user attributes the emissions from energy supply to the end-user of that energy rather than the source. The geographical coverage presented includes UK and Crown Dependencies. Emissions from Overseas Territories are not included in the end-user analysis, but are included as their own row in the table to ensure overall total emissions are consistent with UNFCCC coverage. Emissions by end user are included in this chapter as additional information only. Policies and measures are based on emissions by source discussed earlier in this chapter.

The "exports" sector represents emissions associated with the production of fuels within the UK (for example, from a refinery or a coal mine) which are subsequently exported or sent to bunkers for use outside the UK. Since these fuels are ultimately used for activities which occur outside the UK, it would not be appropriate to allocate the emissions from their production to any of the National Communication sectors, hence they are reported separately.

Table 9: GHG emissions by end-user, $MtCO_2e$

Sector	1990	1995	2000	2005	2010	2011
Agriculture	67.6	65.7	61.9	58.2	53.7	53.6
Business	247.7	215.0	214.2	210.1	183.0	175.0
Industrial Process	57.3	47.4	26.6	19.5	12.6	11.1
LULUCF (net)	4.0	3.3	0.4	-2.6	-3.7	-3.3
Public	30.8	28.2	23.6	22.2	17.9	15.9
Residential	169.7	156.5	158.9	164.0	157.8	130.5
Transport	139.3	143.0	146.5	148.9	136.8	134.8
Waste Management	47.4	41.4	30.8	20.4	17.9	17.3
Exports	9.2	13.3	13.1	16.2	15.9	15.8
Overseas Territories	1.9	1.8	2.0	2.3	2.4	2.4
Total GHG emissions by sources minus removals by sinks	774.8	715.6	677.9	659.3	594.1	553.1

Source: 2011 Final UK greenhouse gas emissions.

2.9.1 Agriculture

The agriculture sector includes emissions from livestock and agricultural soils, stationary combustion sources and off-road machinery (e.g. tractors). There are also small amount of emissions of CO_2 from the breakdown of pesticides. In 1990, GHG emissions from agriculture, forestry and land use were estimated to be 71.6 $MtCO_2e$ or 9% of total UK GHG emissions. This includes net emissions and removals from LULUCF. Joint annual emissions from these sectors have fallen by an estimated 29.7% between 1990 and 2011. The fall in emissions is the result of decreasing animal numbers and fertiliser use, plus expanded forest area and a tendency for towards less intensive agriculture. Further information describing the circumstances that affect this sector is presented in the agriculture profile (1.12) in Chapter 1.

2.9.2 Business

The business sector covers emissions from stationary combustion in all industrial and commercial sectors (including the combustion of fuel to provide the heat required for certain industrial processes or for heating), industrial off-road machinery, refrigeration and air conditioning, and the use of fluorinated gases for other applications. Emissions have fallen since 1990 in the business sector. In 2011, emissions from this sector were estimated to be 29% below 1990 levels and represented an estimated 32% of total emissions. A number of factors contributed to this decrease; primarily due to a reduction in emissions from industrial combustion (including iron and steel). Further information describing the circumstances that affect this sector is presented in the economy and industry profile (1.7) and building stock and urban structure profile (1.11) in Chapter 1.

2.9.3 Industrial processes

The industrial processes sector contains all emissions from industry except for those associated with fuel combustion. Sources include metal production, mineral products (cement and lime) and chemical production. Industrial processes emissions have decreased by an estimated 81% since 1990. The largest reductions are from emissions trading schemes and the chemical manufacturing industry, most notably the abatement of N_2O emissions from nitric and adipic acid manufacture in response to Integrated Pollution Prevention Control. Further information describing the circumstances that affect this sector is presented in the Economy and Industry Profile Subsection (1.7) in Chapter 1.

2.9.4 Land use, land use change and forestry

For the LULUCF sector, emissions measured by end-user are the same as those measured by source, since no emissions from the energy supply sector are reallocated to LULUCF. The UK has moved from being a net source of CO_2 from LULUCF activities in 1990 to a net sink for all years since 2000. Total emissions of direct GHGs from the LULUCF sector decreased by 180% between 1990 and 2011. The size of the net sink has decreased by 10% since 2010. The land use categories which have the greatest effect on the net LULUCF emissions/removals are forest land (a net sink), cropland (a net source) and grassland. Forestland is currently a decreasing sink due to the lower average age of trees as a consequence of historically low rates of afforestation during the 1990s. Emissions from cropland have decreased by 28% since 1990 (4% since 2010). Net removals from grassland have increased by 33% since 1990, although the size of the sink has decreased by 1% since 2010. Further information describing the circumstances that affect this sector is presented in the geographic profile (1.5) and forestry profile (1.13) in Chapter 1.

2.9.5 Public

Emissions from the public sector occur from the combustion of fuel in public sector buildings. This includes public administration and defence; compulsory social security; education; and health and social work. Public sector emissions fell from an estimated 30.8 $MtCO_2e$ in 1990 to 15.9 $MtCO_2e$ in 2011, this has been largely driven by a reduction in the use of oil in this sector. In 2011 this sector now represents 3% of total emissions. Further information describing the circumstances that affect this sector is presented in the government profile Subsection (1.3) in Chapter 1.

2.9.6 Residential

Emissions in the residential sector arise from fuel combustion for heating, cooking, garden machinery, fluorinated gases released from aerosols and metered dose inhalers (such as those used for asthma sufferers), and carbon emissions released from the breakdown of consumer products (such as detergents).

In 2011, residential sector emissions (including those derived from electricity use in the sector) were estimated as 130.5 $MtCO_2e$, compared to 1990 emissions of 169.7 $MtCO_2e$, a reduction of approximately 24%. This net change was the result of interactions between several much larger individual contributions over the decade. Three factors have had a major influence: a growth in demand for underlying energy services (such as warmer homes, hot water and home entertainment); background improvement in energy efficiency; and reduction in the carbon intensity of grid electricity. Further information describing the circumstances that affect this sector is presented in Population Profile (1.4), Climate Profile (1.6), Energy Profile and Building Stock and Urban Structure Profile (1.11) Subsections of Chapter 1.

2.9.7 Transport

This sector includes emissions from domestic aviation, road transport, diesel railways, domestic shipping (coastal, inland waterways), fishing and aircraft support vehicles. Transport accounted for around 24% of UK GHG emissions in 2011, representing a reduction of 3% since 1990. Road transport is the most significant source of emissions in this sector and in particular the changes seen in passenger cars heavily influence the transport category. Although there has been an increase in both the number of passenger vehicles and the vehicle kilometres travelled, the decrease in emissions from passenger cars has been due to lower petrol consumption outweighing an increase in diesel consumption and an increase in vehicle efficiency. Further information describing the circumstances that affect this sector is presented in the Transport Profile Subsection (1.9) in Chapter 1.

2.9.8 Waste management

The waste management sector includes emissions from waste disposed to landfill sites, waste incineration, and the treatment of waste water. Emissions from disposal of waste have decreased by an estimated 64% since 1990, primarily due to the decline in CH_4 emissions. This decrease has been realised mainly due to tighter regulation of landfills, through fitting of CH_4 recovery systems on landfills, and increasing diversion of biodegradable waste from landfill, plus more diversion away from landfills in response to the UK landfill tax and policies to meet the requirements of the EU Landfill Directive. Further information describing the circumstances that affect this sector is presented in the Waste Profile Subsection (1.10) in Chapter 1.

2.10 Uncertainties

The UK GHG inventory uses an error propagation and Monte Carlo simulation method to estimate uncertainties for GWP weighted emissions of all GHGs. The uncertainty estimates from the Monte Carlo method are summarised in Table 10.

Estimated emissions of CO_2, which dominate GWP weighted emissions, have a low uncertainty of around 2%. There are much larger uncertainties associated with emissions of N_2O and CH_4 and the source which makes the major contribution to the overall uncertainty of the UK GHG inventory is agricultural soils. The UK Government has work programmes in place aimed to reduce these uncertainties, which include field based measurement programmes in the agricultural sector, literature review and assessment, and methodological development.

Table 10 demonstrates the estimated uncertainties by GHG, as well as overall uncertainty on total UK GHG emissions, which is 17% in 2011. The uncertainty is not quoted for N_2O as the range is very large, and the distribution of emissions is highly skewed. The analysis of the uncertainties for N_2O is particularly difficult because the sources are diverse and there are little data available to form an assessment of the uncertainties in each source. To put this into context the central estimate of N_2O emissions was 34 $MtCO_2e$, the uncertainty analysis resulted in a 95% confidence interval of 8 to 104 $MtCO_2e$ in 2011.

The likely percentage change between 2011 and 1990 lies between -31% and -26%, with a central estimate of -29%. The uncertainty in the trend of emissions is smaller than the overall uncertainty on the emissions total in a given year. The uncertainty in the trend between years (as a percentage change) is likely to be less than the uncertainty in a given year because the methodology used is consistent throughout the time-series. Therefore, there is more certainty in the trend in emissions than the absolute emissions themselves. This gives more confidence in assessing compliance with percentage reduction targets, where it is the trend that is important.

Table 10: Summary of Monte Carlo uncertainty estimates 1990-2011

	1990 emissions[5] (thousand tonnes CO_2e)	2011 emissions[5] (thousand tonnes CO_2e)	Uncertainty[1] in 2011 emissions	Percentage change between 1990 and 2011	Uncertainty in 2011 emissions as % of emissions category		Range of likely % change between 1990 and 2011[4]	
					2.5 percentile	97.5 percentile	2.5 percentile	97.5 percentile
Carbon dioxide[2]	593,548	460,656	2%	-22%	452,992	468,249	-24%	-20%
Methane	98,977	42,052	19%	-57%	36,317	49,303	-67%	-46%
Nitrous oxide	67,622	34,424	(See footnote 6)	-57%	7,694	103,833	-79%	-32%
Hydrofluorocarbons	11,386	14,649	7%	29%	13,860	15,439	17%	42%
Perfluorocarbons	1,402	325	17%	-77%	281	371	-80%	-73%
Sulphur hexafluoride	1,029	607	7%	-41%	523	692	-52%	-28%
All GHGs weighted by GWP[3]	773,963	552,712	17%	-29%	521,788	622,359	-31%	-26%

Source: 2011 Final UK greenhouse gas emissions.

Notes

1 Expressed as a percentage relative to the mean value 2011 emissions. Calculated as 2s/E where s is the standard deviation and E is the mean.

2 GHG emissions are net emissions. Total emissions minus removals.

3 The GWP of a greenhouse gas measures its effectiveness in global warming over 100 years relative to CO_2.

4 Equivalent to a 95% probability that the percentage change between 1990 and 2011 is between the two values shown. Values include uncertainties for overseas territories data.

5 1990 and 2011 emissions are expressed as the central estimate from the Monte Carlo analysis of uncertainties.

6 Uncertainty is not quoted because the distribution is highly skewed.

2.11 Comparison of Fifth and Sixth National Communications

Since the publication of the Fifth National Communication in 2009, various updates and revisions to methodologies have been implemented in the UK GHG inventory that have impacted on the time-series of emissions. The most significant changes are highlighted in Table 11 below.

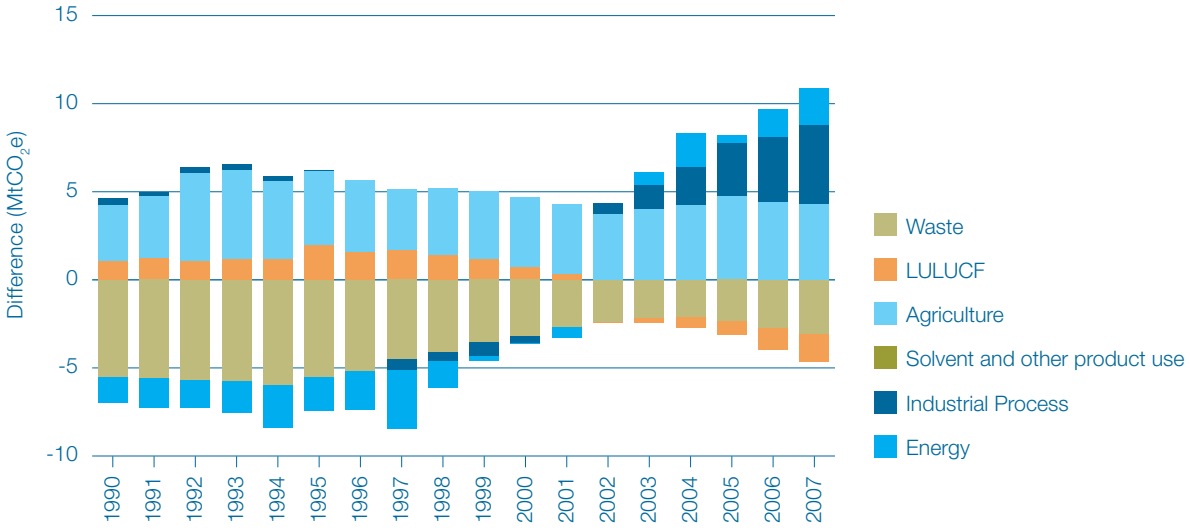
Table 11: Major revisions to the UK GHG inventory since publication of the Fifth National Communication

Change	Effect on inventory
Addition of emissions from combustion of by products at ethylene crackers.	Increase in estimated carbon dioxide emissions from energy.
Inclusion of emissions from industrial wastewater. Revised landfill assumptions and new activity data.	Increase in estimated methane emissions from waste.
Revised split between domestic and international shipping.	Significant reduction in domestic shipping emissions and increase in international shipping emissions.
Incorporation of new data and addition of new nitrous oxide sources from disturbance associated with Land-use conversion to cropland. Improved representation of wildfire and deforestation. Inclusion of pre-1920 forest.	Increase in emissions of nitrous oxide from LULUCF; increased emissions from biomass burning and deforestation; increased strength of forest carbon sink.
Review of waste composition and new activity data included.	Decrease methane emissions from waste.
Methodological improvements to the estimation of emissions from adipic and nitric acid.	Decrease in the estimated emissions of nitrous oxide from industrial processes.
A number of changes have been made to agricultural soils methodology. The largest of these included introducing the application of sewage sludge to agricultural land.	Increase in the estimated emissions of nitrous oxide from agricultural soils.

Source: National Inventory Report

How these and other changes have impacted on total emissions over the time series is summarised by sector in Figure 37 below.

Figure 37: Changes in emissions by source due to revision to the UK GHG inventory, 1990–2007



Source: 2011 National Inventory Report

2.12 Quality assurance & quality control

The current UK GHG inventory complies with the relevant IPCC Guidelines and Good Practice Guidance. The inventory agency is fully accredited to ISO 9001 standards that provide institutional standards that the agency must apply to all projects. Much of the data received by Ricardo-AEA for the UK GHGI compilation come from other government departments, agencies, research establishments or consultants working on behalf of UK government or for trade associations. Some of the organisations (e.g. DECC, the Office of National Statistics and British Geological Survey) qualify as the UK's National Statistical Agencies and abide by strict statistical QA/QC standards. Other organisations (e.g. CEH, providing the LULUCF estimates and the Environment Agency, providing regulated point source emissions data) supply important datasets for the inventory and have their own QA/QC systems.

Whilst these organisations have their own QA/QC systems, Ricardo-AEA is responsible for co-ordinating inventory-wide QA/QC activities relating to the submitted datasets. In addition, Ricardo-AEA is working continuously with organisations supplying data to the GHG inventory to encourage them to demonstrate their own levels of QA/QC that comply with either IPCC Good Practice Guidance or the UK's Official Statistics standards.

The inventory has a well-developed quality assurance and quality control plan, which is described in section 1.6 of the NIR. This plan includes procedures to ensure the timely reporting of the NIR and CRF tables, and the archiving of all relevant information. The QA/QC plan oversees the calculation of GHG estimates and reporting to UNFCCC and EUMM, and calculation of estimates and reporting to UK National Statistics. The key objective of the QA/QC plan is to ensure that the estimates in the GHG inventory are of a suitably high quality, and in achieving this, meet the principles of transparency, completeness, consistency, comparability and accuracy which govern the generation of all GHG inventories. Specific responsibilities have been assigned to the different QA (review) and QC (checking) activities and to different roles within the compilation and reporting process. A QA/QC manager co-ordinates all QA/QC activities. The QA/QC plan is maintained by the inventory's QA/QC manager. The plan defines the specific quality objectives and QA/QC activities required in undertaking the compilation and reporting of GHG estimates. The plan also assigns roles and responsibilities to inventory staff, and provides a timeline for completion of QA/QC activities. An overview of the UK's GHG inventory QA/QC system is illustrated in Figure 38.

To verify the emissions levels and trends reported in the GHG inventory DECC maintains a research programme of high-frequency, high-precision measurements of atmospheric trace gases at the Mace Head research station, in the Republic of Ireland. Three additional UK-based monitoring stations have also recently been established as part of DECC's GHG inventory verification programme, including Angus Tower, in Angus, Scotland; Tacolneston Head, in Norfolk; and Ridge Hill, in Herefordshire. The observations enable estimates of UK emissions to be derived using a technique designed specifically for the DECC research programme, which provide an important cross-check for the GHG inventory. The UK is one of very few countries verifying its inventory in this manner.

2.13 Indirect greenhouse gases

The indirect GHGs emitted in significant volumes in the UK consist of Nitrogen Oxides (NO_x), Carbon Monoxide (CO), Non-CH_4 Volatile Organic Compounds (NMVOC) and Sulphur dioxide (SO_2). Of these, NO_x, CO and NMVOC can increase tropospheric ozone concentration and hence radiative forcing. Sulphur dioxide contributes to aerosol formation in the atmosphere. This is believed to have a negative net radiative forcing effect, tending to cool the surface. Table 12 shows emissions from these gases since 1990.

Table 12: Indirect GHG emissions (Kt)

	1990	1995	2000	2005	2010	2011
Nitrogen oxide	2,879	2,307	1,783	1,576	1,110	1037
Carbon monoxide	9,129	7,611	5,697	3,578	2,250	2159
Non-methane volatile organic compounds	2,700	2,163	1,498	1,050	772	753
Sulphur dioxide	3,724	2,373	1,242	705	410	382

Source: National Inventory Report.

Total emissions of CO in 2011 were 2,159 Kt, and since 1990, emissions have decreased by 76%. A significant part of this reduction was from transport and was due the increased use of three way catalysts, fuel switching from petrol to diesel cars.

In 2011, total emissions of NO_x were 1,037 Kt, and since 1990, emissions have decreased by 64%. The majority of this reduction was from the energy supply sector and due to abatement measures on power stations, three-way catalysts fitted to cars and stricter emissions regulations on trucks.

For SO_2 total emissions in 2011 were 382 Kt, and since 1990, emissions have decreased by 90%. The reductions arise mainly from the energy supply sector due to the increase in the proportion of electricity generated by combined cycle gas turbine (CCGT) stations which are more efficient than conventional coal and oil stations and have negligible SO_2 emissions.

NMVOCs total emissions for 2011 were 753 Kt, and since 1990, overall emissions have decreased by 72%. This has been due to various reasons, but the biggest contributor to the decrease was from the solvent and other product use sector. This sector includes paint application, degreasing and dry Cleaning and chemical products, manufacture and processing.

Chapter 3:
Policies and measures

3.1 Key developments

- The UK has a strong policy portfolio delivering GHG emissions reductions in the electricity sector, in industry, and in homes, offices and buildings. The Devolved Administrations have made strong progress on their mitigation programmes and continue to work closely with the UK government and each other on developing innovative and effective mitigation policies and measures.
- Since its introduction in 2002, the Renewable Obligation (RO) has succeeded in tripling the level of renewable electricity from 2.9% of total UK generation to 11.3% in 2012. In March 2012 total capacity under the RO was almost 12,500 MW, with over 30 TWh of renewable generation, and savings of 15.1 $MtCO_2e$.
- The Energy Bill currently before Parliament will build on the success of the Renewables Obligation, and go further – enabling the biggest reforms to our electricity market since privatisation. EMR will help incentivise investment in low carbon electricity generation to ensure the UK meets its decarbonisation and security of supply goals, while minimising costs to consumers. EMR provides support for low carbon technologies in the short to medium term, working towards a long term vision of a competitive market where all technologies participate on a level playing field without direct financial support.
- To complement the support provided for large-scale low-carbon generation, the Feed-in-Tariffs scheme encourages deployment of small-scale (up to 5 MW), low-carbon electricity generation, particularly by organisations, businesses, communities and individuals that have not traditionally engaged in the electricity market. Over 470,000 installations (2.2 GW capacity) were registered on either the Central Feed-in Tariff Register or the Microgeneration Certification Scheme by the end of August 2013.
- Half of the UK's carbon emissions currently come from the energy used to generate heat. The Renewable Heat Incentive financial support scheme for renewable heat has an important role to play in the UK's transition to a low carbon economy. This policy could result in cumulative savings of 5 $MtCO_2e$ to 2015, increasing to 39 $MtCO_2e$ to 2020.
- A world first, the Green Deal energy efficiency programme is designed to deliver energy efficiency improvements across Great Britain, and to boost long term investment and growth in the energy efficiency products and service sectors. It is already helping consumers to cut waste and the cost of their bills, whilst reducing their energy demand and carbon emissions.

- The Energy Company Obligation (ECO) is a statutory obligation placed on the main energy suppliers to meet a series of targets relating to carbon savings and reducing home heating costs up to 2017.

3.2 Introduction

The UK takes its responsibilities to tackle climate change seriously and takes a leading role in taking action to significantly reduce GHG emissions. Provisional data show that the UK is 27% below 1990 emission levels and on track to meet the 34% 2020 carbon reduction target. This chapter sets out the policies and measures that contribute to the UK meeting its obligations to reduce GHG emissions 80% by 2050.

3.3 Policy-making process

3.3.1 UK

DECC coordinates UK policy on climate change at official level through inter-departmental committees chaired by DECC. A Cabinet Committee chaired by the Chancellor of the Exchequer makes decisions at ministerial level.

Some policies are the responsibility of DECC directly, while others are the responsibility of HMT, DfT, Defra, CLG, BIS, FCO and DFID.

The UK government's programme is supported by action taken by the Devolved Administrations in Scotland, Wales and Northern Ireland. While the UK government has overall responsibility for ensuring that a programme is put in place to deliver the UK's Kyoto target and its domestic carbon budgets, all the administrations will play a part in meeting these targets. The approach taken by each administration will differ, drawing on the range of policies at their disposal. Policies and programmes specific to each Devolved Administration are included throughout this chapter.

The *Stern Review on the economics of climate change,*[66] published in October 2006, underpins the rationale for climate change policy development in the UK. The Review demonstrated that urgent action is needed to mitigate the effects of climate change and estimated the costs of global action to mitigate the most dangerous effects are 1% of global GDP per year, but that if no action were taken to reduce GHG emissions the overall costs in 2050 would be equivalent to losing 5-20% of global GDP per year.

In 2009 the IEA World Energy Outlook found that each year of delaying action to limit temperature rise to two degrees would add approximately $500 billion to the global incremental investment costs of $10.5 trillion for the period 2010-30. This means that for every dollar of investment avoided before 2020 in the power sector and additional $4.40 would need to be spent after 2020 to compensate with emissions rises.[67] In 2011 the IEA estimated that for every $1 of investment avoided in the power sector an additional $4.3 would be spent after 2020 to compensate for increased emissions.

The UK government recognises that taking action isn't free, but the costs are relatively small – and for climate change they pale into insignificance compared to the costs of doing nothing.

3.3.2 Welsh government

The Welsh government's aim of creating sustainable growth through a low carbon, resource efficient and socially inclusive Wales, goes hand in hand with its climate change objectives. The Welsh government is committed to playing a lead role in tackling climate change. The 2010 Climate Change Strategy for Wales and associated Delivery Plans, set out how the Welsh

[66] Stern Review on the Economics of Climate Change: http://www.hm-treasury.gov.uk/sternreview_index.htm

[67] 2011 IEA World Energy Outlook http://www.worldenergyoutlook.org/publications/weo-2011/

government will act and work with partners, to reduce GHG emissions by 3% year-on-year towards a 40% 2020 target, and support effective adaptation to a changing climate. The 2011 *Programme for Government set out key actions and commitments* which are vital to Wales' long term resilience and increasing severe weather incidents, such as flooding, have highlighted its impact.

On December 10th, the Welsh government set out its second annual progress report on climate change and reported against the 3% target for the first time. The report shows a decrease of 10.1% in emissions reported for 2011 data. Provisional data suggests that Wales will meet its 3% reduction figure for 2012. Broken down by sector, the report highlights strong progress in the Public Sector (18.7%) and good progress in in the Waste Sector (8.8%), Business Sector (13.3%), Residential Sector (16.5%) and Transport Sector (6.8% reduction). Emissions in the Agriculture and Land-use Sector have however slightly increased by 1.2% in 2011, largely due to a historical legacy of aging forestry in Wales.

In addition to the detail on emissions, the report also gives a summary of the key action taken on both climate change mitigation and adaptation. In doing so, it summarises key action the Welsh government has taken to not only tackle climate change but also realise the opportunities to support the headline commitments to sustainable economic growth and tackling poverty.

Wales will refresh its climate change policy and focus on the practical action to be collectively taken to ensure that Wales' emission reduction targets will be met; improve resilience to extreme weather and decreasing the societal risks of climate change; and fundamentally to position Wales to take advantage of the significant opportunities for green growth.

The Climate Change Commission for Wales works with the Welsh government to help build agreement on what action is needed to respond to climate change. It also provides leadership in reducing emissions and preparing for the effects of climate change. The Commission has played a central role in developing the Climate Change Strategy, and Commissioners have a lead role to play in making action happen within the sectors they represent

3.3.3 Scottish government

Lead devolved responsibility for climate change policy in Scotland rests with the Minister for Climate Change and the Environment. A senior official level Climate Change Delivery Board is responsible for embedding climate change policy across the Scottish government, and monitoring progress. A Public Sector Climate Leaders Forum brings together key actors from across the wider public sector to provide leadership and share ownership and responsibility for action.

The Climate Change (Scotland) Act 2009 sets mandatory targets to achieve at least a 42% reduction in 1990 levels of Scottish GHG emissions by 2020 and an 80% reduction by 2050. As well as domestic emissions, Scotland's share of emissions from international aviation and shipping are included in the targets.

The Scottish government published a report setting out proposals and policies for meeting those targets. The Report on Proposals and Policies (RPP2) was published in June 2013, and lays out how Scotland can deliver annual targets for reductions in emissions from 2013 to 2027.

In support of this, through its updated Government Economic Strategy, the Scottish government has also established a new strategic priority, the "Transition to a Low Carbon Economy" emphasising the central importance of low carbon to Scotland's future economic success.

In addition, the Scottish Climate Change Act includes a mandatory provision for Scottish Ministers to develop and publish an Energy Efficiency Action Plan.

The latest plan, *The Conserve and Save: Energy Efficiency Action Plan* published in 2010, reaffirms an ambitious energy efficiency and microgeneration agenda for Scotland, with a target to reduce final energy consumption by 12% in 2020 against a baseline averaged over 2005-07. It sets out a wide-ranging programme of activity on behaviour change, household, business and public sector energy efficiency, infrastructure, skills and finance, and is a key component of Scotland's broader approach to meeting climate change targets and securing the transition to a low carbon economy in Scotland. A formal review and progress update on the plan was published in May 2013. The latest energy trends data for 2011 indicates that Scotland has reduced consumption by 9.2% against the baseline in 2011.

3.3.4 Northern Ireland Executive

The Northern Ireland Programme for Government (2011-2015) commits the Northern Ireland Executive to reduce GHG emissions by 35% on 1990 levels by 2025. A GHG Emissions Reduction Action Plan was agreed in 2011 with the aim of achieving the target. Progress is monitored and reported annually by the Environment Minister to the Executive.

The Northern Ireland Renewable Heat Incentive was introduced in November 2012 to support generators of renewable heat within the non-domestic sector. Work continues on introducing a domestic RHI scheme that will replace the existing Renewable Heat Premium Payment scheme. This will contribute to the Northern Ireland Executive target of 10% of heat from renewable sources by 2020.

Plans are progressing for a £200 million extension of the natural gas network to the west of Northern Ireland that will offer connection for up to 34,000 domestic and business customers. The proposals should deliver significant carbon savings over the period of the gas licences, through reducing dependence on oil in particular. It is anticipated that the Utility Regulator will award the necessary gas licences in the first half of 2014, allowing planning approval to be sought with the aim of starting construction work on the new network in 2015.

A Northern Ireland Energy Bill is being progressed that includes proposals for an energy efficiency obligation to replace the Northern Ireland Sustainable Energy Programme (NISEP), primary powers for a feed-in tariff for small scale renewable electricity installations and revisions to the powers of the Department of Enterprise, Trade and Investment (DETINI) and the Utility Regulator in light of the increased need to ensure the sustainability of energy in Northern Ireland.

3.3.5 Quantified economy-wide emissions reduction targets

3.3.5.1 EU target

Alongside the EU and its member States, the UK communicated an independent quantified economy-wide emission reduction target of 20% by 2020 compared with 1990 levels (base year). The target for the European Union and its member states is based on the understanding that it will be fulfilled jointly with the European Union and its member states. The 2020 target is unconditional and supported by legislation in place since 2009 (climate and energy package).

The climate and energy package implements the 2020 emissions reduction target. The reduction effort is shared out as follows:

- a 21% reduction in emissions from sectors covered by the EU emissions trading system (EU ETS) compared to 2005 levels;
- around 10% reduction from most other sectors compared to 2005. These sectors are covered by the Effort Sharing Decision (ESD).

Since a single, EU-wide cap on EU ETS emissions has been introduced from 2013, the effort-sharing arrangement between member states under the ESD has been determined solely for

the reduction in emissions from non-traded sectors that are not covered by the EU ETS. Further information can be found in the cross-cutting section of this chapter.

The ESD establishes binding annual GHG emission targets for member states for the period 2013–2020. These targets concern emissions from most sectors not included in the EU ETS such as transport (except aviation and international maritime shipping), buildings, agriculture and waste. The UK's ESD target is a reduction of 16% compared to 2005 GHG emissions levels by 2020.

By 2020, the UK's national target along with other member state targets will collectively deliver a reduction of around 10% in total EU emissions from the sectors covered compared with 2005 levels. Together with a 21% cut in emissions covered by the EU ETS, this will accomplish the overall emission reduction goal of the climate and energy package of a 20% cut below 1990 levels by 2020.

Detailed information on the EU target, including the gases regulated, GWP values and international market-based mechanisms in achieving its emissions reduction – are provided in Annex 2 (Table 2).

3.3.5.2 Domestic target

The Climate Change Act 2008[68] established the world's first long-term legally-binding framework to reduce GHG emissions, committing the UK to reducing its emissions by at least 80% below the 1990 baselines levels by 2050, with an interim target to reduce GHG emissions by at least 34% compared to the 1990 baseline by 2020.

To help set the trajectory, the Climate Change Act also introduced carbon budgets, which set legally-binding limits on the total amount of GHG that the UK can emit for a given five-year period. This section discusses the carbon budgets and the UK's progress in achieving the limits.

The targets

- The UK has put the first four carbon budgets in law through secondary legislation, covering the period from 2008 to 2027, with the fifth carbon budget due to be set in 2016.
- These carbon budgets limit GHG emissions to:

Figure 38: Targets

	First carbon budget (2008–12)	Second carbon budget (2013–17)	Third carbon budget (2018–22)	Fourth carbon budget (2023–27)
Carbon budget levels ($MtCO_2e$)	3018	2782	2544	1950
Percentage reduction below base year levels	23%	29%	35%	50%

Coverage of the targets set out in the Climate Change Act comprises UK territory only (i.e. England, Wales, Scotland and Northern Ireland) and not our Crown Dependencies or Overseas Territories. They cover both the traded and non-traded sector, with the traded sector cap based on the UK's share of the EU Emissions Trading System (EU ETS). The target includes the impact of LULUCF, but excludes International aviation.

The base year consists of emissions of CO_2, CH_4, and N_2O in 1990, and of HFCs, PFCs and SF_6 in 1995. It also includes an allowance for net emissions from the LULUCF sector in 1990. The baseline is revised annually.

[68] http://www.legislation.gov.uk/ukpga/2008/27/contents

Figure 39: Progress against the first carbon budget

$MtCO_2e$

First carbon budget		Actual emissions including EU ETS						
Total emissions (2008-12)	Equivalent average emissions p.a.	2008	2009	2010	2011	2012 (p)	Cumulative emissions (2008-12)	Overall emissions below budget
3,018	604	606	585	597	573	582	2,943	75

Figure 39 shows that UK GHG emissions including the impact of trading within the EU ETS had decreased by 25% in 2012 relative to the carbon budgets baseline. The first carbon budget requires that the total UK GHG emissions do not exceed 3,018 $MtCO_2e$ over the five year budget period (2008-12). This is approximately 22% below the carbon budget baseline level on average over the period.

Based on latest published projections, the UK government expects to reduce emissions to below the level required for the second and third carbon budgets by 79 and 42 $MtCO_2e$. Further details on this QEWER target are contained in the Biennial Report.

3.3.6 The Kyoto mechanisms

The UK's Kyoto target for the first commitment period 2008–12 is to achieve an average reduction of 12.5% compared to the fixed base year emissions (1995 for F-gases and 1990 for all other gases). The latest inventory (for 2008-11) and provisional inventory (for 2012) indicate that the UK will be 29% below fixed base year levels on a territorial emissions basis and 24% below after allowing for trading of permits in the EU Emissions Trading Scheme.[69] The UK will therefore comfortably exceed its Kyoto Protocol first commitment period target.

3.3.7 Summary of polices and measures

The UK has a significant package of policies and measures that will ensure the targets are met. Many of the policies described in this chapter cut across different sectors and involve a number of different delivery mechanisms. Details of these can be found in Annex 2, Table 3.

Name of mitigation action	Sectors affected	Type of instrument	Status of implementation	Start year of implementation
Forestry Act, Felling Licence Regulations and Environmental Impact (Forestry) regulations	LULUCF	Regulatory	Implemented	1999
Warm front (In Scotland the Energy assistance package, in Wales nest and in Northern Ireland the warm homes scheme)	Residential	Economic	Implemented	2000
Montreal protocol	Business, Industrial Processes	Regulatory	Implemented	2001
Renewables obligation	Energy Supply	Regulatory, Economic	Implemented	2002
Building Regulations Part L 2002, 2006, including 2005 condensing boiler update along with parallel measures in the devolved administrations	Business, Residential, Public	Regulatory	Implemented	2002
Carbon Trust measures	Business, Public	Information, Education	Implemented	2002
EEC 1 and 2, Original CERT	Residential	Regulatory	Implemented	2002
Salix, public sector loans	Public	Economic	Implemented	2004
Loans to SMEs by the Carbon Trust	Business	Economic	Implemented	2004

[69] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/211907/Progress_towards_targets_2012_provisional_figures.pdf

EU ETS carbon price	Energy Supply, Business, Public, Industrial Processes	Economic	Implemented	2005
Environmental stewardship (entry level schemes and higher level stewardship)	Agriculture	Economic	Implemented	2005
Catchment sensitive farming	Agriculture	Economic, information	Implemented	2006
Large combustion plant directive	Energy Supply, Business, Industrial Processes	Regulatory	Implemented	2007
The Energy Performance of Buildings (Certificates and Inspections) Regulations, along with parallel measures in the devolved administrations	Business, Residential, Public	Regulatory, Information	Implemented	2007
Rural development programme	LULUCF	Economic	Implemented	2007
Additional renewables in generation (renewable energy strategy)	Energy Supply	Regulatory, Economic	Implemented	2009
National products policy (tranche 1 - implemented measures)	Business, Residential, Public	Regulatory	Implemented	2009
Community energy saving programme (CESP)	Residential	Regulatory	Implemented	2009
Low carbon buses	Transport	Economic	Implemented	2009
Soils for profit	Agriculture	Education	Implemented	2009
Landfill tax	Waste	Fiscal	Implemented	2009
Building Regulations Part L 2010 along with parallel measures in the devolved administrations	Business, Residential, Public	Regulatory	Implemented	2010
CRC energy efficiency scheme	Business, Public	Economic, Information	Implemented	2010
English Agriculture sector Greenhouse Gas Action Plan (GHGAP)	Agriculture	Voluntary, Information, Education	Implemented	2010
Renewable Heat Incentive	Business, Residential, Public	Economic	Implemented	2011
Carbon emissions reduction target (CERT) uplift and extension	Residential	Regulatory	Implemented	2011
Local sustainable travel fund	Transport	Economic	Implemented	2011
Woodland carbon code	LULUCF	Economic	Implemented	2011
Revised UK forestry standard	LULUCF	Regulatory, Information	Implemented	2011
Woodfuel implementation plan	LULUCF	Information, Economic	Implemented	2011
EU timber regulations	Forestry	regulatory	implemented	2012
The Green Deal and Energy Company Obligation *	Business, Residential	Economic, Regulatory	Implemented	2012
Car policies (EU new car CO_2 emissions targets: 130 gCO_2/km by 2015 and 95 gCO2/km by 2020; and complementary measures)	Transport	Regulatory, Information, Voluntary/negotiated agreement	Implemented	2012
LGV policies (EU new LGV CO_2 emissions targets: 175g CO_2/km by 2017 and 147 gCO2/km by 2020; and complementary measures)	Transport	Regulatory, Information, Voluntary/negotiated agreement	Adopted	2012
HGV policies (low rolling resistance tyres and industry-led action to improve efficiencies)	Transport	Regulatory, Information, Voluntary/negotiated agreement	Adopted	2012
Carbon price floor	Energy Supply	Economic	Implemented	2013
Green Investment Bank	Finance	Economic	Implemented	2012
Forest law enforcement governance and trade regulations	Forestry	Economic	Implemented	2013
National products policy (tranche 2 - adopted measures)	Business, Residential, Public	Regulatory	Adopted	2013
Climate change agreements (CCA) 2013-23	Business	Economic, Voluntary/ negotiated agreement	Implemented	2013

Rail electrification	Transport	Economic	Implemented	2013
Biofuels policy (8% by energy by 2020)	Transport	Regulatory	Adopted	2013
Nitrates action plan	Agriculture	Regulatory, Information	Implemented	2013
Grown in Britain	LULUCF	Information, Economic	Implemented	2013
Smart metering	Business, Residential	Information	Adopted	2014
Industrial emissions directive (as it applies to large combustion plant)	Energy Supply, Business, Industrial Processes	Regulatory	Adopted	2016
Zero carbon homes	Residential	Regulatory	Adopted	2016
Electricity market reform (CfD and capacity mechanism)	Energy Supply	Economic	Adopted	2017
Carbon capture & storage (CCS) commercialisation competition	Energy Supply	Economic	Implemented	2017
Anaerobic digestion	Waste, Energy			
Non-food crops	Agriculture, Energy			

3.4 Cross-cutting measures

3.4.1 Highlighted cross-cutting measures

Name of mitigation action	Sectors affected	Type of instrument	Status of implementation	Start year of implementation
Building Regulations Part L 2002, 2006, including 2005 condensing boiler update along with parallel measures in the devolved administrations	Business, Residential, Public	Regulatory	Implemented	2002
EU ETS carbon price	Energy Supply, Business, Public, Industrial Processes	Economic	Implemented	2005
The Energy Performance of Buildings (certificates and inspections) Regulations, along with parallel measures in the devolved administrations	Business, Residential, Public	Regulatory, Information	Implemented	2007
National products policy (tranche 1 - implemented measures)	Business, Residential, Public	Regulatory	Implemented	2009
Building Regulations Part L 2010 along with parallel measures in the devolved administrations	Business, Residential, Public	Regulatory	Implemented	2010
National products policy (tranche 2 - adopted measures)	Business, Residential, Public	Regulatory	Adopted	2013

3.4.2 UK Climate Change Act 2008

The UK passed the Climate Change Act in November 2008, introducing the world's first long-term legally binding framework to reduce GHG emissions. The Act is the central piece of legislation that governs the UK approach to tackling climate change.

The Act specifies that the UK must reduce its emissions by at least 80% by 2050 relative to 1990 levels (the international baseline) and by at least 34% by 2020. The Act requires carbon budgets be set providing a framework for meeting our statutory targets by setting a maximum emissions limit over each five-year period.

The Act established the Committee on Climate Change (CCC) – an independent body that advises the government on emissions targets, and reports to Parliament on progress made in reducing GHG emissions.

Post-legislative scrutiny of the Act has begun with a memorandum, sent to the UK Parliament's Energy and Climate Change Committee, which includes an outline of how the provisions in the Act have been brought into operation and a preliminary assessment of the Act. The memorandum was submitted on 4 September 2013.[70]

3.4.3 Carbon budgets

The central part of the Climate Change Act 2008 is the carbon budget framework which defines the emissions pathway to the 2050 target by limiting the total amount of GHG emissions allowed in the UK in each five-year period. Carbon budgets have been set to 2027. By the fourth carbon budget period (2023–27) the UK will have halved emissions relative to 1990.

The government takes into account the advice of the CCC when setting the level of carbon budgets, as well as taking into account a range of matters set out in the Act and representations by the devolved administrations of Scotland, Wales and Northern Ireland.

Figure 40: Projected Performance against the first four carbon budgets ($MtCO_2e$)

	First Carbon Budget (2008–12)	Second Carbon Budget (2013–17)	Third Carbon Budget (2018–22)	Fourth Carbon Budget (2023–27)
Carbon budget levels	3,018	2,782	2,544	1,950
Territorial emissions	2,925	2,607	2,223	2,093
Net UK carbon account	2,964	2,703	2,502	2,165
Uncertainty range	-54 to -54	-114 to -49	-103 to 24	135 to 315

*These values encompass 95% of all possible CO_2 emissions outcomes modelled.

In December 2011, the government published *The Carbon Plan*, which set out proposals for achieving the emissions reductions committed to in the first four carbon budgets, on a pathway consistent with meeting the 2050 target. *The Carbon Plan* sets out three main phases of action:

- **Complete and prepare:** (2011–2020) focus on energy efficiency and preparing for the future through innovation support and building markets.
- **Mass deployment:** (2020s and 2030s) move to large scale deployment of key technologies such as low carbon heating and electric vehicles.
- **Finalising:** (2030 onwards) tackle "harder to decarbonise" sectors such as industry, aviation, shipping and agriculture.

The Carbon Plan sets out four scenarios to show how emissions could be reduced to meet the fourth carbon budget (2023-27).

3.4.4 Energy efficiency

The UK government is committed to realising the energy efficiency opportunity in the UK. Energy efficiency improvements offer one of the most cost-effective ways to reduce the amount of energy we use, and our carbon emissions across the business, residential, public and industrial sectors. Energy efficiency improvements can also save households and businesses money on their energy bills, promote economic growth and enhance business productivity, and revitalise our energy infrastructure.

The UK is committed to building on progress already made on energy efficiency; in 2012 the UK's energy intensity was 39% lower than the G8 average.[71] However, there remains significant untapped cost-effective energy efficiency potential in the UK economy.

[70] https://www.gov.uk/government/publications/memorandum-to-the-energy-and-climate-change-committee-post-legislative-scrutiny-of-the-climate-change-act-2008

[71] DECC Energy Efficiency Statistical Summary (November 2012).

The government's *Energy Efficiency Strategy: the Energy Efficiency Opportunity in the UK,*[72] published in November 2012, estimated that through socially cost-effective investment in energy efficiency the UK could be saving 196 TWh in 2020.[73] Our existing policy package should save the UK 154 TWh in 2020.

The *Energy Efficiency Strategy* identified **four key barriers** to the deployment of cost-effective energy efficiency investments in the UK economy:

Embryonic markets: The UK already has an energy efficiency market but it is small relative to the size of the opportunity. There are significant economic benefits to be realised from growing this market and making energy efficiency a mainstream activity.

Information: There is currently a lack of access to trusted and appropriate energy efficiency information. Where information is available it may be generic and not tailored to specific circumstances, which means that enterprises are not able to fully assess the benefits of an energy efficiency investment.

Misaligned financial incentives: Those investing in energy efficiency measures are not always the ones receiving the direct benefit. For example, the wider benefits of energy efficiency investment, such as improved security of supply and reduced carbon emissions, are not always realised by those making the investment.

Undervaluing energy efficiency: Partly as a result of the lack of trusted information, the long-term benefits of improved energy efficiency are often regarded as less certain. Consequently, energy efficiency is undervalued relative to other investment options and not prioritised as it might otherwise be.

Over the last twelve months, the UK has made good progress towards overcoming these barriers. The introduction of new policies and the simplification of existing ones has resulted in: expanded choice and support for households; simplified and extended support for UK businesses and the public sector; improved access to financing for energy efficiency measures; and improved awareness of the benefits of energy efficiency.

The transposition of the EU Energy Efficiency Directive[74] is a key priority for the government. The Directive aims to put the EU on track to meet its target to reduce primary energy consumption by 20% by 2020. Earlier this year (April 2013), the UK submitted to the European Commission (under Article 3) its non-binding target to achieve a 18% reduction in final energy consumption relative to 2007 Business As Usual projections (equivalent to a 20% reduction in primary energy consumption). The directive must be transposed by 5 June 2014; as government work towards this deadline, it will be working closely with business and other stakeholders to drive the uptake of cost-effective energy efficiency opportunities in a way that minimises administrative costs.

3.4.5 The European Emissions Trading System

The European Emissions Trading System (EU ETS) was established in 2003 by Directive 2003/87/EC and is the largest emissions trading system in the world. In the UK, the system covers 1,000 installations responsible for approximately 50% of the UK's CO_2 emissions. The EU ETS incentivises participants to reduce emissions by placing a cap on total EU GHG emissions from the power and industrial sectors and enabling trading of allowances to ensure emissions reductions are delivered cost efficiently.

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[72] The Energy Efficiency Strategy: The Energy Efficiency Opportunity in the UK, November 2012

[73] TWh means Terawatt hours

[74] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2012:315:0001:0056:EN:PDF

The current phase of the EU ETS (phase III 2013–20) builds upon the previous two phases and is significantly revised to make a greater contribution to tackling climate change including an EU-wide cap on the number of available allowances and an increase in auctioning of those allowances. From 1 January 2012, the EU ETS has also included aviation emissions flying into or out of an EU airport.

The phase III EU cap will reduce the number of available allowances by 1.74% each year, delivering an overall reduction of 21% below 2005 verified emissions by 2020. Many sectors covered by the sectors covered by the EU ETS are provided with free allocation of allowances in order to assist with their transition towards a low carbon economy.

Installations in the EU ETS can meet their obligations by purchasing allowances, which might come from installations in other EU countries, government auctions, or credits from the Kyoto Protocol project mechanisms. This means that the emissions reductions in the EU ETS will not necessarily take place in the UK, nor will they necessarily be CO_2. While DECC lead on designing the policy, the Environment Agency lead on its administration.

3.4.6 Auctioning under the EU ETS

Auctioning is an effective way of distributing allowances to the market and reinforces the 'polluters pay' principle. It encourages businesses to take account of the full cost of carbon in the decisions they make. For phase III at least 50% of allowances will be auctioned across the EU. This includes full auctioning for the power generation sector in the UK and most member states and for all member states by 2020.

The European Commission's Auctioning Regulation governs the auctioning of phase III European Union allowances (EUAs) and European Union aviation allowances (EUAAs). It provides for the establishment of a common EU auction platform and grants member states the right to opt out and set up national platforms – the UK, Germany and Poland exercised this right. The UK's first phase III EUA auction was held on 21 November 2012.

3.4.7 Economic instruments

Market-based solutions to price carbon are at the heart of delivering the UK's climate change objectives at the lowest possible cost, by providing incentives for behaviour that protects or improves the environment, as well as deterring actions that are damaging to the environment. By internalising environmental costs into prices, they help to signal the structural economic changes needed to move to a more sustainable economy. They can provide the right incentives for investment, encouraging innovation and the development of new technology.

The government has pledged to increase the proportion of tax revenue accounted for by environmental taxes. Tax policy will also be developed in the context of wider government levers (such as voluntary agreements and regulation) to avoid overlap of policy instruments and meet the general tests of good taxation.

The government has published a definition of environmental taxes to facilitate effective policy making. These measures work in tandem with other economic instruments, for example the Renewables Obligation and Climate Change Agreements and more traditional regulation and spending programmes. The government also recognises that other taxes not included within its definition can deliver environmental benefits. Transport taxes, whose aim is predominantly revenue raising, also have a role in reducing harmful emissions and signalling fuel-efficient choices, while continuing to raise revenue to fund public services. For example, since 2001 reforms to Vehicle Excise Duty and Company Car Tax have incentivised the purchase of lower-carbon vehicles.

3.4.8 Building regulations (energy efficiency)

Around 45% (27% from dwellings and 18% from non-domestic buildings) of UK CO_2 emissions come from buildings, principally space heating and cooling, water heating, lighting and other fixed building systems – energy uses that are covered by building regulations. These regulations are devolved in all four UK administrations, with a similar agenda being pursued across the UK in response to the need to reduce emissions arising from the built environment. This is achieved though minimum performance standards applicable to new buildings and when new work is carried out to existing buildings.

3.4.8.1 England

The government has announced that from 2016 all new homes, and from 2019 all new non-domestic buildings, in England will be built to zero-carbon standards. The 2013 Budget document reaffirmed its commitment to implementing 'zero-carbon homes' from 2016.

Building Regulations Part L, which sets limits on the emissions of new buildings, is expected to be used to achieve the onsite elements of these zero-carbon standards.

3.4.8.2 Wales

Following a review of Part L of the building regulations (Conservation of Fuel and Power) reductions in CO_2 emissions of new housing and non-domestic buildings were announced in September 2013. Improvements in energy performance to existing buildings where renovation and extension is taking place were also announced.

The revised building regulations, intended to be made in December 2013, will require new buildings to achieve an 8% reduction (domestic) or 20% reduction (non-domestic) in CO_2 emissions in comparison to Part L 2010 standards.

From June 2014, developers and designers will have to demonstrate that they have met the new requirements which are intended as a step towards delivering EU obligations to achieve 'nearly zero-energy' by 2019 for the public sector and 2021 for all new buildings.

3.4.8.3 Scotland

Energy standards within building regulations in Scotland were reviewed and improved in 2002, 2007 and, most recently, 2010. New homes constructed to current standards produce approximately 70% less GHG emissions than those built to the standards applicable in 1990.

In September 2013, following consultation,[75] Scottish ministers announced that further improvements to energy standards within building regulations would be introduced in October 2015.[76] These will reduce emissions from new homes by approximately 21% and for new non-domestic buildings by around 43%, when compared to standards introduced in October 2010.

Further review of standards is planned and ministers recently reconvened the Sullivan Report Panel[77] to consider a range of issues relevant to review of energy standards beyond 2014. This follows the Panel's original 2007 report – *'A Low Carbon Building Standards Strategy For Scotland'* – which has informed the review process in recent years.

In 2011 building regulations introduced sustainability labelling. The system awards new dwellings that meet the current building standards with a bronze level label, further optional upper levels are defined by silver gold and platinum. These address topics including resource use (CO_2 emissions and energy efficiency), building flexibility and adaptability, and occupant well-being.

[75] http://www.scotland.gov.uk/Publications/2013/01/4018

[76] http://news.scotland.gov.uk/News/Drive-for-greener-buildings-483.aspx

[77] http://www.scotland.gov.uk/sullivanreport

3.4.8.4 Northern Ireland

The Buildings Regulations (Northern Ireland) 2012 came into operation on 31 October 2012. These included enhanced thermal standards for all new buildings and those undergoing major renovation in the progression towards low or zero-carbon buildings.

3.4.9 Energy performance of buildings directive

The Energy Performance of Buildings directive, 2002/91/EC, was recast in 2010 as directive 2010/31/EU. The UK updated and amended legislation accordingly from 9 January 2013. The recast strengthened the original directive, giving the public sector a lead role in improving the energy efficiency of its building stock. Key additional provisions in the recast directive include:

- minimum energy performance requirements to achieve cost-optimal levels
- energy use of technical building systems (heating, hot water, air-conditioning and large ventilation systems) to be optimised to specified requirements
- nearly zero-energy buildings target dates
- property advertisements to include the energy performance certificate (EPC) performance indicator
- EPC content to be more specific to the particular building
- EPCs to be displayed in buildings larger than 500 m^2 (previously 1,000 m^2) occupied by a public authority and frequently visited by the public. This threshold will fall to 250 m^2 in 2015
- EPCs to be displayed in commercial premises larger than 500 m^2 frequently visited by the public, where an EPC has previously been issued
- a statistically significant percentage of EPCs and air conditioning reports to be checked by independent experts for quality assurance.

In the UK, advice has been developed in partnership with the Carbon Trust and EST.

Legislation to introduce inspections for air-conditioning systems (Directive Article 9) was introduced in May 2007 and updated in January 2013. Air-conditioning inspections assess the efficiency and sizing of the system compared to the cooling requirements of the building, and promote the improvement of the energy performance of buildings.

3.5 Energy supply

3.5.1 Highlighted energy supply policies and measures

Name of mitigation action	Sectors affected	Type of instrument	Status of implementation	Start year of implementation
Renewables obligation	Energy Supply	Regulatory, Economic	Implemented	2002
Additional renewables in generation (renewable energy strategy)	Energy Supply	Regulatory, Economic	Implemented	2009
Renewable heat incentive	Business, Residential, Public	Economic	Implemented	2011
Carbon price floor	Energy Supply	Economic	Implemented	2013
Electricity market reform (CfD and capacity mechanism)	Energy Supply	Economic	Adopted	2017
Carbon capture & storage (CCS) commercialisation competition	Energy Supply	Economic	Implemented	2017

3.5.2 Policy framework

The government has set three clear priorities in delivering the UK's energy policies:

- helping households and businesses take control of their energy bills and keep their costs down
- unlocking investment in the UK's energy infrastructure that will support economic growth
- playing a leading role in efforts to secure international action to reduce GHG emissions and tackle climate change.

3.5.3 Carbon price floor

The carbon price floor (CPF) is a tax on fossil fuels used to generate electricity. It came into effect on 1 April 2013. It changes the existing climate change levy (CCL) regime, by applying carbon price support (CPS) rates of CCL to gas, solid fuels and liquefied petroleum gas (LPG) used in electricity generation.

A minimum carbon price sends an early and credible signal to incentivise billions of pounds of investment in low-carbon electricity generation now by providing certainty on the carbon price for UK electricity generation and helps ensure the UK's long-term energy security.

The CPF as announced in Budget 2011 begins at around £16/tCO_2 in 2013 and follows a straight line increase to £30/tCO_2 in 2020, rising to £70/tCO_2 in 2030 (real 2009 prices).

The carbon price support (CPS) uses rates for CCL and fuel duty to make up the price floor and reflect the differential between the future market price of carbon (i.e. the EU ETS futures prices) and the CPF trajectory. Each year the Budget will announce and the Finance Bill legislate for the rates two years ahead to provide certainty to the market. In addition, government will set out the provisional rates for the following two years to give an indication of the likely rates required to meet the floor.

Table 13: Carbon price

CPS rates	Confirmed rates			Indicative rates	
	2013-14	2014-15	2015-16	2016-17	2017-18
Carbon price equivalent (£ per tCO_2)	4.94	9.55	18.08	21.20	24.62

Source: http://www.hmrc.gov.uk/budget2013/tiin-1006.pdf

This is a fiscal policy for which HMT are the leading government department.

3.5.4 Electricity Market Reform

The UK government is reforming the electricity market to attract investment in low carbon electricity generation while maintaining security of supply and minimising consumer bills. Electricity Market Reform (EMR) provides support for low carbon technologies in the short to medium term, working towards a long term vision of a competitive market where all technologies participate on a level playing field without direct financial support.

The government published its White Paper on EMR, *Planning our electric future: a White Paper for secure, affordable and low-carbon electricity* on 12 July 2011. This set out the government's commitment to transform the UK's electricity system to ensure that our future electricity supply is secure, low carbon and affordable. The White Paper was informed by previous recommendations made by the CCC. The key elements of EMR are:

- Contracts for difference (CfDs) to stimulate investment in low carbon technologies by providing predictable revenue streams that encourage investment and make it easier and cheaper to secure finance.
- Capacity market to ensure security of supply.
- Carbon price floor to provide a clear economic signal to drive the move towards a low carbon economy by increasing the cost of emitting CO_2.
- Emissions performance standard (EPS) to provide a regulatory backstop to prevent the construction of the most carbon intensive forms of electricity generation, such as unabated coal fired power stations.

The government is currently consulting on detailed proposals to implement EMR. Updated CfD contract terms and strike prices for renewable technologies, and the *EMR Delivery Plan* were published in December 2013. The government is on track to deliver EMR in 2014: The first CfDs under the enduring regime are expected to be signed in the latter half of 2014; and the first capacity auction is expected to be run in 2014, for delivery of capacity in winter 2018-2019 (subject to state aid approval).

3.5.5 Renewables obligation

The renewables obligation (RO) is currently the main mechanism for supporting large-scale renewable electricity projects in the UK. It is a market-based support mechanism and works by placing an obligation on licensed electricity suppliers (the biggest contributors of carbon into the atmosphere) to source a specified and annually increasing proportion of their electricity sales from renewable sources, or pay a penalty.

The RO is administered by Ofgem which issues tradable Renewables Obligation Certificates (ROCs) to renewable electricity generators relating to the amount of eligible renewable electricity they generate. Suppliers can meet their obligation either by acquiring ROCs or by paying a buy-out price, set at £42.02 per ROC for 2013/14 (linked to RPI), or by a combination of both. Money paid into the buy-out fund is recycled to ROC holders at the end of the 12-month Obligation period on a pro rata basis. The level of the obligation for 2013/14 in England, Wales and Scotland is 0.206 ROCs/MWh and 0.097 ROCs/MWh in Northern Ireland.

The most significant reform of the RO since its establishment was the introduction of banding in April 2009, that moved the RO from a mechanism which offered a single level of support for all renewable technologies to one where support levels vary by technology according to a number of factors, including their costs and level of potential deployment. As part of the operation of the banding mechanism, the support levels are subject to periodic reviews every four years, to allow adjustments of the support level and to reflect the evolution of costs and revenues.

A review took place between 2010 and 2012, and set the support levels for 2013–17, for new developments and capacity added to existing generating stations accredited under the RO during this period. This support package balances growth and affordability, providing reassurance to investors and value for money for consumers. The RO has helped to support the £31 billion of investment in renewable generation announced since 2010 and will help to drive growth and support jobs across the renewables sector in the future.

These support levels will ensure continuity of support as we transition towards the new Contracts for difference (CfDs). The RO will operate in parallel to CfDs during the transition towards RO closure to new generation in April 2017. Thereafter it will provide grandfathered support (for 20 years from the date of accreditation) for the generating capacity that is accredited under the RO before this date. The RO scheme will end in 2037.

Since its introduction in 2002, the RO has helped in tripling the level of renewable electricity (from 2.9% of total UK generation to 11.3% in 2012). In March 2012 total capacity under the RO was almost 12,500 MW, with over 30 TWh of renewable generation, and a saving of 15.1 $MtCO_2e$. It is estimated that the RO was worth around £2 billion in support to the renewable electricity industry in 2012/13.

3.5.6 Energy transmission

Investment in the electricity transmission and distribution networks is a key part of meeting the UK's renewable energy and climate change goals.

The independent regulator, Ofgem, has agreed up to £21.5 billion of funding for Great Britain's onshore transmission network under the RIIO-T1 electricity transmission price control that sets out funding for transmission owner activities, including investment in new and replacement assets. RIIO-T1 started in April 2013 and runs until 2021 and will help ensure that new generation can be accommodated in a timely and cost effective manner while maintaining network security and reliability.

The innovative regulatory regime for offshore transmission, jointly developed by the government and Ofgem, has been established. There have now been eight Offshore Transmission Owner licences granted by Ofgem under the regime, securing over £1 billion of investment in offshore transmission, with a further four preferred bidders also appointed by Ofgem.

The government's enduring 'Connect and Manage' regime was established in August 2010 and has significantly reduced grid connection timescales for new generation projects. Under Connect and Manage, 163 large generation projects (total capacity of 36.5 GW) have seen their connection times reduced by an average of five years. Of these, 155 projects (31.5 GW) are renewable. A further 128 small scale renewable generators have also benefited.

In 2010 Ofgem approved £14 billion of funding for distribution network operators' (DNOs) activities for the 2010–2015 price control. The DNO role is vital for the delivery of smaller-scale renewable projects. DNOs submitted their business plans for the 2015–2023 price control to Ofgem in July 2013 and have requested around £29 billion of funding for their proposed activities. The final funding will need to be agreed by Ofgem and the DNOs, with the price control starting in April 2015.

3.5.7 Biomass heat

Solid and gaseous biomass have huge potential to deliver significant and cost-effective carbon savings when substituting fossil fuels in the short-to medium-term particularly in commercial and industrial applications. In 2012, biomass provided 1% of the total energy needs for heating across the economy. By 2020, biomass could deliver 30–35 TWh, representing around 6% of the total energy needs of heating.

Solid and gaseous biomass typically deliver high GHG savings, particularly when used in heat generation.

Biomass and biogas combustion in installations below 200 kilowatts thermal (kWth) and biomethane injection are eligible for support under the Renewable Heat Incentive (RHI). Biomass generators of 1 MWth and above, together with producers of biomethane, are required to report to Ofgem on the sustainability of their biomass feedstock at the end of each year.

It is important that encouraging the uptake of bioenergy does not result in untoward environmental and social impacts and this has been a guiding principle in devising the UK government's policy approach. The UK government is introducing similar biomass sustainability criteria (cultivation, harvesting, processing and transport, including shipping if used) to the RHI as those in the Renewables Obligation. These criteria will consist of a target GHG lifecycle emissions saving for the resulting biomass heat of 60% compared to fossil fuel use, and land criteria to protect land such as primary forest with high biodiversity or high carbon stock value. The government intends to introduce the GHG criteria in April 2014 and the land criteria in April 2015.

Our intention is that whether the biomass is from the UK, the EU, North America or from further afield, the resulting bioenergy delivers genuine GHG savings, and deforestation or environmental degradation is prevented.

As at end October 2013, the non-domestic RHI was supporting 1,659 biomass boiler installations, representing 472 GWh of renewable heat generated.

3.5.8 Combined heat and power

Combined heat and power (CHP) is supported by a range of policies depending on size, fuel type and sector. Support for electricity exported by fossil fuel, CHP to the transmission grid in the form of Levy Exemption Certificates has been withdrawn with effect from 1 April 2013 on the grounds that this policy was administratively complex and poor value for money for the taxpayer. However, CHP remains exempt from Climate Change Levy on fuel consumed (an incentive relative to fossil fuel fired boilers) and on electrical output consumed onsite. Modelling suggests economic potential for up to 18 GW of CHP capacity in the UK, well in excess of the current 6.1 GW of good quality CHP capacity in the UK. However, high project hurdle rates and, for smaller plant, accessing the wholesale price for electricity exported are barriers to significant growth in capacity. For these reasons the government committed in *The Future of Heating: Meeting the challenge* to develop a bespoke policy to support deployment of new, good quality natural gas fired CHP, subject to further work to examine how this capacity will interact with the electricity market, in order to confirm that generation from lower carbon sources will not be displaced. This policy will supplement other existing forms of support for CHP and will to some extent replace support via Levy Exemption Certificates although the policy mechanism is likely to be quite different. Under the carbon price floor CHP below 2 MW capacity is exempt from carbon price support costs and CHP above 2MW is subject to relief on carbon price support costs according to its heat output.

Biomass CHP is currently still eligible for support via an 'uplift' in the number of Renewable Obligation Certificates per MWh of electricity generated compared to biomass power-only plant. Availability of this support will close to new plant from 1st April 2015. It is proposed that new biomass CHP commissioned after this date will be eligible for a Renewable Heat Incentive tariff on its heat output and support on electrical output via Renewable Obligation certificates or a Contract for Difference strike price. This will more directly focus support on the two outputs of the plant and encourage plant that operate at higher heat power ratios and overall efficiencies.

3.5.9 Microgeneration

Since 2009 the UK government has continued to make progress on microgeneration and decentralised energy.

The Low Carbon Buildings Programme (LCBP) was closed to new applications in May 2010 and completed payments in March 2011. The LCBP offered grants towards the cost of installing domestic microgeneration technologies and larger-scale distributed generation installations for public buildings and businesses, subject to energy conservation standards being met.

The programme supported 19,216 installations at a cost of £91.37 million. A report on the programme has been produced.[78]

In June 2011 the UK government published a new microgeneration strategy, which set out a number of actions to tackle non-financial barriers. In particular it addressed the quality of installations, skills, technology development and information/advice. It set out the vision of 'microgeneration becoming an everyday technology used in homes and businesses' helping to reduce carbon emissions. Industry was actively involved in the development of the strategy and participated in the implementation process. An interim report was published in July 2012[79] and the final report published at the end of October.[80]

The government has continued the development of the Microgeneration Certification Scheme (MCS) making it more accessible to people working in related professions – such as heating engineers and plumbers – so that they can qualify to install microgeneration. The MCS installation standards have been strengthened. New guidance for solar PV installers has been published and substantially revised the heat pump installation standard to improve the design and sizing of heat pumps, based in part on learning from extensive heat pump field trials.

In line with the Renewable Energy Sources Directive, the government developed the national competence requirements framework for microgeneration technologies, derived from the National Occupational Standards. Working through the sector skills councils the UK now have qualifications in place for microgeneration technologies that are included in the national Qualification Credit Framework (QCF). QCF is competence based which means they reflect the knowledge and skills needed by operatives to attain and demonstrate occupational competence relevant to the sector.

The Welsh government has also been supporting microgeneration at a community level through the *Ynni'r Fro* community renewables scheme. This five-year scheme provides technical development officer support and preparatory grants to enable communities to get schemes to the construction stage. Loans are also available to support construction. The scheme has worked with nearly 200 community groups, and there are currently more than twenty schemes receiving comprehensive support, which are approaching the construction stage. The scheme is currently being evaluated in order to inform development of a successor scheme.

Scotland published its own microgeneration strategy in June 2012, setting out support for microgeneration and its ambitions for the sector. It showcases what has been achieved by national and local government, industry, communities, householders, the skills sector and other stakeholders across Scotland to grow the market for microgeneration.[81]

In Scotland, many small-scale on site household energy technologies such as solar/PV or ground source heat pumps have benefitted from permitted development rights since 2009, removing the need to apply for planning consent in order to install them. Limited permitted development rights for domestic air source heat pumps (ASHPs) and Micro-wind were introduced in March 2010. permitted development rights for the non-domestic sector[82] were introduced in March 2011.

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78 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48160/2578-lcb-programme-2006-11-final-report.pdf

79 https://www.gov.uk/government/publications/microgeneration-strategy-industry-action-plan-interim-report

80 Further information is available in the Microgeneration Strategy document.

81 http://www.scotland.gov.uk/Publications/2012/06/9678/2

82 http://www.scotland.gov.uk/Topics/Built-Environment/planning/National-Planning-Policy/themes/renewables/Microgeneration

3.5.10 Feed-in tariffs

The Feed-in tariffs (FITs) scheme was introduced on 1 April 2010, under powers in the Energy Act 2008. The intention of the FITs scheme is to encourage deployment of small-scale (up to 5MW), low-carbon electricity generation, particularly by organisations, businesses, communities and individuals that have not traditionally engaged in the electricity market. The technologies supported under FITs are solar PV, wind, hydro, anaerobic digestion and micro (less than 2 kW) CHP.

The person investing in a renewable energy installation, such as solar PV panels, can benefit from FITs in three ways: a payment for every unit of electricity generated – the 'generation tariff'; a payment for any surplus electricity not used on site, and exported to the local grid – the 'export tariff'; and savings on the electricity bill for each unit used in the property. The return on investment is calculated at between 4.5 and 8% per annum over the 20 year duration of the FITs payments. The FITs scheme is administered by Ofgem and the payments are made to generators by the FITs suppliers, who recover the costs through the electricity bills of their customers.

The scheme has been a success since its launch in April 2010, with over 470,000 installations (2.2 GW capacity) registered on either the Central Feed-in Tariff Register (CFR) or the Microgeneration Certification Scheme (MCS) by the end of August 2013. Of these, around 99% are solar PV installations.

3.5.11 Carbon abatement technologies

The focus of the UK government's approach on carbon abatement technologies is the development of carbon capture and storage (CCS). CCS is a chain of technologies designed to remove the CO_2 from power and industrial sources and transport it for safe permanent storage in saline aquifers or depleted oil and gas fields. It is the only approach that has the potential to turn high carbon fuels into genuinely low carbon electricity and to decarbonise many industrial activities.

The UK government believes CCS could play a significant role in low carbon electricity generation, as well as decarbonising energy intensive industry. To encourage this, the government has developed a comprehensive package of measures designed to help the industry develop to be competitive with other low carbon technologies in the 2020s. Details of this approach were set out in the *CCS Roadmap,*[83] published in April 2012.

The five key components outlined in the roadmap are:

- The CCS Commercialisation Programme ('The Competition'), designed to bring forward the first phase of commercial scale projects, with £1 billion in capital funding and additional operational support available through low carbon Contracts for Difference.
- A £125 million, four-year, co-ordinated R&D and innovation programme and a new UK CCS Research Centre.
- Development of a market for low carbon electricity through Electricity Market Reform, including availability of Contracts for Difference to encourage investment and provide a route to market for the second and subsequent phases of CCS deployment.
- Commitments to working with industry to address other important areas including developing the CCS supply chain, storage and assisting the development of CCS infrastructure.
- International engagement focused on sharing knowledge generated through the UK programme and learning from other projects around the world. The government is

[83] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48317/4899-the-ccs-roadmap.pdf

also now looking at the potential role that enhanced oil recovery could play in the development of some CCS projects.

The UK's CCS Commercialisation Programme is progressing well. The £1 billion CCS Competition attracted eight projects and these have been shortlisted to two preferred bidders:

- Peterhead Project in Aberdeenshire, Scotland – a project which involves capturing 85% of the CO_2 from part of the existing gas fired power station at Peterhead before transporting it and storing it in a depleted gas field beneath the North Sea. The project involves Shell and Scottish and Southern Energy.
- White Rose Project in Yorkshire, England – a project that involves capturing 90% of the CO_2 from a new super-efficient coal-fired power station at the Drax site in North Yorkshire, before transporting and storing it in a saline aquifer beneath the southern North Sea. The project involves Alstom, Drax Power, BOC and National Grid.

The UK government is currently negotiating contracts for detailed front end engineering and design (FEED) studies with these bidders. These FEED studies will inform final investment decisions, expected to take place in 2015. The White Rose project has also been put forward for funding through the European Commission's NER300 programme, the only project in Europe to do so.

The government is committed to building the UK's world-class CCS research base and together with our partners we are delivering a £125 million CCS Research and Development Programme, supporting around 100 separate projects – full details of which can be found on our website.[84]

The government has also been working closely with industry to address the issue of cost – one of the fundamental factors influencing deployment levels of CCS – by convening a CCS Cost Reduction Task Force.[85] The task force found that CCS has potential to be cost competitive with other low carbon technologies by the early 2020s and provided a series of recommendations on how to achieve this. These are now being taken forward by industry and government as set out in the government's response to the task force published in October 2013.[86]

3.5.12 Hydrogen

Hydrogen is an energy carrier (like electricity) which has the potential to link energy generation, transport, heat, electricity grid balancing and energy storage. Improved energy system modelling is needed so that the potential benefits can be properly evaluated.

UK activities on hydrogen include support for innovation across the spectrum from basic research, through to development and demonstration, as well as a specific programme on hydrogen transport (UK H2Mobility). The UK also participates in international activities, including the International Partnership for Hydrogen and Fuel Cells in the Economy (IPHE), the IEA Hydrogen Implementing Agreement, and the (European) Fuel Cells and Hydrogen Joint Undertaking. The Transport section has further information.

3.5.13 Energy Wales

The Welsh government's strategy, *Energy Wales: A Low Carbon Transition* sets out the intent to drive the change to a sustainable, low carbon economy for Wales.

'Energy Wales' recognises that whilst issues such as climate change are challenges, they also present opportunities to generate investment into Wales, increase the resilience of its communities, address fuel poverty and create a greater awareness of the choices facing the country.

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84 https://www.gov.uk/government/publications/cross-government-carbon-capture-and-storage-r-d-programme-2011-2015-list-of-projects

85 https://www.gov.uk/government/publications/ccs-cost-reduction-task-force-final-report

86 https://www.gov.uk/government/policy-advisory-groups/ccs-cost-reduction-task-force

The Welsh government is leading the transition by focusing on the removal of barriers to investment and maximising the long term benefits to Wales at every stage along the way including developing changes to its planning regimes to streamline the process.

The Welsh government is also carefully planning and managing the relationship between energy developments and our natural environment in line with the ambition of *Sustaining a Living Wales*. This includes engaging with National Grid to mitigate the impact of new transmission infrastructure.

3.5.14 Northern Ireland's Strategic Energy Framework

Northern Ireland's Strategic Energy Framework has set a target of 40% of electricity consumption to be met from renewables by 2020. An interim target of 20% by 2015 is included in the Programme for Government 2011-2015. In 2012, renewables represented approximately 13% of electricity consumption, mainly from onshore wind. Offshore renewables can also make a contribution to the 40% target and in October 2012, the Crown Estate announced the award of development rights for a 600MW offshore wind project off the County Down coast and two 100MW tidal energy projects off the North Antrim coast.

3.6 Business

3.6.1 Highlighted business policies and measures

Name of mitigation action	Sectors affected	Type of instrument	Status of implementation	Start year of implementation
Montreal protocol	Business, Industrial Processes	Regulatory	Implemented	2001
Carbon trust measures	Business, Public	Information, Education	Implemented	2002
Loans to SMEs by the Carbon Trust	Business	Economic	Implemented	2004
Large combustion plant directive	Energy Supply, Business, Industrial Processes	Regulatory	Implemented	2007
CRC energy efficiency scheme	Business, Public	Economic, Information	Implemented	2010
Green Investment Bank	Finance	Economic	Implemented	2012
Climate change agreements (CCA) 2013-23	Business	Economic, Voluntary/ negotiated agreement	Implemented	2013
Industrial Emissions Directive (as it applies to large combustion plant)	Energy Supply, Business, Industrial Processes	Regulatory	Adopted	2016

3.6.2 Framework for action

It is essential for business that the policy framework is clear, flexible and non-prescriptive. The government has put in place a range of instruments that cover economic instruments, regulation, market improvement measures and access to information.

Businesses are an essential component in delivering climate change objectives in all sectors and in particular energy efficiency objectives.

3.6.3 CRC energy efficiency scheme

The CRC Energy Efficiency Scheme, launched in April 2010, is a UK-wide mandatory emissions trading scheme covering 2,000 large users of energy across the business and public sector. They are responsible for approximately 10% of UK CO_2 emissions (based on 2011-12 data). The CRC has been designed to complement existing policy by covering emissions outside CCAs (see below) and direct emissions outside the EU ETS. Analysis indicates that, by driving energy efficiency, the CRC will deliver emissions reductions cost-effectively while saving participants money. It is estimated that CRC will bring £1 billion energy savings to participants by 2020.

The CRC aims to improve energy efficiency and cut emissions in the targeted large public and private sector organisations. It is a tailored blend of three drivers:

1. Information – awareness of energy use (it requires participating organisations to report on their energy usage);
2. Reputational – organisations' aggregated emissions data are published annually; and,
3. Financial – organisations must buy allowances for the emissions from their energy use.

The CRC scheme is projected to deliver carbon reductions of at least 16 $MtCO_2$ by 2027 – the end of the fourth carbon budget. The sale of allowances, which will cost participants around £16/tCO_2 from April 2014 delivers around £700 million per annum to the UK government, forecast to increase to around £1 billion per annum from 2016.

DECC is, in partnership with the Devolved Administrations (Scotland, Wales and Northern Ireland), the government policy lead. The Environment Agency is the UK Scheme Administrator and responsible for auditing and enforcement of the scheme in England. The devolved administrations' regulators, the Scottish Environment Protection Agency (SEPA), Natural Resources Wales (NRW) and Northern Ireland Environment Agency (NIEA), are responsible for auditing and enforcement in their countries. The UK Treasury (HMT) is responsible for setting the allowance price for the scheme.

3.6.4 Non-domestic Green Deal and energy efficiency

Non-domestic Green Deal finance, allows for qualifying energy efficiency improvements to be paid for overtime through instalments on a customer's electricity bill. It is intended to contribute to the reduction of those GHGs associated with building level energy consumption. Repayments should be the same or less than the expected savings generated as a result of the improvements. The domestic section has further information on the domestic Green Deal.

At the beginning of 2013 the government established the legal framework for the domestic and non-domestic Green Deal. The UK government expects that the non-domestic Green Deal market will take longer than the domestic market to develop. Government is running a Green Deal Communities[87] scheme where local authorities, working with their partners, can apply for funds of between £1 million and £3 million to help drive Green Deal energy efficiency improvements in their area. The UK government have indicated our interest in applications for the Green Deal Communities scheme involving non-domestic properties to further explore the application and benefits of the non-domestic Green Deal.

The framework for the non-domestic Green Deal has been established by central government. However it is market participants that offer the services and the finance for the scheme. Such participants must meet specified standards as set out by government.[88]

3.6.5 Climate Change Levy (CCL) and Climate Change Agreements (CCA)

The Climate Change Levy (CCL) and Climate Change Agreements (CCA) were described in detail in the third National Communication. The levy is a tax on the use of energy in industry, commerce and the public sector and has been a central policy in encouraging energy efficiency. Climate Change Agreements (CCAs) are part of a package of government measures aimed at encouraging UK business to save energy and reduce CO_2 emissions. They set the terms under

[87] https://www.gov.uk/government/news/green-deal-communities

[88] Paragraphs 31 – 36 of the Green Deal Impact Assessment expected impacts of the non-domestic Green Deal for different scenarios https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48196/3223-EA2011-green-deal-impact-assessment.pdf

which eligible energy-intensive industries can claim up to 90% discount on the CCL, provided they meet targets for improving their energy efficiency or reducing their carbon emissions.

DECC has recognised the need to give special consideration to energy-intensive industries with regards to climate change, given their energy use and their need to compete internationally. Consequently, energy-intensive industries can obtain up to 90% discount from the CCL, provided they meet challenging targets for improving their energy efficiency or reducing their carbon emissions. Through this scheme government is supporting industry to implement energy efficiency measures that will help reduce the impact of rising energy prices.

In Budget 2011 government announced the extension of CCAs to 2023. CCAs provide energy intensive industries with tax discounts (worth £170 million a year) in return for committing to improve energy efficiency.

From the start of the new CCA scheme (1 April 2013), the Climate Change Levy discount on electricity increased from 65% to 90%. Facilities with over 70% of their energy use claimed under the eligible CCA installation will claim the entire site for Climate Change Levy discount.

The new scheme's sector energy efficiency improvement targets (to 2020) have now been set. The target setting process include bilateral discussions with industry to ensure targets were challenging yet realistic in the current and projected economic climate.

3.6.6 Business carbon reduction support

The UK has established a number of support companies focussed on helping businesses and governments accelerate the move to a sustainable, low carbon economy. The Carbon Trust and the Energy Savings Trust are two of the most successful independent companies developing services for carbon footprinting emission reduction expertise, and developing, commercialising and deploying innovative low carbon technologies and solutions, from energy efficiency to renewable power. These companies, through the support from UK and regional government have helped champion energy efficiency and carbon reduction in businesses and government operations. DECC presently funds the Carbon Trust to deliver three schemes, including a large collaborative programme with the offshore wind industry. DECC and the UK's regional governments also provide funding to the EST to provide support to SMEs to gain accreditation to the Microgeneration Certification Scheme. In addition, interest free loans for investment in carbon reduction infrastructure are available, managed by Salix Finance.

The Welsh government is developing a future range of services and is introducing a new delivery model from April 2015. The revised and simplified service will provide resource efficiency support to a range of audiences through existing advice services such as Business Wales and Farming Connect, and through a single contact number for the remaining domestic, community and public sector audiences.

The Scottish government is committed to improving energy and resource efficiency across business and public sector and to continuing sustainable economic growth for Scotland. From 1 April 2013, the Scottish government simplified and streamlined the energy and resource efficiency advice and support delivery landscape. This was done through the integration of previous non domestic energy and material resource efficiency services provided by Zero Waste Scotland, Carbon Trust and EST into one holistic programme of activity.

The new Resource Efficient Scotland programme offers comprehensive information, advice and support to business, the third sector and public sector organisations to implement energy, material resource and water efficiency measures that will translate into cost savings, increased competitiveness and reduced emissions.

Resource Efficient Scotland provides a degree of assistance to businesses of all sizes, but has a particular focus on SMEs.

3.6.7 Non-domestic renewable heat incentive

The Non-Domestic Renewable Heat Incentive (RHI) provides subsidy, payable for 20 years, to eligible non-domestic renewable heat generators based in England, Scotland and Wales. The first scheme of its kind in the world, the technologies supported are: biomass, biogas combustion, biomethane injection to the grid, ground-, water-source and air-water heat pumps, solar thermal, and commercial and industrial energy from waste.

The non-domestic sector includes industrial, commercial, public sector and not-for-profit organisations – e.g. businesses, hospitals and schools, and district heating schemes. The scheme is also open to producers of biomethane.

The scheme was introduced in November 2011. The following emissions limits came into effect on 24 September 2013:

- a maximum of 30 grams particulate matter can be emitted per gigajoule (GJ) net rated thermal input from the biomass installation;
- a maximum limit of 150g/GJ for nitrous oxide.

These limits apply to all solid biomass installations participating in the RHI, including combined heat and power (CHP) installations which burn biomass.

In autumn 2012, government consulted on proposals to extend the scheme and in spring 2013 on proposals to amend some of the tariff levels. government intends to introduce any changes resulting from this process in spring 2014.

As at the end of October 2013, there were 2,657 accreditations to the scheme, representing nearly 547 MW of installed capacity. The 1,776 installations that had received RHI support had generated 497 GWh of renewable heat.

The scheme is implemented and administered by Ofgem. According to Ofgem's public reports as of 27 November 2013, nearly £26 million in tariff payments had been made. government estimates that payments associated with 2012-13 will total £27m, once all applications have been accredited.

The scheme helps to strengthen security of energy supply by increasing diversification of heating technologies and sources, and reducing dependence on imports. It also supports emerging technologies and businesses in the UK.

A separate RHI operates in Northern Ireland and was introduced on 1 November 2012. The scheme is largely similar to the Great Britain RHI, however, has differing tariff levels designed specifically for the Northern Ireland market.

3.6.8 Building regulations (energy efficiency)

Around 18% of UK CO_2 emissions come from non-domestic buildings, principally space heating and cooling, water heating, lighting and other fixed building systems – energy uses which are covered by building regulations. These are described in more detail in the cross cutting section.

3.6.9 EC Regulation 842/2006 on Certain Fluorinated Greenhouse Gases

Fluorinated greenhouse gases (F gases) are covered by the Kyoto Protocol and have high global warming potential. They are widely used in commercial refrigeration and air-conditioning systems and other more specialised uses, such as in insulation foams, electrical equipment, aerosol sprays, fire protection systems and as solvents. Emissions of these gases amounted to just under 2% of UK GHG emissions in 2012. European regulations to address emissions of F gases entered into force in May 2006 with the main provisions taking effect from July 2007. They have been fully implemented by supporting GB Regulations coming into force in March 2008. The focus is on containment during use including minimum training and certification requirements for companies and personnel, but also includes some very limited and specific use bans.

UK F gas emissions are projected under the current regulatory regime to fall to 50% of 1990 CO_2e levels by 2030. However, a comprehensive European Commission review of the current F gas regulatory regime concluded it is unlikely there will be any overall reduction in total F gas emissions across Europe as a whole unless further measures are implemented. Further measures would also enable the UK to achieve reductions in F gas emissions significantly beyond 50% of 1990 levels by 2030. The European Commission has therefore proposed further controls that are intended, in concert with strengthened provisions of the existing regulations, to achieve real reductions in emissions of F gases across Europe.

The core new elements of the Commission's proposal are a phase down in EU market availability of hydrofluorocarbons (HFCs) the most widely used of the F gases, alongside a number of specific use bans. The UK is currently considering the European Commission's proposals with other EU member states with a view, if agreement can be reached, to introducing new EU measures on F gases in 2015 or as soon as possible thereafter.

Additionally, HCFCs represent the largest remaining use of Ozone Depleting Substances. The use of HCFCs in new equipment was banned in 2001. From 1 January 2015, the use of HCFCs to service existing equipment will be prohibited. In the UK the Environmental Protection (Controls on Ozone-Depleting Substances) Regulations 2011 (SI 2011/1543) enforces EU Regulation (EC) 1005/2009 and meet UK obligations under the Montreal Protocol.

3.6.10 The large combustion plant directive

The Large Combustion Plant Directive (LCPD, 2001/80/EC) sets limits on emissions of sulphur dioxide, nitrogen oxides, and dust from combustion plants with a thermal capacity of 50 MW or greater. In the UK, some 100 plants have taken the option to participate in a National Emissions Reduction Plan in which each receives a transferrable annual mass emission allowance. A few others took the option of not being bound by the Directive's emission limits subject to undertaking to operate for no more than 20,000 hours after 1 January 2008 and to close by 31 December 2015.

The LCPD will be replaced from 1 January 2016 by similar although more stringent provisions set out in chapter III of the Industrial Emissions Directive (2010/75/EU). Those provisions already apply in respect to any plant newly permitted since 7 January 2013.

3.6.11 The UK Green Investment Bank

The UK Green Investment Bank (GIB) became fully operational on 29 October 2012, following state aid approval. It has been established as a Companies Act company and operates at arm's length from government.

Its role is to provide finance on commercial terms to green infrastructure projects and mobilise the additional private sector capital needed if investment in UK green infrastructure is to reach the level required to achieve UK environmental policy targets.

GIB operates to a double bottom line of delivering both positive portfolio returns and green impact since it is only by making strong commercial returns from financing green projects, that GIB will be able to demonstrate the commercial case for this and stimulate the wider financing market in relevant sectors. To ensure it is additional and does not crowd out private sector capital, GIB must also invest only in projects which would not proceed without GIB participation.

GIB's current priority sectors are:

- Offshore wind;
- Energy from waste;
- Waste processing and recycling;
- Energy efficiency, including the Green Deal.

The Bank may also operate in the following further sectors:

- Biomass power;
- Marine energy;
- Renewable heat;
- Biofuels for transport;
- Carbon Capture & Storage.

3.6.12 Local Enterprise Partnerships (LEPs)

In June 2010 the government invited local business and civic leaders to propose ways of establishing Local Enterprise Partnerships reflecting natural economic geography. In October 2010 the Local Growth White Paper provided more detail on LEPs and announced the first 24. More have been approved since; there are now 39 LEPs covering the whole of England.

The purpose of LEPs is to provide a clear vision and strategic leadership to drive sustainable growth and job creation in their area. Local businesses are crucial to the transition to a green economy as they will drive much of the investment and innovation in new and existing products which will create growth and jobs.

LEPs can have a key role in this transition, in terms of strategic economic planning (for instance investing in the necessary infrastructure and skills), and through local leadership, helping local business communities to recognise and seize opportunities.

Case study – New Anglia LEP

New Anglia is a Green Economy Pathfinder – the national leader on promoting, showcasing and recommending to government and businesses a cutting-edge approach to the green economy, setting out the barriers and opportunities around sustainable economic growth and highlight New Anglia's aspirations for the future. The results of this work will be shared with other Local Enterprise Partnerships, across England, to help them develop the green economy locally.

The New Anglia area is ideally suited to leading the UK's transition to a green economy across three focus areas:

- Low carbon – Through regional universities, research centres and science parks, Norfolk and Suffolk have a wealth of world class innovation and thinking, and exportable skills. The region's well-established 'all energy' base, which embraces oil, gas and nuclear, is evolving into onshore and offshore renewables.
- Natural capital – An abundance of agricultural farmland means the region also has many food and drink producers of repute. Tourism is one of the region's major sectors, thanks to a beautiful, abundant and diverse bank of natural capital.
- Social capital – The New Anglia area is home to many award-winning businesses, of all sizes, that are on the leading edge of a low-carbon future. The East of England Co-operative, the largest independent retailer in East Anglia, exemplifies a strong cooperative and social enterprise movement in the region.

As the driest, lowest-lying area of the country, the New Anglia region is at the frontline of climate change. It is also largely rural, and towns and cities of any size are few and far between. New Anglia is determined that its green economy agenda should not be restricted by such constraints. For example, the Pathfinder's ambition for high-value jobs doesn't rely on the standard paradigm that equates only major urban centres with growth and investment.

3.6.13 Scottish Enterprise

Scottish Enterprise (SE) contributes to the Scottish government's purpose of increasing sustainable economic growth targets to increase support to help companies take advantage of the transition towards a low carbon economy.

SE's focus is on accelerating the exploitation of low carbon opportunities in those markets where Scottish firms have a global advantage and maximise economic and environmental benefits. Supporting its priorities on renewable energy (particularly offshore wind and marine & tidal energy) and business efficiency, SE will also prioritise market opportunities in relation to: low carbon built environment, smart mobility, water technologies, carbon capture and storage, low carbon heat and cross-cutting technologies. SE has also published its third Low Carbon Implementation Plan, which summarises how it complies with the public sector duty on climate change. The Plan details SE's progress during 2012-13 and its planned actions for 2013-16, providing a comprehensive overview of the actions SE is taking to help deliver sustainable, low carbon economic growth.

3.6.14 Highlands and Islands Enterprise

The Highlands and Islands of Scotland cover more than half the Scottish landmass, including over 90 inhabited islands. It is recognised as being one of the windiest places in Europe and has enormously powerful tidal flows operating around its coastline. Capitalising on these natural assets to generate renewable energy and create wealth are key areas of activity for HIE in

its implementation of the Government Economic Strategy, which, in 2011, established a new strategic priority – transition to a low carbon economy – to reflect the current opportunity to place Scotland in an advantageous position in the global economy and ensure that the benefits of transformational change are shared across the country.

In developing the renewable energy sector, HIE will focus development, inward investment and infrastructure activity on marine energy and offshore wind, recognising that infrastructure, fabrication and supply chain activities will also support wave and tidal development. Investment in digital communications technology will deliver benefits not only in terms of increased business performance, but will reduce the need to travel, impacting on the carbon footprint of the region. In addition, HIE supports businesses, social enterprises and communities to capitalise on low carbon opportunities in the environmental and clean technology sectors, and encourages and supports them to maximise resource efficiency and minimise waste.

3.6.15 Wales national tourism strategy

Wales's new national tourism strategy - A Partnership for Growth: The Welsh government Strategy for Tourism 2013-2020 - was launched in June 2013 with a clear strategic direction for development, investment and marketing.

As part of its strategic approach, the Welsh government recognises the challenge that climate change presents to the industry. It has established and manages a Sustainable Tourism Framework and Forum and has developed a suite of information and guidance tools aimed at helping tourism businesses respond to the challenge in a sustainable way.

The toolkit is designed for small and medium businesses based in Wales and contains information and advice with practical guidance on how they can reduce their energy bills and carbon footprint. It includes steps for mitigation and adaption measures, and other ways for promoting a more sustainable business.

3.7 Transport

3.7.1 Highlighted Transport Policies and Measures

Name of mitigation action	Sectors affected	Type of instrument	Status of implementation	Start Year of implementation
Low carbon buses	Transport	Economic	Implemented	2009
Local sustainable travel fund	Transport	Economic	Implemented	2011
Car policies (EU new car CO_2 emissions targets: 130 gCO_2/km by 2015 and 95 gCO_2/km by 2020; and complementary measures)	Transport	Regulatory, Information, Voluntary/negotiated agreement	Implemented	2012
LGV Policies (EU new LGV CO_2 emissions targets: 175g CO_2/km by 2017 and 147 gCO_2/km by 2020; and compementary measures)	Transport	Regulatory, Information, Voluntary/negotiated agreement	Adopted	2012
HGV policies (low rolling resistance tyres and industry-led action to improve efficiencies)	Transport	Regulatory, Information, Voluntary/negotiated agreement	Adopted	2012
Rail Electrification	Transport	Economic	Implemented	2013
Biofuels policy (8% by energy by 2020)	Transport	Regulatory	Adopted	2013

3.7.2 Policy framework

The UK government and devolved administrations are committed to the challenge of tackling emissions from the transport sector. In 2012, transport accounted for 39% of all final energy consumption in the UK. Road transport accounted for 27% of final energy consumption with aviation accounting for 9%. The direct use of petroleum accounted for 98% of transport energy consumption.

Key initiatives are:

- improving the fuel efficiency of vehicles
- reducing CO_2 tailpipe emissions of road vehicles
- reducing the fossil fuels content of road transport fuels
- encouraging behaviour change

3.7.3 Improving fuel efficiency of vehicles

Road transport accounted for 23.5% of UK CO_2 emissions in 2011 and, of this, 60% of emissions were from passenger cars. Improving the efficiency of vehicles is therefore a key element of the UK's strategy to reduce CO_2 emissions.

Mandatory CO_2 emissions targets are now in place for both new passenger cars and new light commercial vehicles registered in the EU and are driving innovation from vehicle manufacturers and their suppliers. Europe has some of the most demanding vehicle CO_2 regulations in the world with manufacturers facing fines if they fail to meet strict average CO_2 targets for the fleet of cars or vans they sell.

For passenger cars a combination of regulation, high oil prices and a trend to smaller cars has led to a steady decrease in fleet average CO_2 emissions since EU regulation was first proposed in late 2007. The 130g target in 2015 represents an 18% reduction on 2007 levels and the 95g target in 2020 a 40% reduction. In 2012 the UK fleet average CO_2 emissions from vans in 2009 for new cars sold was 133 g/km. A fall of 3.6% on the previous year and an overall 26.5% reduction since 2000.

To build the market for ultra-low emission vehicles the Office for Low Emission Vehicles (OLEV) was established in September 2009 as a cross-government, industry-endorsed, team based in DfT, combining policy and funding streams and people from DfT, BIS, and DECC. The 2013 Spending Review[89] (SR) contained provision of £500 million to support OLEV's work to 2020 with the Roads Command Paper *Action for roads: a network for the 21st century*[90] providing more detail.

OLEV published *Driving the Future Today*[91] (4 September 2013) a strategy document providing a framework for government support for the ultra low emissions vehicles (ULEV) market. A call for evidence will be made shortly to help inform how best to use the £500m investment. This includes:

- Infrastructure: A £37 million package of measures announced that drivers could benefit with grants towards 75% of the installation cost of home and on-street charging.
  - Local authorities installing rapid charge points to facilitate longer journeys, or providing on-street charging on request for plug-in vehicle owners and train operators are installing new charge points at railway stations.

[89] https://www.gov.uk/government/publications/spending-round-2013-documents

[90] https://www.gov.uk/government/publications/action-for-roads-a-network-for-the-21st-century

[91] https://www.gov.uk/government/publications/driving-the-future-today-a-strategy-for-ultra-low-emission-vehicles-in-the-uk

- Eight Plugged-in Places (PIPs) are trialling different business models and technologies to inform the roll-out of recharging infrastructure nationally. To date over 5500 charge points had been provided by the PIPs. About 65% of these PIP charge points are publicly accessible. Using data provided by charge point manufacturers, it is estimated that these organisations have also installed about 5000 charge points nationwide.
- Energy: The mass adoption of ULEVs will have significant implications for the energy sector on both a local and a national level. As the number of plug-in vehicles on our roads increases, so will the demand for electricity. This represents a series of challenges, which must be anticipated and prepared for – issues which the government and industry are working together now to address. There is also a potential prize as ULEVs can help to balance the demand for electricity at peak periods and support the efficient use of energy by consumers.
- Consumer Incentives: Promote uptake of ultra-low emission cars through the provision of consumer grants. As of 30 September 2013, 5702 claims have been made through the Plug-in Car Grant scheme and 364 claims have been made through the Plug-in Van Grant scheme.
- R&D: Providing £82 million support for R&D to be managed by Technology Strategy Board. Priority "sticky" technologies have been identified by the Automotive Council: improvements to internal combustion engines; energy storage and energy management; lightweight vehicles and power train structures; development of power electronics and electric machines; and developing and applying Intelligent Transport Systems.
- Industry: The automotive industry is worth £11.2billion GVA to the UK economy.
- On 12 July government published the automotive strategy which was developed in close collaboration with the Automotive Council. It sets out how the government will support automotive R&D, skills and the supply chain and announces the creation of the £1billion Advanced Propulsion Centre.
- Regulation: OLEV also has responsibility for the EU CO_2 car and van Regulations, the biggest CO_2 savers in road transport. New car CO_2 regulation sets targets of 130g CO_2/km by 2015 and 95g CO_2/km by 2020. OLEV also leads on the negotiation of the European Commission's Clean Power for Transport proposal on the deployment of alternative fuels infrastructure.
- Hydrogen: Launched in January 2012 UKH_2Mobility is a joint industry-Government project assessing the potential for hydrogen for transport in the UK. Following the completion of the evaluation phase and publication of a report in April 2013, the UKH_2 Mobility project has been working to develop a plan for the roll-out of hydrogen fuel cell vehicles and the associated refuelling infrastructure in the UK from 2015.

In Scotland, the Scottish government published *Switched on Scotland: A Roadmap to Widespread Adoption of Plug-In vehicles*[92] on 12 September 2013. Switched On Scotland establishes a vision that by 2050 Scotland's towns, cities and communities will be free from the damaging effects of petrol and diesel fuelled vehicles and sets out the challenges and opportunities posed.

Scotland's charging point infrastructure is expanding: at the end of September 2013 there were approximately 300 charge points available to the public across Scotland and a further 200 in place in non-public locations such as council depots, private workplaces or domestic installations. Work is also underway to provide rapid charge points at 50 mile intervals on Scotland's trunk roads.

[92] http://www.transportscotland.gov.uk/files/Switched%20On%20Scotland%20.pdf

3.7.4 Reducing the carbon content of fossil

The Renewable Energy Directive (RED) requires the UK to source 15% of its overall energy, and 10% of energy used in transport, from renewable sources by 2020. The related Fuel Quality Directive (FQD) requires fuel and energy suppliers (principally those providing fuel and energy for land-based transport) to reduce the lifecycle GHG emissions per unit energy ("GHG intensity") of the fuel/energy they supply by 6% by 2020.

The UK transposed the FQD in full on 15 April 2013 and the RED on 15 December 2011, through amendments to the Renewable Transport Fuel Obligation (RTFO) Order 2007. The RTFO obligates road transport fuel suppliers[93] who supply at least 450,000 litres a year to produce evidence that a specified percentage of their fuels for road transport in the UK comes from renewable sources. This obligation level is currently set at 4.75%.

Only biofuels meeting EU mandatory sustainability criteria are counted towards the RED and FQD targets and receive Renewable Transport Fuel Certificates (RFTCs) under the RTFO. These criteria require that biofuels, with some exceptions, must deliver GHG savings of at least 35% when compared to fossil fuels and that biofuels must not be sourced from areas of high biodiversity, or from high carbon soils (e.g. wetlands). Biofuels produced from wastes (such as used cooking oil), residues, non-food cellulosic material, and ligno-cellulosic material benefit from double certification.

There remain concerns that the increased use of some biofuels increases GHG emissions rather than reduces them, due to indirect land use change (ILUC). ILUC occurs where production of biofuel from crops grown on existing agricultural land results in the displacement of production on to previously uncultivated land.

The European Commission proposed a directive in October 2012 to address ILUC through amendments to the RED and FQD and negotiations are still on going.

The UK government wants to go further than the Commission's proposed directive and are seeking to ensure that support only goes to biofuels that are significantly better than fossil fuel, when everything is considered.

The RED and FQD require the European Commission to monitor and report every two years on the impact of biofuel policy and increased demand for biofuel on social sustainability. The first *Renewable Energy Progress Report* was published in March 2013.

3.7.5 Encouraging a move towards environmentally friendly means of transport

To encourage the uptake of more fuel efficient vehicles the Fuel Consumption and Carbon Emission Database[94] allows searches for car details by fuel consumption, CO_2 and other emissions as well as by make and model. DfT also provides funding for the Energy Saving Trust's (EST) work giving advice and practical help to businesses to encourage them to reduce carbon emissions from their vehicle fleets, including by choosing the most appropriate low carbon vehicles, training drivers in fuel efficient driving techniques, and suggesting how businesses can use alternatives to travel such as video conferencing

Since March 2001, a system of Graduated Vehicle Excise Duty (VED) has been in operation for new cars based primarily on their level of CO_2 emissions. Since April 2010, the system has comprised of 13 CO_2 bands and a higher level of tax applies to a vehicle at first registration (first year rate) with CO_2 emissions of above 165 g/km. The system was revised in 2010 to encourage

[93] As well as road transport fuel, fuel used in the following end uses is also obligated: non-road mobile machinery (including inland waterway vessels which do not normally operate at sea), agricultural and forestry tractors, and recreational craft which do not normally operate at sea

[94] http://carfueldata.direct.gov.uk/

a shift to 'best in class' cars and to reward drivers of lower emission cars and to better influence purchasing choices at the point of sale. Since 2010, to reduce cost of living pressures on motorists, VED rates have increased in line with inflation only.

Provision of a company car, made available for an employee's personal use, is a Benefit in Kind that is subject to Income Tax (for the employee) and Employer National Insurance Contributions (NICs). Since being reformed in 2002, this tax is graduated according to the vehicle's CO_2 emissions – the less CO_2 the vehicle produces, the lower the benefit on which tax must be paid. Budget 2013 announced a commitment to maintain the differential in rates for the lowest emitting cars – 75g CO_2/km or less until 2019. Electric cars will continue to benefit from the lowest rates. By providing tax incentives to both employers and employees in favour of lower CO_2-emitting cars, graduated Company Car Tax will help the UK meet EU targets for average new-car CO_2 emissions and support the growth of the ULEV market.

3.7.5.1 Rail

As part of its strategy to improve public transport as an alternative to private road transport, government is investing over £9 billion in the rail network between 2014 and 2019. This will deliver the Crossrail and Thameslink programmes, a new fleet of energy efficient intercity trains (the Intercity Express Programme) and 850 miles of new rail electrification. The UK now has one of the fastest growing railways in Europe and is expected to continue to grow with the development of the UK's new high speed line – HS2.

The government is working closely with the rail industry to improve rail's environmental performance. Notable successes in recent years have included the roll-out of regenerative braking across all capable electric train fleets and the introduction of driver advisory systems to help drivers operate their trains in the most efficient way. The government is embedding environmental requirements in future rail franchises requiring train operators to deliver reductions in carbon emissions from operating trains, stations and depots.

3.7.5.2 Buses and local sustainable travel

Low carbon buses emit at least 30% fewer GHG emissions than comparable diesel buses. Since 2009, four rounds of the Green Bus Fund in England have provided £87 million of funding to bus operators and local authorities to help them purchase around 1,200 new low carbon buses. Each year, by switching to low carbon alternatives, bus services in England operated by these 1200 buses are expected to save around 28,000 tonnes of CO_2 per annum. The Scottish government operates a similar scheme, the Scottish Green Bus Fund, which to date has provided £7.7 million of funding to support the introduction of 94 low carbon buses across Scotland. The Scottish Green Bus Fund will continue in 2013/14 and 2014/15 providing a further £7.5 million of funding to support the introduction of more low carbon buses across Scotland.

The *Local Sustainable Transport Fund* was announced through the October 2010 Spending Review[95] to support delivery of the White Paper. £560 million was made available to the fund for 2011-15. The Fund has been universally popular, with all eligible local authorities applying with bids across 2011 and 2012. Due to this volume of interest and the high quality of bids received, DfT injected an additional £40 million into the fund in 2012. This enabled ministers to approve a greater number of bids across three funding announcements, making £600 million available in total for local sustainable transport. The fund is providing grants to 77 local authorities to deliver 96 sustainable transport projects across England. The 2013 Spending Round[96] announced an extra £100 million capital funding for sustainable transport in 2015/16. £78.5 million of resource funding will be set aside for the LSTF (including Bikeability).

[95] https://www.gov.uk/government/publications/spending-review-2010

[96] https://www.gov.uk/government/publications/spending-round-2013-documents

The Local Transport White Paper *Creating Growth, Cutting Carbon – Making Local Sustainable Transport Happen*[97] (January 2011) represented a significant step towards meeting two key Coalition government objectives: helping to create economic growth by making sure people can get to work, to the shops or their local amenities; and tackling climate change by cutting transport carbon emissions through encouraging more low-carbon journeys.

DfT published the *Door to Door Strategy*[98] (March 2013) aimed at encouraging people to make their whole journey by sustainable transport modes. The UK government is making it easier for people to use public transport, walk or use a bike by ensuring that there is better integration across these modes from door-to-door. Improvements around information provision, ticketing, connectivity and transport facilities will make choosing to travel sustainably straightforward, convenient and affordable.

3.7.5.3 Cycling

Since 2010, there has been over £277 million of investment in cycling aiming to increase the number of cyclist in the UK. The funding has delivered transformational change in eight cities (Manchester, Birmingham, Leeds, Bristol, Newcastle, Norwich, Cambridge and Oxford) and four national parks (Dartmoor, South Downs, Peak District and the New Forest) in England. Funding has also covered Bikeability cycle training, cycle-rail facilities, cycle safety improvements to junctions and grants for linking communities through cycling.

In addition, the government is committed to cutting red tape that can stifle cycle-friendly road design and to encourage changes to the way roads are built or altered. Councils will be expected to deliver infrastructure that takes cycling into account from the design stage. DfT will publish a Cycle Delivery Plan in coming months and will continue to work with other departments, local authorities and stakeholders to increase cycling as a means to reduce transport emissions and improve economic growth.

In Scotland, the Scottish government has worked with local authorities, stakeholders and delivery partners to publish the updated Cycling Action Plan for Scotland (CAPS)[99] which sets out a series of co-ordinated actions to be taken to realise the shared vision that by 2020 10% of all everyday journeys undertaken in Scotland will be by bicycle.

3.7.5.4 Managing the road network

In 2008-9 the previous UK government reported that it was examining how pricing could be used to manage congestion and reduce emissions. In June 2010 the newly elected Coalition government announced that it had 'ruled out for the duration of the Parliament national road pricing for cars on existing roads and any preparation for such a scheme beyond that time horizon'.[100]

In recent years, the UK has led the world in the use of technology and traffic management to improve the flow of traffic on our motorways – measures known collectively as managed motorways. This brings together many technology developments such as MIDAS (motorway incident detection system), variable messaging and a national state of the art communication system.

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[97] https://www.gov.uk/government/publications/creating-growth-cutting-carbon-making-sustainable-local-transport-happen

[98] https://www.gov.uk/government/publications/door-to-door-strategy

[99] http://www.transportscotland.gov.uk/strategy-and-research/publications-and-consultations/cycling-action-plan-2013

[100] http://www.publications.parliament.uk/pa/cm201011/cmhansrd/cm100615/text/100615w0009.htm

In March 2011, results were published for the first three years of the first managed or smarter motorway trial on the M42. The road was handling substantially more traffic, journey times were 24% faster and fewer vehicles experienced slow conditions. Reliability was much better, which meant that the emissions from individual vehicles went down and noise levels reduced.

As a result the UK is committing to this technology on a grand scale. Of the 26 new Highways Agency national roads schemes due to start work by 2015, 13 are smarter motorway schemes.

In July this year, the government published *Action for Roads: A network for the 21st century,*[101] in which was announced a series of changes to how motorways will be managed in future, and made clear that any improvements to the network must be made in a way that supports the nation's overall quality of life. This included a requirement for a stretching policy of decarbonisation, to address the carbon consequences of motoring and move us to a lower-impact future.

3.7.5.5 Aviation

The UK government is working with international organisations to ensure that total aviation CO_2 emissions are set to fall. The UK government contributes actively to the International Civil Aviation Organization (ICAO) discussions on measures to reduce international aviation emissions, and this is our preferred option for addressing the climate change impacts of aviation. Through the ICAO the UK has made significant progress on a wide portfolio of measures to reduce aviation emissions, including:

- setting international goals such as carbon neutral growth in international aviation by 2020, and 2% fuel efficiency savings per annum between 2010 and 2020
- setting a CO_2 standard for aircraft that imposes a mandatory emissions limit for new aircraft types from around 2020
- making operational improvements in air traffic navigation services in order to increase fuel efficiency and reduce emissions
- promoting sustainable alternative fuels
- developing a global market-based measure for implementation from 2020.
- publishing the UK state action plan which outlines the government's strategy for reducing emissions from aviation
- working in partnership with developing countries to develop and implement state action plans

Government supports the EU strategy to tackle aviation emissions at a European level. A key component of the EU strategy is the inclusion of aviation in the EU ETS from 2012. Following the positive progress made at ICAO towards a global agreement addressing aviation emissions, in October 2013 the European Commission adopted a proposal to amend Aviation EU ETS.

3.7.5.6 Goods vehicles

EC Regulation 661/2009 sets minimum requirements and introduces labelling for the rolling resistance, wet grip and external rolling noise of tyres for both light and heavy goods vehicles. Industry and government are taking a range of actions to reduce freight emissions, including:

- the Freight Transport Association's Logistics Carbon Reduction Scheme which is a voluntary industry-led approach to reducing carbon emissions from road freight by recording and reporting reductions in CO_2 emissions

[101] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/212590/action-for-roads.pdf

- The low carbon truck and Infrastructure Trial supporting over 300 low carbon heavy goods vehicles and the associated refuelling infrastructure to help encourage other freight operators to consider using alternative fuels
- The government has established a joint task force with industry to promote low carbon HGV technologies
- Encouraging modal shift from road to rail or water through freight grant schemes. The Mode Shift Revenue Support and Waterborne Freight Grant schemes provide support towards the operating costs and Freight Facilities Grants the capital costs.

3.7.6 Transport in the devolved administrations

The Wales Transport Strategy, which is a statutory document, was published in 2008. It includes clear objectives to reduce GHG emissions from transport and for climate change adaptation in the transport system.

The Climate Change Strategy for Wales and its associated Emission Reduction and Adaption Action Plans set out the specific action being taken in transport. There has been good progress on delivering the actions in the Emission Reduction Action Plan. For example the Welsh government:

- is currently making primary legislation to underpin the provision of a comprehensive and integrated network of active travel routes. This will help make walking and cycling the most natural way of getting about for short journeys. It builds on substantial investment in walking and cycling infrastructure over the last few years.
- introduced measures to improve the management of our road infrastructure. Better traffic management, including variable speed limits on the busiest parts of the network, helps improve traffic flows and reduce greenhouse emissions.

In Northern Ireland, the *New Approach to Regional Transportation* published in March 2012 to provide a strategic framework for future transport investment. This sets out a new direction to inform decision making on transportation investment beyond 2015 and to ensure more integrated and sustainable transport arrangements. The New Approach establishes a high level aim to reduce the impact of transport with a strategic objective to reduce GHG emissions.

DRDNI continues to promote sustainable transport through the Travelwise NI initiative by encouraging walking, cycling, car sharing and public transport.

The ecar Project was introduced in 2011. By the end of July 2013 the project had installed 160 standard/fast charge points and 14 rapid charge points throughout Northern Ireland. The ecar Project provides a grant of £1,500 to electric vehicle owners to install a home or workplace charge point.

3.8 Domestic sector

3.8.1 Highlighted domestic policies and measures

Name of mitigation action	Sectors affected	Type of instrument	Status of implementation	Start year of implementation
Warm front (In Scotland the energy assistance package, in Wales nest and in Northern Ireland the warm homes scheme)	Residential	Economic	Implemented	2000
EEC 1 and 2, Original CERT	Residential	Regulatory	Implemented	2002
Community energy saving programme (CESP)	Residential	Regulatory	Implemented	2009
Carbon emissions reduction target (CERT) uplift and extension	Residential	Regulatory	Implemented	2011
The Green Deal and Energy Company Obligation	Business, Residential	Economic, Regulatory	Implemented	2012
Smart metering	Business, Residential	Information	Adopted	2014
Zero carbon homes	Residential	Regulatory	Adopted	2016

3.8.2 Policy framework

The government has put in place a range of policies to improve domestic (residential) energy efficiency. These include building standards, financial incentives, advice to consumers, information and advice. This broad approach aims to empower the consumer to make changes to behaviours and tackle rising energy demand.

3.8.3 Household energy efficiency

Since the publication of the *Energy Efficiency Strategy,*[102] the government has taken significant action to address the barriers to energy efficiency take up in households. The measures the government has introduced are aimed at helping households to insulate their home and reduce fuel bills; empowering households to take control of their energy use and providing households with access to trusted information and advice about energy efficiency. Further information can found in the cross-cutting energy efficiency measures section.

At a time of rising energy prices, it essential that there is support in place to manage the costs of energy bills. In March 2013 DECC estimated households will be saving on average 5%, or £65 in 2013 (and 11%, or £166 by 2020) on their energy bills compared to what they would have paid in the absence of the government's energy and climate change policies.[103] By 2022 it is expected that around half of all UK households will have had at least one major insulation measure (loft, cavity wall or solid wall insulation) delivered through government policies, saving between £25 to £270 on their annual energy bill.

3.8.4 The Green Deal and ECO

Specifically, in January 2013 the Green Deal was launched, a world first in energy efficiency programmes. It is a 20 year programme with key objectives to boost long term investment and growth in the energy efficiency products and service sectors and deliver energy efficiency improvements across Great Britain. Since its introduction in January 2013 the Green Deal has been steadily gaining momentum and already 101,851 Green Deal assessments have been carried out (as of 30 September 2013), whilst the supply chain is continuing to grow. Also, as of 31 October 2013, there were 112 authorised Green Deal providers and 2,020 organisations accredited to carry out installations.

[102] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/65602/6927-energy-efficiency-strategy--the-energy-efficiency.pdf

[103] DECC, Estimated impact of energy and climate change policies on energy prices and bills (March 2013).

The introduction of the Green Deal is an opportunity for growth and building localised markets for the installation of energy efficiency measures. It is already helping consumers to cut waste and the cost of their bills, whilst reducing their energy demand and carbon emissions. To drive early uptake of the Green Deal, the government has established incentive schemes, including:

- A cash-back offer: £40 million phase which by August 2013 had supported the installation of 5,773 measures; and
- £80 million of funding targeted at cities and local authorities to support Green Deal activity.
- In December 2013, the UK government announced a further £540m of funding over 3 years from 14/15 to 16/17. £90m of this funding will be targeted at investing in energy efficiency improvements in schools, hospitals, universities and other public sector buildings. The remaining £450m will be designed to dovetail with the Green Deal. Amongst the planned schemes, a stamp duty rebate will be designed to incentivise people who have recently moved home, while an incentive in the Private Rental Sector will support upcoming regulations

The new Green Deal Finance Company is ensuring that finance is available to Green Deal Providers to draw on when they are ready to do so. This aims at creating a dynamic market, supporting new providers to enter the marketplace as quickly as possible by minimising the cost of doing so.. Green Deal finance is just one option available to consumers to finance the installation of measures and has been available since May.

Since May 2013 the new Green Deal Finance Company has been ensuring that finance is available to Green Deal Providers to lend out to consumers. This is one of the options available to help consumers meet the initial cost of installing energy efficiency measures. Already a number of companies are providing this finance offer to consumers and more are expected to be active in the market by the end of 2013.

The Government is committed to raising awareness and understanding of the Green Deal and has invested £2.9 million in a marketing and communications campaign. The Energy Saving Advice Service (see energy savings advice below) has also been established, which will ensure there is an impartial source of advice for consumers enquiring about the Green Deal.

The Energy Company Obligation (ECO) operates alongside the Green Deal to fund energy saving improvements in vulnerable and low-income households and those living in harder to treat properties, such as solid walled properties.

ECO is a statutory obligation placed on larger energy suppliers to meet a series of targets relating to carbon savings and reducing home heating costs.

The current ECO is planned to run until 2015. On 2 December 2013, Government announced proposals to extend the scheme to 2017.

3.8.5 Building regulations

Around 27% of UK CO_2 emissions come from domestic buildings, principally space heating and cooling, water heating, lighting and other fixed building systems - energy uses which are covered by building regulations. Further details can be found in the cross cutting-section.

3.8.6 Raising product standards and encouraging consumer engagement

Policy on improving the performance of energy-using products is dominated by two European framework directives and the product-specific measures that implement them (which take the form of either regulation or voluntary agreements between the European Commission and industry):

The EU Ecodesign of Energy Related Products framework directive allows for the development of minimum energy performance standards (MEPS) for energy-using and energy-related products, banning the least-energy efficient products from either production for the EU market, or import into the EU. Standards are set at a cost-effective level.

The EU Energy Labelling Framework Directive allows for mandatory 'A to G' energy labels that rank products in terms of relative energy efficiency and provide consumers with information on energy during use, and other information. Labelling can be an effective 'pull' of markets for efficient products, increasing their penetration in the market as well as consumer choice.

By September 2013, around 30 ecodesign and labelling measures, plus two industry voluntary agreements, were in place.

In 2020, Ecodesign and Labelling measures agreed so far will have annual benefits to the UK economy of around £1 billion or 5 $MtCO_2e$. The next tranche of measures will generate around a further £0.5 billion or 6 $MtCO_2e$ savings annually.

The government is also continuing to pursue other measures which include: industry voluntary agreements such as the Code of Conduct for data centres and public procurement policy.

The UK is also working with two international collaborations to promote harmonised product standards (testing and minimum energy performance energy labelling):

- the International Energy Agency Efficient End-use Electrical Equipment (4E) Implementing Agreement.
- The Super Efficient Appliance Deployment Initiative (SEAD), which is a work stream under the Clean Energy Ministerial process.

3.8.7 The energy savings advice service

Since April 2012 DECC has been providing advice to customers through the contracted Energy Saving Advice Service. Following the DECC Delivery Review in May 2011, DECC has transitioned from providing grant funding for advice services to contracted services.

The Scottish government offers integrated non-domestic energy and material resource efficiency advice and services through open competitive tender via the streamlined Resource Efficient Scotland programme.

The Welsh government continues to fund the EST to deliver an enhanced energy advice service within Wales and, following a review of advice services, the Welsh government is establishing an integrated resource efficiency service from April 2014. The revised and simplified service will provide resource efficiency and microgeneration support through a single contact number for the domestic, community and public sector audiences.

3.8.8 Billing and metering

Smart meters perform the traditional meter function of measuring energy consumption, but they also store consumption data and transmit this to energy suppliers (or other third parties). The data collected can be used to provide consumers and their energy suppliers with detailed and accurate real-time feedback on their energy use.

The government believes smart meters will play an important role in our transition to a low-carbon economy, and in helping to meet some of the long term challenges the UK faces in ensuring affordable, secure and sustainable energy. Consumers will have more control over their own energy use and carbon emissions, and new opportunities will be opened up for energy retail services, infrastructure management and renewable energy generation.

The government's vision is that every home and smaller business in Great Britain should have a smart energy meter by 2020. Significant progress has been made in establishing the technical, commercial, regulatory and policy framework for the roll out. Energy supply companies, who will be responsible for metering deployments, are now in the design, build and test phase ahead of an expected mass roll out from autumn 2015.

It estimated that this will result in annual reductions in UK emissions of about 2.8 $MtCO_2e$ by 2020. There are two elements to this reduction. The first will be annual savings of about 1.8 $MtCO_2e$ from reductions in residential combustion of natural gas; in addition, the UK will be better off, annually, the equivalent of about 1 million tonnes of EU ETS CO_2 allowances which the government would, otherwise, have needed to buy.

3.8.9 Tackling fuel poverty

In July 2013, following an independent review by Professor Sir John Hills and a public consultation, the government announced the intention to adopt a new definition of fuel poverty in England. This finds a household to be fuel poor if it is below the official poverty line and it has higher than typical energy costs. This new definition represents a better way of measuring fuel poverty. It gives new insight, supplementing understanding of how widespread fuel poverty is with an awareness of how badly affected households are. It also opens up the possibility of targeting resources more effectively towards those households that most need support.

The government has published a framework for future action on fuel poverty in England and is seeking through the Energy Bill to put in place a new fuel poverty target supported by a statutory strategy setting out how it will be achieved. This overall approach represents an important recommitment to tackling the major, structural problem of fuel poverty.

Beyond this, a range of policies are already in place to ensure there is targeted support for low income and vulnerable households:

- Through the Warm Home Discount scheme, over 1.2 million of the lowest income pensioners will get £135 off their electricity bills in winter 2013-14, 1.16 million of them automatically. The scheme will help around two million households in total this year; and the government has committed to extending it to 2015-16 with an increased spend of £320 million.
- Under the ECO scheme energy suppliers will fund energy saving home improvements in around 230,000 low income and vulnerable households each year throughout the duration of the scheme.
- Through the local authority fuel poverty competition, £31 million was awarded to 60 projects involving 169 local authorities delivering valuable support to low income and vulnerable households across England.
- The government is providing Cold Weather Payments to low income and vulnerable households on certain benefits in areas experiencing periods of very cold weather. These payments will remain at £25, for each qualifying period, for the duration of this government. Direct from the government, all pensioner households aged up to 79 years will get a tax free £200 Winter Fuel Payment in winter 2013-14 (£300 for those aged over 80). These payments helped over 12.6 million older people in over 9 million homes in winter 2011-12.

- The government has provided £900,000 in 2013/14 to fund the creation of the Big Energy Saving Network. The network pools the expertise of a number of trusted third sector organisations and aims to deliver proactive, assisted action encouraging vulnerable consumers to engage with the energy market and realise the savings possible through switching tariff or supplier.

3.8.10 Nest energy efficiency scheme

The Welsh government's Nest scheme, which replaced the former Home Energy Efficiency Scheme (HEES) in April 2011, installed free energy efficiency improvements in over 4,900 of the most energy inefficient homes in Wales in 2012-13, helping these households to save energy, reduce their fuel bills and reduce carbon emissions. The improvements are estimated to deliver energy use savings averaging over 14,000 kWh per annum and total lifetime savings of over 250,000 $MtCO_2e$.

In addition to improving the homes of low income private-sector households, Nest also provides advice to all households on reducing energy bills. In 2012-13, Nest provided energy saving advice to over 21,500 households, helping these households to reduce their energy use, lower their energy bills, and reduce their carbon emissions.

The Arbed 2 European Regional Development Fund (ERDF) project aims to provide social, economic & environmental benefits for Wales along with tackling fuel poverty within communities where it is most needed.

The three year project is now in its second year with over 2,500 properties across Wales approved for a range of energy efficiency measures to be implemented. The Arbed programme contributes to the eradication of fuel poverty, cutting GHG emissions and to improving the energy performance of homes in Wales.

Arbed 2 ERDF takes a 'whole-house' approach when assessing potential energy efficiency measures for a property; this approach considers the nature of the property, the occupancy, the potential impact of different measures and value for money. Potential measures within Arbed can include external wall insulation, heating system upgrade, solar hot water, heating controls and energy efficiency advice.

The introduction of the Welsh Housing Quality Standard (WHQS) in May 2002 provides a common target standard for the physical condition of all existing social housing within Wales to be originally achieved by 2012 (now 2020).

The WHQS provides for the annual energy consumption for space and water heating to be estimated using the SAP (Standard Assessment Procedure) method and specifies the minimum ratings to be achieved.

WHQS specifies a single SAP score of 65 out of a possible 100 and the energy efficiency targets within WHQS are challenging in relation to the difficulties faced in improving the older existing stock.

The latest published statistics on achievement of the WHQS shows that (at 31 March 2012) over 159,000 dwellings (nearly 72%) are fully compliant in achieving an EPC rating of 65 or above, and over 170,000 dwellings (nearly 77%) are fully compliant in having a central heating system.

For new social housing energy efficiency is defined by Planning Policy Wales and is required to meet Code for Sustainable Homes 3+. From December 2013, Part L of the Building Regulations Wales will apply to new social housing.

3.8.11 Fuel poverty and domestic energy efficiency in Scotland

The Scottish Parliament has set a challenging legally binding commitment 'to ensure, so far as reasonably practicable, that people are not living in fuel poverty in Scotland by November 2016'. In Scotland, a household is said to be in fuel poverty if, in order to maintain a satisfactory heating regime, it would be required to spend more than 10% of its net household income (including Housing Benefit or Income Support for Mortgage Interest) on its total energy use.

The Scottish government launched the Home Energy Efficiency Programmes for Scotland in April this year to tackle fuel poverty, reduce carbon emissions and support jobs. The programme has three strands:

- Area Based Schemes will deliver provide a range of insulation measures helping to reduce heat loss and save households money. They are delivered by local authorities and prioritise fuel poor areas.
- Affordable Warmth Scheme delivered nationally and targeted at private tenure households who are vulnerable to fuel poverty as defined by the UK government's affordable warmth group. A range of measures are available under this scheme, including insulation, heating measures and micro-generation.
- Energy Assistance Scheme (EAS) focusses assistance on the most vulnerable and poor households who are not eligible under the Affordable Warmth Scheme. The scheme provides repairs and replacement insulation and central heating measures.

Through the Home Energy Efficiency Programmes for Scotland the Scottish government will invest £74 million in 2013-14 levering in additional investment from major energy companies, under the ECO, creating a £200 million fund. The Scottish government has allocated £79 million to tackling fuel poverty and domestic energy efficiency in both 2014-15 and 2015-16 resulting in almost a quarter of a billion pounds spend over a three year period.

In addition, the Scottish government launched the Warm Homes Fund in November 2012 which provides grants and loans to support renewable energy projects, including district heating, in fuel-poor communities.

To support and encourage the improvement of the energy efficiency of our existing housing stock, the Scottish government will publish a new energy efficiency standard for existing Social Housing by Autumn 2013, with expectations that landlords will meet the standard by 2020. A working group to develop proposals for minimum energy efficiency standards in existing private sector housing has been established and the Scottish government will consult by 2015 on draft regulation for existing private housing.

3.8.12 Fuel poverty in Northern Ireland

The 'Warmer Healthier Homes: A New Fuel Poverty Strategy for Northern Ireland' was launched in March 2011 and recognised that 44% of people in Northern Ireland live in fuel poverty. Funding of £63 million has been allocated from 2011-2015 to the 'Warm Homes Scheme' to improve the energy efficiency of at least 9,000 homes a year and help reduce energy usage. The measures are targeted to help the 13% of households who need to spend more than 20% of their income on energy costs.

In September 2012 a Boiler Replacement Scheme was launched providing grants to lower income households to replace old and inefficient boilers. The budget available will assist approximately 24,000 households and will deliver an average annual household energy saving of at least 8,221 kWh and also deliver an annual reduction in carbon emissions of 2.4 $MtCO_2e$ per household. In the first year, more than 6,500 homes have had new boilers installed, each one seeing an increase in thermal efficiency.

3.8.13 Creation of the Energy Efficiency Deployment Office

The UK is absolutely committed to energy efficiency and the Prime Minister has made it one of the government's key strategic priorities. Energy efficiency policies:

- Support economic growth by reducing business costs, boosting competitiveness, creating jobs and driving investment in energy efficient technology.
- Support households and businesses to reduce their energy bills and cut down on waste at a time of rising prices.
- Enable cost-effective reductions in GHG emissions.
- Support a sustainable and secure energy system, guarding against energy price shocks.

To realise the energy efficiency opportunity in the UK the government set up the Energy Efficiency Deployment Office (EEDO), within DECC. EEDO's role is to drive a step change in energy efficiency by bringing greater coherence to the design and delivery of energy efficiency policies; understanding and taking steps to realise further energy efficiency potential; and demonstrating best practice and the benefits of energy efficiency.

As highlighted within the *UK Energy Efficiency Strategy*, a priority is the government's implementation of the Energy Efficiency Directive – where the UK is committed to delivering against the June 2014 transposition deadline. The directive represents an important step forward in terms of delivering on the EU's non-binding target to reduce primary energy consumption by 20% by 2020 against 2007 business as usual projections. A key new requirement of the Energy Efficiency Directive, introduced through Article 8, is the requirement for all large enterprises to undertake an energy audit by 5 December 2015 and every four years thereafter. By June 2014 the government will have legislated to introduce the Energy Saving Opportunity Scheme (ESOS), to satisfy the requirements of Article 8. ESOS targets a gap in the existing policy landscape by identifying cost-effective energy efficiency recommendations and, once introduced, it will support large enterprises to save money on their energy bills. Early analysis indicates it has the potential to drive £1.9 billion worth of benefits for the UK.

The UK government is committed to implementing the Energy Efficiency Directive, and has already consulted on the introduction of ESOS, ahead of transposing the requirements in Article 8, and the smart metering elements within the Directive. We will also consult on:

- Public procurement (Article 6).
- Options for installing heat metering (Articles 9 and 11).
- Licence conditions for billing (Articles 10 and 11).
- Amendments to the Environmental Permitting Regulations concerning co-generation requirements (Article14).

3.8.14 Heat strategy

The UK spends £32 billion a year on heating. It accounts for nearly half of our final energy consumption, and over three quarters of the energy used in homes, as well as around 80% of the natural gas consumed. Our demand for heat causes a third of all our carbon emissions, and without changing the way we produce and consume heat, the UK will not meet our long-term climate change target. To get there, the UK needs to change the way it generates, distributes and uses heat in buildings and industry.

The government recognises the scale of this challenge, and is taking steps to meet it. In 2012 it published *The Future of Heating – A strategic framework for low carbon heat in the UK*.[104] This document set out the options the UK could take to decarbonise its heat supply, and began a conversation that has helped develop its thinking on how effective each option could be. The government has worked closely with a range of sectors since its publication, and set out its updated thinking earlier this year in *The Future of Heating – Meeting the challenge.*[105] This outlined the measures it is currently undertaking and intends to put into practice in the near future.

3.8.15 Domestic Renewable Heat Incentive

The scheme is a financial support scheme for renewable heat targeted at, but not limited to, off-gas grid households. The support will be paid at a set rate per unit of renewable heat produced (per kWh, over seven years, to the owner of the heating system. The level of support will reflect the expected costs of renewable heat generation over 20 years. The technologies supported are biomass boilers, air- and ground-source heat pumps, and solar thermal panels.

The scheme will be open to homeowners, private and social landlords, third party owners of heating systems and people who build their own homes.

Currently half of the UK's carbon emissions come from the energy used to generate heat. The RHI has an important role to play in our transition to a low carbon economy, and could result in cumulative savings of 5 million tonnes of carbon to 2015, increasing to 39 million tonnes of carbon to 2020. The UK Government estimates the cumulative gross costs to society of domestic RHI tariffs over the lifetime of the policy at around £2.9 billion with a £1.1 billion monetised benefit to the economy. There will also be significant non-monetised benefits such as preparing for mass roll out of renewables technologies and compliance with the Renewable Energy Directive.

The scheme helps to strengthen security of energy supply by increasing diversification of heating fuels. It aims to encourage the development of a sustainable renewable heat market and supply chain in the UK, which is in a position to support the mass roll-out of low carbon heating technology required in the 2020s and onwards to help meet the government's ambitious long-term carbon reduction targets.

The scheme is designed to provide financial incentives to encourage greater take-up of renewable heating technologies by consumers. Through its links with the Green Deal, it will also encourage greater energy efficiency, which should help to reduce the cost of consumer bills. Green Deal Finance lets people pay for energy efficiency improvements including renewable heating systems through savings on their energy bills and householders are able to take up Green Deal finance and claim the RHI payments. Applicants will need to complete a Green Deal Assessment before submitting their application and must ensure they have met minimum loft and cavity wall insulation requirements, where appropriate.

3.8.16 Renewable Heat Premium Payment scheme

The scheme provides cash back vouchers for householders (mainly those not connected to the gas grid) in England, Scotland and Wales in order to incentivise the purchase of eligible renewable heat generating installations.

[104] https://www.gov.uk/government/publications/the-future-of-heating-a-strategic-framework-for-low-carbon-heat

[105] https://www.gov.uk/government/publications/the-future-of-heating-meeting-the-challenge

Registered social landlords can also bid for money to support the installation of cost-effective renewable heating systems in social housing stock. Again, the focus is on areas not connected to the gas grid.

The scheme's purpose is to support the take-up of renewable heating technologies in the domestic sector prior to the introduction of the domestic Renewable Heat Incentive.

Renewable Heat Premium Payment (RHPP) scheme was introduced in August 2011 and ran until March 2012. It supported over 6,000 installations.

Phase 2 of the scheme ran from April 2012 to March 2013 and, in May 2013, was extended to run until March 2014. Phase 2 is expected to support more than 10,000 installations.

As of November 2013, the RHPP scheme has spent over £21m to help social landlords and private households install more than 17,000 renewable heating systems in homes across Great Britain. We expect the scheme to deliver around 25,000 installations in total before it closes in March 2014.

The scheme will allow us to learn more about what people think of these technologies, and how the technologies perform in a variety of conditions. Since May 2013, new applicants for RHPP support are required to undertake a Green Deal Assessment before submitting a claim to the Energy Savings Trust for payment of their voucher.

Recipients of RHPP support can subsequently apply for support under the domestic RHI scheme, but the level of their RHI payments will be correspondingly reduced in order to avoid a double subsidy.

DECC presently provides grant funding for the Energy Saving Trust (3.8.7) to deliver the Renewable Heat Premium Payment (RHPP) scheme. The scheme provides cash back vouchers for householders (mainly those not connected to the gas grid) in England, Scotland and Wales in order to incentivise the purchase of eligible renewable heat generating installations. Also, registered social landlords can bid for money to support the installation of cost-effective renewable heating systems in social housing stock. Again, the focus is particularly on areas not connected to the gas grid. The scheme's purpose is to support the take-up of renewable heating technologies in the domestic sector prior to the introduction of the domestic Renewable Heat Incentive.

A separate RHPP scheme was launched in Northern Ireland on 24 May 2012 administered by DETI. By 30 November 2013, nearly 1400 applications had been made for support with over 50% being for biomass boilers. DETI has consulted on the design and introduction of a domestic RHI in Northern Ireland, to be in place in 2014.

3.8.17 Heat network delivery unit

The government's *Future of Heating* work identified the key role that heat networks could play in helping to decarbonise heat supplies in densely populated areas that may have difficulty installing other forms of low-carbon heat. Its subsequent work has identified the critical role local authorities can play in the delivery of heat networks. However, there are a range of barriers facing local authorities attempting to undertake such projects, particularly lack of technical expertise. To overcome these barriers, DECC has committed £3 million to setting up the Heat Network Delivery Unit which will provide specialist advice to local authorities looking to procure technical advice during the feasibility stage of a project, helping them to bridge the gap between themselves and the market. A £6 million funding stream will help provide a contribution towards the costs to local authorities of procuring this advice and technical reports.

The government is also taking steps to ensure that heat network customers are treated fairly and that their bills are transparent. Heat metering can enable customers to more effectively manage their heating supply. As a result, the government is seeking views on options for installing heat meters, and is considering the types of meters available and their associated costs. The policy is due to be put into law by June 2014.

3.8.18 Supporting green engineers

Rolling out renewable heating technologies on the scale required to meet our 2020 targets requires expansion of the supply chain. A key barrier to this expansion is the provision of skilled installers. Government research has found that new companies and individuals looking to enter this sector are confronted by an array of training courses of varying quality. To help incentivise companies to engage in the sector and to choose the right courses, DECC is investing £250,000 into a voucher scheme for courses that are accredited or mapped against the relevant national skills criteria. These vouchers will help meet the costs of training. A further £250,000 will be spent on a pilot scheme for microgeneration apprenticeships, which will support 100 apprentices.

3.8.19 Low carbon heat in industry

Decarbonising industrial heat presents a range of challenges, many of which are sector specific. The DECC and BIS are seeking to work with industry to understand how heat is currently used in key heat-intensive sector and to jointly identify the kinds of technologies that can enable heat to be produced more efficiently and with lower carbon emissions. A 'roadmap' which sets out pathways and action plans for each sector will be developed over the next two years.

In addition to the roadmaps work, the government is undertaking a techno-economic study to help better understand the necessary technologies and costs involved in industrial CCS. Research has also been commissioned to assess the technical and economic potential of recovered waste industrial heat.

3.8.20 Rural communities energy fund

Off gas grid properties, which are primarily in rural areas, are a key target demographic for the deployment of low carbon heating devices. DECC and Defra are jointly funding a £15 million initiative which provides grants and loans for communities in rural areas to carry out feasibility and pre-planning work to ready community-scale renewable energy projects for private investment. A range of heat technologies, including biomass, anaerobic digestion, air and ground source heat pumps will be eligible.

3.9 Agriculture, forestry and land management

3.9.1 Highlighted agriculture, forestry and land management policies and measures

Name of mitigation action	Sectors affected	Type of instrument	Status of implementation	Start year of implementation
Forestry Act, felling licence regulations and environmental impact (forestry) regulations	LULUCF	Regulatory	Implemented	1999
Environmental stewardship (entry level schemes and higher level stewardship)	Agriculture	Economic	Implemented	2005
Catchment sensitive farming	Agriculture	Economic, Information	Implemented	2006
Rural development programme	LULUCF	Economic	Implemented	2007
Soils for profit	Agriculture	Education	Implemented	2009
English agriculture sector greenhouse gas action plan (GHGAP)	Agriculture	Voluntary, Information, Education	Implemented	2010
Woodland carbon code	LULUCF	Economic	Implemented	2011
Revised UK forestry standard	LULUCF	Regulatory, Information	Implemented	2011
Woodfuel implementation plan	LULUCF	Economic, Information	Implemented	2011
EU timber regulations	Forestry	Regulatory	implemented	2012
Forest law enforcement governance and trade regulations	Forestry	Economic	Implemented	2013
Nitrates action plan	Agriculture	Regulatory, Information	Implemented	2013
Grown in Britain	LULUCF	Economic, Information	Implemented	2013

3.9.2 Policy framework

The UK government and Devolved Administrations have each developed a policy framework to reduce all GHG emissions from the agriculture, forestry and land management sector to enable the sector to fulfil its potential in contributing to climate change mitigation. Many of these actions explicitly relate to production efficiency, sustainably increasing the productivity of the sector by improving resource use efficiency.

The respective governments are also working directly with the sector to raise awareness and encourage behaviour change. One of the ways in which the UK government is doing this is through engagement with the Industry Task Force, a group comprising 16 organisations that represent the breadth of the agricultural industry in England. The Task Force published its Greenhouse Gas Action Plan (GHGAP) in 2010 which details 15 on farm measures that reduce emissions whilst improving the efficiency of agriculture. This supports the product roadmaps published by the agricultural sector levy bodies and contributes to Defra's growth plan for agriculture.

Defra's 2012 review of voluntary initiatives to reduce GHG emissions from agriculture detailed there is still significant scope to reduce emissions from agriculture through efficiency gains. However, as the Task Force implement the action plan cost effective opportunities to reduce emissions from the sector will decrease, unless new practices and technologies are developed. In recognition of this Defra has recently announced a Sustainable Intensification Research platform, which will investigate novel ways to increase production whilst reducing environmental impacts of food production. Transformative technologies may also present opportunities for emissions reductions. The government has therefore announced a £160 million Agri-Tech strategy to bring new technologies to market, and to develop national centres of excellence for research on agricultural technologies.

The UK government is also working with the sector to drive faster growth in the update of anaerobic digestion through the AD Strategy and action plan. In September 2013 the UK government announced that it would extend the scope of the Anaerobic Digestion Loan Fund to provide up to £3 million to support the development of small scale on farm AD treating agricultural wastes. The intention is to stimulate interest in the sector, create growth and to attract investment for UK businesses and developers.

All this work is supported by a strong Farming and Food Science Programme which includes a specific programme of research on agriculture and climate change.

The Scottish government continues to fund an expanding range of research to understand the role of land use in GHG emissions and their mitigation, and on adaptation to the impacts of climate change. Including impacts upon biodiversity, water, soils, and the implications for ecosystem functioning, adaptation of farming systems (including crops, livestock and their diseases), changes in land capability under climate change, land use planning for delivering integrated responses across sectors, the costs and benefits of biomass energy crops, the role of forestry in relation to carbon sinks, changes in consumer demand in the move to a low carbon economy, visualisation of future landscapes and stakeholder perceptions of these changes, understanding policy instruments to reduce GHG emissions, evaluation of uncertainty related to climate scenarios and the scope for risk-based approaches.

In Wales, the report *Sustainable Farming and Environment – Action towards 2020* recommends that action is taken by the Welsh Assembly Government to achieve carbon neutral status for agriculture by 2020.

Through the Cambrian Mountains Initiative, Welsh Assembly Government is working with the Countryside Council for Wales, Environment Agency Wales and Forestry Commission to implement an ecosystems services approach that includes conserving soil carbon, reducing emissions, and ways to adapt to climate change.

Under the new Farming Connect Climate Change theme, Welsh Assembly Government will promote nutrient and resource management planning and best practice advice and ensure that adherence to the Code for Good Agricultural Practice (COGAP) occurs. Welsh Assembly Government will use Farming Connect farm development programmes to deliver technical efficiency methods for the dairy, beef, sheep, arable and horticulture sectors to deliver emission reductions. It will also encourage farmers to take stock of farm emissions by use of an on-farm carbon-accounting tool which is part of the new agri-environment monitoring contract.

The current Northern Ireland Rural Development Programme (NIRDP) includes a range of agri-environment measure within a Countryside Management Scheme. An Organic Farming Scheme and Woodland Schemes are also included in the NIRDP. Additionally, a range of mitigation measures are being encouraged within an 'efficient farming cuts greenhouse gases' strategy and action plan.

3.9.3 Agriculture in Scotland

Scottish government's approach to reducing emissions from the rural land use sector is guided by the Land Use Strategy, which sets out three objectives relating to the economy, environment and communities.[106] These support an integrated approach to managing the competing demands placed on the land resource. They seek to balance a productive land-based sector and a successful tourism and leisure industry, with the vital role that land plays in maintaining Scotland's rich biodiversity and in storing carbon.

[106] www.scotland.gov.uk/Topics/Environment/Countryside/Landusestrategy

The transition to low-emission agriculture is aided by a number of linked initiatives developed and supported by the Scottish government, as well as by industry-led action:

- research provides innovative and sustainable solutions and advice on improving efficiency and reducing emissions from farming systems
- advisory initiatives promote sustainable farm practices focusing on resource efficiency and advise on cross-cutting benefits of on-farm action
- support mechanisms like the Scotland Rural Development Programme (SRDP) aid uptake of sustainability measures in agriculture.

3.9.3.1 Farming for a Better Climate

Farming For A Better Climate (FFBC) is an advisory programme aims at influencing farming and land management practices through a programme of best practice advice and demonstration.[107]

Scottish government launched the FFBC initiative in 2010. The programme is delivered by Scotland's Rural College (SRUC) and targeted at land managers to help them take action to mitigate climate change and adapt to impacts of changing climate. FFBC activity includes web-based advice, technical guidance, demonstration events, seminars, conferences and knowledge exchange through farming press. It is designed to encourage voluntary uptake of actions in five areas:

- Using energy and fuels efficiently
- Developing renewable energy
- Locking carbon into soils and vegetation
- Optimising use of fertiliser and manures
- Optimising livestock management practices through a programme of best practice advice and demonstration.[108]

3.9.3.2 Agri-renewables strategy Scotland

Scottish government's Agri-renewables Strategy aims to encourage the uptake of renewable technologies by agricultural businesses and to promote engagement with local communities so as to increase community benefits from renewable energy development. The Community And Renewable Energy Scheme (CARES) is offering loans for the pre-planning costs of renewables projects to land managers, farmers and SMEs.

3.9.3.3 Farm energy auditing and resource efficiency in Scotland

Practical advice on carrying out a farm energy and fuel audit and developing an action plan is available on the FFBC website. This aims to ensure that farm equipment, vehicles and buildings are using energy and fuel as efficiently as possible in order to reduce greenhouse gas emissions and provide cost savings for farm businesses. Advice on zero and low cost options that can be implemented immediately and bring about noticeable savings is also available.

Advice and support in relation to energy and water efficiency, as well as waste, is available to farmers and agricultural businesses through the Scottish government funded Resource Efficient Scotland programme. Resource efficiency and energy audits provided through the programme are only available for diversified activities of a farm operation, such as processing activities for retail ready produce, as well as farm shops, cafés and a farm visitor centre.

[107] www.farmingforabetterclimate.org

[108] www.farmingforabetterclimate.org

3.9.4 Agriculture in Wales

The Welsh government has adopted most of the recommendations set out in the report of an independent Land Use Climate Change advisory group in March 2010. The report identified a scenario whereby the agriculture, land use and food sectors could contribute proportionately to GHG reduction targets through protecting existing carbon stores, sequestering carbon, and cutting or offsetting emissions. This would be achieved while still allowing the industry to deliver other ecosystem services (including food production) and meet future challenges to maintain viable businesses.

The Welsh government's Climate Change Strategy (October 2010) Delivery Plan for Emissions' Reduction sets out five main interventions for the agriculture and land use sectors:

- Woodland creation
- Optimal management of current woodland sink
- Glastir – sustainable land management scheme
- Supporting behaviour change in farming practice – through its Farming Connect scheme.
- Dairy and red meat environmental Roadmaps.

The Welsh government is currently developing its next Rural Development Plan (2014-20) under the EU Common Agricultural Policy. Climate change will be a key cross-cutting theme throughout all parts of the Plan with both reducing GHG emissions and building resilience to a changing climate being embedded into policy measures.

3.9.5 Agriculture in Northern Ireland

The Department of Agriculture and Rural Development (DARD) along with key environmental, agriculture and forestry stakeholders has established an Implementation Partnership to encourage on-farm changes that incorporate the suite of mitigation measures within the Efficient Farming Cuts Greenhouse Gas Emissions Strategy and Action Plan.

Consultation on GHG related schemes to be included in the Northern Ireland Rural Development Programme (NIRDP) 2014–2020, is underway. Phase 2 of the reduction strategy and action plan is under development and will include NIRDP measures, subject to approval of the EC, to provide stronger incentives for farmers. The overall aim of the sector remains to improve its carbon intensity over time leading to a lower carbon impact.

3.9.6 Reducing nitrous oxide emissions

The use of inorganic nitrogen as a fertiliser is a major source of nitrous oxide, which can also arise from manures during storage and application. Estimates of emissions are very uncertain as it is very difficult to model the complex processes in fertilized soils. Although some loss of nitrogen from agriculture is inevitable, such losses represent missed opportunities for food production and contribute to the costs of production. The practices needed to reduce these emissions are, in many cases, similar to those required to address other negative impacts of the use of nutrients. Measures aimed at protecting soils, water quality and biodiversity such as Soils for Profit, Catchment Sensitive Farming and Environmental Stewardship can therefore provide co-benefits for GHG mitigation.

The UK government is improving the advice it gives concerning nutrient management planning and the efficient use of fertiliser and manures. In January 2009 under the revised Nitrates Action Programme it published Protecting our Water, Soil and Air: A Code of Good Agricultural Practice for farmers, growers and land managers (the CoGAP) which offers advice on minimising risk

to pollution while protecting natural resources and allowing economic agriculture to continue. The UK government has also updated the Fertiliser Manual (RB209) which will act as a key point of reference in support of a range of policies aimed at improving nutrient management on farms. The UK government also offers the PLANET decision support software which is the industry standard software tool for helping farmers and advisers plan and record their nutrient applications. PLANET is a computerised version of the RB209 book.

3.9.7 Reducing methane (CH_4) emissions

Emissions of CH_4 result from diffuse sources and through variable biological processes. Major sources include landfill, enteric (digestive) emissions from ruminant livestock, and agricultural manure management. Research funded by the UK government is examining a range of options for decreasing emissions from livestock. Areas currently being researched include ruminant nutrition regimes to reduce enteric CH_4 and nitrogen emissions from livestock, research to improve the productivity of dairy cattle and a study to assess the level and type of farming activity in the livestock sector that UK resources can sustain in order to reach UK GHG and ammonia targets. This work is all part of our broader aim of achieving a thriving farming and food sector with an improving net environmental contribution.

3.9.8 Anaerobic Digestion Strategy and Action Plan

In June 2011, the UK government published the Anaerobic Digestion Strategy and Action Plan to increase the energy for waste produced through anaerobic digestion (AD) and so relates to the energy supply section. This set out the benefits of AD in dealing with food and farm wastes. It included 56 actions designed to tackle the barriers to AD.

Government estimates that sending a tonne of food waste to AD, rather than to landfill, saves about 500 kgCO_2e.

A range of measures have been taken under the Anaerobic Digestion Action Plan including research, studies, market development, development of training standards, field trials, finance (loan funding and funding for research) and simplifying the regulatory framework.

The action plan is taken forward jointly by government and industry. Since the Action Plan was published, the number of AD plants dealing with food and farm wastes has increased from 54 to 120 (October 2013). This complements the long-established used of AD by the water industry in treating sewage sludge.

Many of the actions have been delivered by the Waste and Resources Action Programme particularly those that were concerned with:

- developing markets for digestate
- supporting innovation through the Driving Innovation in AD Fund and
- running the Anaerobic Digestion Loan Fund providing loans at commercial rates where developers were unable to secure alternative funding. The Environment Agency have also delivered a number of actions on the regulation of AD. The AD sector itself and other industry group have also delivered a number of the actions particularly in relation to training and to providing information that assist potential developers to move their projects forward.

The Action Plan complements the support available under renewable energy subsidy schemes: AD is eligible for support under the Renewables Obligation, Feed in Tariffs, the RHI and the RTFO.

3.9.9 Rural development regulation and environmental stewardship

Rural development programmes for Scotland, Wales, Northern Ireland and England are being implemented using expenditure under the EU Rural Development Regulation for 2007-13, of which environmental stewardship is a key part. Addressing climate change is a key element of these Programmes

Rural development programmes for 2014-2020 are currently being developed in Scotland, Wales, Northern Ireland and England. These will include delivering agri-environment-climate schemes, and climate change will be a cross-cutting priority across each Programme.

3.9.10 Non-food crops

In April 2012 the government published its Bioenergy strategy, which built on the work of the 2007 Biomass Strategy. The strategy provides a strategic framework to manage the government's approach to bioenergy including four key principles which cut across the whole sector, they are:

- that policies that support bioenergy should deliver genuine carbon reductions that help meet UK carbon emission objectives to 2050 and beyond
- support for bioenergy should make a cost effective contribution to UK carbon emission objectives in the context of overall energy goal;
- support for bioenergy should aim to maximise the overall benefits and minimise costs (quantifiable and non-quantifiable) across the economy
- when policies promote significant additional demand for bioenergy in the UK, beyond that envisaged by current use, policy makers should assess and respond to the impacts of this increased deployment on others areas, such as food security and wider environmental impacts such as water, air and biodiversity.

The production of biomass, including purpose-grown energy crops, has been encouraged through support schemes such as the Energy Crops Scheme. This closed in August 2013 having approved just over 11,000 hectares of land for the planting of energy crops since the scheme first began. The UK government now wants to see a greater use of waste in bioenergy (particularly in anaerobic digestion) rather than focus on incentivising the use of purpose-grown crops. However, under the Common Agricultural Policy reform proposals on support for rural development there may be opportunities to support the use of energy crops and other renewable energy schemes in the future.

It is estimated that the use of non-food crops for the production of renewable materials and products for industrial applications led to annual carbon savings of 0.14 $MtCO_2e$ in 2005. This figure is estimated to rise to 0.32 $MtCO_2e$ and to 0.87 $MtCO_2e$ by 2010 and 2020 respectively.

Scotland is well placed to develop the use of bioenergy as it has significant forest resource. There are a range of measures in place to support bioenergy from expanding the resource to installing woodfuel systems. The Scottish Rural Development Programme supports woodland creation and management, as well as the establishment of Short Rotation Coppice. A range of support is available to help grow the sector including support for supply chain development and installation of biomass boilers.

The Scottish government has set a target for 11% of the heat consumed in 2020 to come from renewable sources. The Renewable Heat Incentive is providing significant support for the installation of biomass heating plants. The aim is to encourage investment to help achieve renewable heat targets, whilst balancing the demand for construction and other timber from the processing sector.

3.9.11 Sustainable forestry policy

UK forestry policy is devolved in the UK. All four countries have established policies for woodland creation, co-financed through the EU Rural Development Programme. The development of the Woodland Carbon Code, including its launch on an international carbon registry is attracting private and corporate funding to complement the Rural Development Programme. A revised UK Forestry Standard (UKFS) was published in November 2011, including a new guideline on Forests and Climate Change. The requirement for climate change mitigation is that 'forest management should contribute to climate change mitigation over the long term through the net capture and storage of carbon in the forest ecosystem and in wood products'. Meeting the requirements of the UKFS is a condition of grant-aid, and also underpins both the Woodland Carbon Code and forest certification under the UK Woodland Assurance Standard. A strong regulatory framework continues to protect existing woodland from deforestation and degradation.

In England, objectives for forestry are set out in the Forestry and Woodlands Policy Statement (2013), including an aspiration to increase woodland cover from 10% to 12% by 2060 and Northern Ireland aims to double woodland cover to 12% by 2056. The policy statement recognises the need to make woodland planting more attractive to landowners and attract private investment to fund it, particularly through the development of payments for ecosystem services as set out by the Ecosystems Market Task Force. The Woodland Carbon Task Force has been established to help deliver emissions reduction by the forestry sector. A policy on when to convert woods and forests to open habitats in England is in place, which includes as assessment of implications for carbon balance in the process of prioritising sites for restoration. The development of a thriving forestry sector, through an industry-led action plan (Grown in Britain), is highlighted as an essential element to achieve woodland planting aspirations and deliver emissions savings in other sectors through the sustainable use of woodfuel as a source of renewable energy and harvested wood products substituting for other materials.

In Scotland, forestry is recognised as having an important role in contributing to emissions reduction targets through carbon sequestration and climate change mitigation is a specific objective of woodland creation. Following on from the 2012 Woodland Expansion Advisory Group review, a target to create an additional 100,000 ha of new woodland by 2022 was set out in the 2013 Low Carbon Scotland Report. This level of woodland creation aims to reduce Scotland's emissions by around 4.8 $MtCO_2e$ in the period to 2027. To complement woodland creation, a framework to better control woodland removal is also in place along with proposals to further increase emissions abatement through greater use of Scottish timber in building construction and refurbishment.

England, Scotland and Wales also have established Woodfuel Strategies that aim to maximise the contribution of both existing and new woodlands to renewable energy production. For example, the supply of small to medium scale heat in off gas grid areas is the focus of Forestry Commission England's Woodfuel Implementation Plan, which is supported by renewable energy policies including the Renewable Heat Incentive.

An independent study (*the Read Report: combating climate change – a role for UK forestry*), commissioned by the Forestry Commission, was published in 2009 and evaluated the role of forests and harvested wood products in GHG balance.

3.10 Public sector

3.10.1 Highlighted public sector policies and measures

Name of mitigation action	Sectors affected	Type of instrument	Status of implementation	Start year of implementation
Salix, Public Sector Loans.	Public	Economic	Implemented	2004

3.10.2 The role of local government

Local authorities are uniquely placed to provide vision and leadership to local communities, to raise awareness, and to help change behaviours. Through their powers and responsibilities (housing, spatial planning, local transport) they can significantly influence local emissions.

The government commissioned the CCC to produce guidance for local authorities on designing and implementing low-carbon plans to cut carbon emissions locally. *How local authorities can reduce emissions and manage climate risks* was published on 17 May 2012.

DECC publishes annual estimates of CO_2 for all UK local authorities and regions, and requests local authorities to measure emissions from their own estate and operations and to publish on their websites a summary report of these.

Local authorities can benefit from the Salix Finance interest free loan scheme for energy efficiency measures (see "Funding schemes for public sector organisations" below).

The Central Energy Efficiency Fund (CEEF), launched in 2004, is one of the Scottish government's key vehicles for delivering energy efficiency as well as renewable energy measures and reducing carbon emissions in the public sector in Scotland.

The £20 million CEEF funding was split between Scotland's 32 local authorities (£15 million with amounts allocated depending upon the authorities' population and their geographical area), NHS Scotland (£4 million) and Scottish Water (£1 million).

Between 2012-2014, the Scottish government will award a further £5.5 million to the existing £4 million Salix Finance energy efficiency loans fund and has opened up the eligibility to all public sector bodies in Scotland who are permitted to borrow.

In Scotland, all local authorities have signed Scotland's Climate Change Declaration and committed to taking action on climate change.

All of Scotland's local authorities are engaged with the Resource Efficient Scotland programme and have completed their Carbon Management Programme. A number of other public sector bodies, including the Scottish government's own estate, have either undertaken or are actively engaged in this programme.

3.10.3 Planning

The statutory land use planning system is complemented by a framework of national planning policies issued by the government and the devolved administrations.

3.10.3.1 Planning in England

The government published a new National Planning Policy Framework in 2012, replacing most previous Planning Policy Statements.

It recognises the importance of the planning system in helping to shape places that minimise vulnerability and provide resilience to the impacts of climate change. It makes clear that local authorities should proactively plan to mitigate and adapt to climate change, taking full account of flood risk, coastal change and water supply and demand considerations.

3.10.3.2 Planning in Scotland

Scotland's Third National Planning Framework (NPF3) and revised Scottish Planning Policy is due to be published in June 2014.

The transition to a low carbon economy has been identified as a key theme for the NPF3

- The Spatial Planning Assessment for Climate Emissions (SPACE) tool will ensure that the implications for GHG emissions of alternative spatial planning options are factored into decision-making
- The expansion of renewable energy generating capacity is strongly supported by national planning policy
- Sustainable and active travel are promoted by Scottish Planning Policy and the National Planning Framework
- The Scottish government is supporting planning authority work on heat mapping to inform future strategic and local policy on the development of heat networks
- Scottish Planning Policy provides clear guidance on development and flood risk, and a replacement Planning Advice Note on Flooding, Water and Drainage will be published in 2013.

The land use planning actions of local government under the public bodies duty aim to cover low carbon, investment, place making and connectivity that will aid the transformational changes required.

3.10.3.3 Planning in Wales

Planning Policy Wales was updated through a Planning for climate change Ministerial Interim Planning Policy Statement (MIPPS) in 2006 which included a comprehensive set of changes to PPW to further increase the emphasis on tackling climate change in national planning policy. In 2009 guidance was updated on access statements and advice on design statements to increase the emphasis of climate change as a key design consideration.

3.10.4 Funding schemes for public sector organisations

In 2004 Salix Finance was established to accelerate public sector investment in energy efficiency technologies through interest-free loans. It has established recycling energy efficiency loan funds with public sector bodies, including local authorities, universities, hospitals and schools. The aim of the scheme is to remove the upfront capital barrier to energy efficiency investment. Loans are provided for projects with a payback period of normally less than 5 years. Repayments are met from energy bill savings and once the loan is repaid the organisation continues to benefit for the lifetime of the installed measures. To date Salix loan funding has helped around 800 public sector clients across England, Wales and Scotland to undertake over 11,500 energy saving projects valued in excess of £270 million.

The scheme delivers good value for money: for every £1 invested in a project, Salix estimates that £4 is saved on energy bills over the lifetime of that project. The scheme also has a positive impact on the energy efficiency supply chain through increased demand for energy efficiency measures.

3.10.5 Public sector procurement

Public sector procurement amounts to £230 billion, around a sixth of purchasing power in the UK. The government is committed to using this purchasing power sustainably, building on the work that has been done since the Sustainable Procurement Action Plan (2007) was put in place.

With stakeholders and industry, the UK government continues to develop and promote tools to support sustainable procurement. These include a suite of Government Buying Standards (based on the former Buy Sustainable-Quick wins which are now mandatory for central government), for a range of products and services commonly purchased by the public sector, the Flexible Framework and prioritisation tool, as well as product/sector specific guidance and training modules. For example it is now looking at disseminating the highly successful approach to construction procurement adopted for the London 2012 Olympics. Government also seeks to ensure its framework contracts embed sustainability considerations into their tenders and that departments do the same. The Scottish government's National Electricity Contract will be 100% supplied with renewable electricity saving the public purse at least £40 million with 99% of the public sector already committed to using the contract. The Procurement Reform (Scotland) Bill was introduced to the Scottish Parliament on 3 October 2013. It aims to support sustainable economic growth through improved procurement and gives public bodies a place to focus.

The Greening Government Commitments requirement for government departments and their agencies to use Government Buying Standards within the context of achieving value for money. The commitments also require departments to monitor and report on their supply chain emissions.

3.10.6 Central government (including the government estate)

The Greening Government Commitments deliver the estates and operations element of government's Vision for Sustainable Development. Published in 2011, these targets require 21 central government departments to reduce GHG emissions, water consumption and waste by 25% by 2015, and to procure more sustainably. The GGCs are firm commitments which cover more of the government's estate and operations than the predecessor regime, and present a more streamlined set of targets for departments to meet and the public to scrutinise.

The GGC targets are ambitious targets set for improving the environmental performance of the government estate, requiring deep cuts in emissions, waste and water use in a tight timescale. To reduce its environmental impact, by 2015 government will:

- Reduce GHG emissions by 25% from the whole estate and business-related transport
- Cut domestic business travel flights by 20% by 2015
- Reduce the amount of waste that government generates by 25%
- One year target in 2011-12 to cut paper consumption by 10%

Article 5 of the EU Energy Efficiency Directive requires central government departments either to renovate annually 3% of the total floor area of buildings over a certain size that do not meet minimum energy performance requirements per year or take alternative measures to achieve an equivalent amount of energy savings. This requirement starts in January 2014 and runs until 2020. The UK intends to comply with Article 5 by relying on achievement of the 25% GHG emission reduction target set under the *Greening Government Commitments* and stock rationalisation within the government estate.[109]

[109] https://www.gov.uk/government/publications/greening-government-commitments

3.10.7 Welsh government sustainable development

The Welsh government places sustainable development as its central organising principle. This commitment to sustainability includes managing the environmental impacts of in house activities. For example, the Welsh government is committed to achieve at least a 30% reduction in GHG emissions from its buildings and other fixed infrastructure by 2020 (on a 2011 baseline). This not only ensures alignment with the Welsh Climate Change Strategy, but also shows leadership to the public sector and more broadly to the citizens of Wales. It also provides a background against which to base future decisions.

Results to date indicate positive progress and CO_2 emissions from the Welsh Government's Administrative Estate have fallen by 17% over the past 3 years. Monitoring and managing other environmental parameters have resulted in similar improvements: a 28% improvement in domestic waste created; and a 37% reduction in water consumption over the past two years, each of which have beneficial climate change impacts.

3.10.8 Schools

3.10.8.1 ECO Schools

The Eco Schools movement is an initiative designed to encourage whole-school pupil-led action for the environment across a range of issues, including water and energy use, waste minimisation, bio-diversity and sustainability. It also helps support pupil learning through linking environmental and sustainable development issues with curricular areas.

Scotland is a leading player in the international Eco-Schools movement, The number of schools and pre-schools centres registered and participating with Eco-Schools Scotland currently stands at over 4,100, with around 97% of local authority schools participating in the Programme. To date over 1,700 schools in Scotland have been awarded the prestigious Green Flag, making the Scottish Eco-Schools programme amongst the best performing in the world.

The Welsh government, either directly or via Natural Resources Wales and Waste Awareness Wales, funds the Eco-Schools programme which is delivered in Wales by Keep Wales Tidy. Some 90% of Welsh schools take part in the programme. There are over 750 Green Flag schools in Wales (almost 8% of the global total) and a further 120 have also achieved a platinum award for receiving four Green Flags. Platinum schools act as beacons in mentoring other schools in their locality to move through the award stages towards a Green Flag.

Eco-Schools is managed in England by Keep Britain Tidy, which has the most Eco-Schools in the world – with 70% of all schools in England currently registered with the programme. There are currently 1,736 schools in England that have been awarded the Green Flag. 4,863 schools have achieved the bronze award and 5,292 the silver award.

3.10.9 Higher education

3.10.9.1 Student green fund

The Student green fund provides £5 million for student led sustainability projects providing between £150,000 and £300,000 for 25 students' unions over two years. The projects will engage over 50,000 students across the country, and save 4 $MtCO_2e$.

Embedding sustainability into the core purpose of higher education, the students' green fund will empower cohorts of graduates to leave higher education as part of the solution to our environmental challenges. The fund turns students' unions into hubs of sustainability and helps students to adopt pro-environmental habits which last far beyond their time in education. Further information can be found in Chapter 8.

3.10.9.2 Revolving green fund (RGF)

The RGF provides recoverable grants to institutions for projects investing in energy-efficiency and low-carbon technologies. For example, for RGF3 LED lighting is the most popular type of project followed by pipework insulation. RGF3 projects will reduce carbon emissions by around 20 $MtCO_2e$ per year, representing 2.5% of the sector's 2020 carbon reduction target.

Table 14: Revolving Green Fund

	Value (£000)	Annual carbon savings	% of 2020 target	Av payback on small scale projects
RGF1	30,000	92,232 (2)	4.8	
RGF2	10,800	18,500	2.3	
RGF3	20,546	20,580 (3)	2.5	4.6 years
	61,346	131,312	9.6 (4)	

The 2010 evaluation of RGF1 found that If the current level of success and trajectory of project implementation is sustained then the RGF will lead to significant further carbon and cost savings, potentially up to 8.6% of current English HEI carbon emissions every year by 2020.

3.10.9.3 Centres for Excellence in Teaching and Learning

Two of the Centres for Excellence in Teaching and Learning were in sustainability. Plymouth provided central support for champions working within each academic department and Kingston worked to increase students' understanding of sustainable communities. The Higher Education Academy are active and successful in developing good practice and the Green Academy helps those who want to make a step change. The Quality Assurance Agency are developing a Guide to Education for Sustainable Development. Bristol, Gloucester, Nottingham, UWE, Exeter, Aston, Keele and Plymouth are particularly active in this area.

3.10.9.4 Higher education in Wales

Starting in September 2013, Live Greener is a 12-month project which aims to put Welsh students at the heart of the sustainability agenda. NUS (National Union of Students) Wales, in partnership with TYF, was awarded a £68,000 contract substantially funded by the Welsh government and managed through the Higher Education Funding Council Wales (HEFCW). Some 6,000 students will be actively engaged giving around 9,000 hours of their time to obtain real impacts such as significant reductions in electricity and water usage in halls of residence, and in carbon emissions.

Further information, including the targets of the project, can be found in Chapter 8.

3.10.10 The NHS in England

The National Health Service (NHS) in England, Europe's largest employer and a leader in local communities across the country, launched a next step Carbon Reduction Strategy for England in January 2009. Entitled *Saving Carbon – Improving Health*, the strategy aimed to significantly reduce the carbon footprint of the NHS by 80% by 2050.

The strategy also identified an interim aim to reduce its 2007 carbon footprint by 10% by 2015. This requires the current level of growth in emissions to not only be curbed but the trend to be reversed and absolute emissions reduced.

In 2014 a new Sustainable Development Strategy for the NHS, Public Health and Social Care System will be launched to cover the period 2014-2020. The new strategy is not just for the NHS but embraces the whole health and care system including public health and adult social services. The strategy describes the most important principles, mechanisms and actions needed to foster a more sustainable health and care system over the next five years. In leading

by example the NHS and the wider health system can help mitigate climate change, prepare for the impacts of climate change and improve our health tomorrow as well as today.

3.10.11 The NHS in Wales

NHS Wales contributes to the Welsh government's target of a 3% year-on-year reduction in GHG emissions. It acts as an exemplar for the rest of the public sector.

In the 2011-12 Estates Performance and Condition Report the carbon performance indicator (PI) showed an improvement at five of the health boards/trusts. It is notable that among the lowest PIs are those of Aneurin Bevan Health Board and Cardiff and Vale University Health Board both of which are fully ISO14001 certified and, in the case of Cardiff and Vale, a high proportion of its energy used is derived from CHP which has considerably improved its performance in this area. With the introduction of ISO 14001 certification at all major NHS sites in Wales by the end of 2012 and the introduction of annual carbon footprint reporting it is expected that both absolute CO_2 emissions and the carbon PI will improve in subsequent years.

Local health boards (LHBs) and trusts submit their carbon diagnostic tool (CarDio) returns each year. This allows them to report their carbon emissions on an annual basis, to benchmark against each other and to compare against the 2010-11 baseline.

An Emissions Reduction Action Plan Tool has also been developed for NHS Wales by Carbon Trust Wales and NHS Wales Shared Services Partnership – Facilities Services (NWSSP-FS). This tool, which has been completed by each NHS organisation, provides a 5 year programme of projects that will lead to emissions reductions and identifies the capital cost, the revenue savings and carbon savings in future years. LHBs and Trusts have just submitted their first returns using the Tool and these are being assessed and reviewed by Welsh government and NWSSP-FS.

NWSSP-FS continues to facilitate the Welsh Health Environmental Forum and its associated website, which acts as a central hub for the sharing of good practice and the exchange of environmental information including carbon reduction for LHBs and NHS Trusts in Wales.

LHBs in Wales will also have to register for Phase 2 of the CRC Energy Efficiency Scheme currently by January 2014. This will provide an increased focus on cutting down emissions whilst recognising that the most important thing for the NHS remains the safe treatment of patients.

3.11 Waste

3.11.1 Highlighted waste policies and measures

Name of mitigation action	Sectors affected	Type of instrument	Status of implementation	Start year of implementation
Landfill tax	Waste	Fiscal	Implemented	2009

3.11.2 Waste

Consistent with the EU Landfill Directive, the government and the devolved administrations have published waste strategies aiming to reduce the quantity of waste produced and to increasingly recover value from it. The strategies also set targets for reducing the amount of waste sent to landfill and to increase the amount of recycling or composting. These targets will further reduce the level of CH_4 emissions from the waste sector in the UK.

In 2011-12 households in England produced 22.9 million tonnes of waste, continuing the year on year fall seen since 2007-8. The last data for commercial and industrial from 2009 also shows a significant decrease with 47.9 million tonnes, a decrease of 29% since the previous survey in 2002-3. The industrial sector accounts for 24.1 million tonnes and the commercial sector 23.8 million tonnes.

In 2011-12, 43% of household waste was recycled, the highest recycling rate recorded for England, local authorities recycled, composted or reused 10.7 million tonnes of the waste they collected. This amounted to more than was landfilled for the first time since records began, although an increase in incineration may have partly

A total of 25 million tonnes, or 52%, of commercial & industrial (C&I) waste was recycled or reused in England in 2009, compared to 42% in 2002-3. A total of 11.3 million tonnes, or 24%, of C&I waste was sent to landfill in 2009, compared to 41% in 2002-3.

Small enterprises, with up to 49 employees, produced 16.6 million tonnes of C&I waste in England, in 2009, or 35% of total C&I.[110]

UK waste policy contributes to emission reductions via three routes: reductions in CH_4 emissions from landfill; emission reductions from efficient use of materials, waste prevention, re-use and recycling; and, via energy recovery from waste, which offsets fossil fuel energy generation elsewhere in the economy. Methane emissions from biodegradable waste in landfill alone account for 40% of all UK CH_4 emissions and 3% of all UK GHG emissions.

The EU Landfill Directive stipulates a reduction of biodegradable municipal waste landfilled to 35% of 1995 levels by 2020 (with interim targets in 2010 and 2013). England set up the Landfill Allowance Trading Scheme (LATS) to meet its share of the UK target but LATS has now ended as the single most important driver for diverting waste from landfill is the landfill tax. This is currently set at £72/tonne landfilled (non-inert) waste, and will not fal below £80 per tonne from 2014-15 to 2019-20. The landfill tax not only encourages diversion of wastes from landfill, but also encourages waste prevention through an increase in the cost of disposal. The June 2011 Waste Review for England outlined our commitment to move waste up the waste hierarchy and away from landfill, with waste prevention a priority. Defra are currently finalising the Waste Prevention Programme for England, to be published by the end of 2013. The programme will set out how central and local government, businesses, communities, civil society groups and individuals can work to achieve better resource efficiency and reduce the amount of waste produced across the economy.

Food waste has been proposed as one of the priority waste streams under the Waste Prevention Programme. The government and devolved governments in Wales, Scotland and Northern Ireland are providing advice to consumers through WRAP's 'Love Food Hate Waste'[111] campaign and working with the industry to improve products and practices through the Courtauld Commitment.[112]

The UK is seen as a leader in the EU on food waste prevention. The UK government and devolved governments have worked very successfully with industry to reduce supply chain food and packaging waste by nearly 10% over the last 3 years, while household food waste is down by even more – 13% since 2006. The Courtauld Commitment results show that the voluntary approach can deliver real reductions in waste, while allowing businesses to be more efficient and competitive. In May 2013 the UK government and devolved governments in Scotland, Wales and Northern Ireland launched a third phase of the Courtauld Commitment. The scheme aims increase to further reduce the weight and carbon impact of household food waste, grocery product and packaging waste, both in the home and the UK grocery sector. During the three phases of the Courtauld Commitment, it is expected that a 20% reduction in household food waste to be achieved.

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[110] Commercial and industrial waste generation and management https://www.gov.uk/government/publications/commercial-and-industrial-waste-generation-and-management

[111] http://www.lovefoodhatewaste.com/

[112] http://www.wrap.org.uk/category/initiatives/courtauld-commitment

The new Hospitality and Food Service Agreement is a voluntary agreement between the four governments across the UK and the hospitality and food service sector, which includes restaurants, hotels, caterers and pubs. This agreement supports the sector in preventing and recycling food and packaging waste. There is now over 20% coverage of the sector by food and drink sales. The target is 25%. If 25% of businesses in the sector measured by turnover, sign up to the agreement, they could save a total of £76 million and reduce their CO_2 emissions by 570,000 tonnes over the period of the agreement. It aims increase the overall rate of signatories' food and packaging waste that is being recycled, sent to anaerobic digestion or composted to 70% by 2015.

Further incentives for recycling arise from the EU Packaging Directive targets for packaging recovery and recycling. The Packaging Recovery Note (PRN) scheme enables compliance with these targets, allowing obligated parties to acquire PRNs (generated through verified recycling/ recovery of packaging) in order to demonstrate compliance. Further, in 2010 the revised EU Waste Framework Directive stipulates a minimum household recycling target of 50% of household waste, to be achieved by 2020.

Alongside instruments to reduce landfilling of waste, regulations on the landfill sites themselves, and an incentive through the Renewables Obligation, have helped to increase the capture of landfill gas (CH_4) – up to 70% of this gas is now captured and is either utilised for energy generation (which is supported by receiving 0.25 Renewable Obligation Certificates per MWh), or is flared. This ensures not only a reduction in CH_4 emissions escaping to the atmosphere, but also produces electricity, offsetting the need for other electricity generation.

All UK waste policies are based around the waste hierarchy with the aim of driving waste out of landfill to avoid the CH_4 emissions and towards reuse or recycling. However, for genuinely residual waste, energy from waste is supported. The biogenic content of waste used for energy production is counted towards renewable energy targets and is eligible for renewable financial incentives. England currently has about 50 operational EFW plants with a capacity of over 10 million tonnes a year. In 2011 1.2 TWh of waste derived renewable electricity was produced from thermal combustion. In February 2013 Defra published "Energy From Waste – a guide to the debate" to inform discussion and aide decision makers.

3.11.3 Scottish government ambition for decarbonising waste

The Scottish government's Zero Waste Plan[113] (2010) sets out a vision for a zero waste society; a society where waste is seen as a valuable resource, landfill is phased out, and increasing amounts of materials are reused or recycled, leaving only limited amounts to be treated. This is complemented by actions to progressively design out avoidable waste from the Scottish economy.

The plan sets waste management targets including:

- the proportion of household waste subsequently recycled, composted and or prepared for re-use. The targets are 40% by 2010, 50% by 2013, 60% by 2020 and 70% by 2025;
- recycling 70% of all waste (including commercial and industrial waste) by 2025; and
- reducing the proportion of total waste sent to landfill to a maximum of 5% of all waste by 2025.

[113] http://www.scotland.gov.uk/Publications/2010/06/08092645/0

Safeguarding Scotland's Resources: Blueprint for a more Resource Efficient and Circular Economy[114] *(2013)* sets ambitious targets to cut Scotland's total waste from households and businesses by 7% by 2017 and by 15% by 2025. Measures cover:

- working with key business sectors through our Resource Efficient Scotland[115] programme to cut waste and use energy and materials more efficiently – delivering environmental benefits and improving competitiveness
- promoting reuse through improving supply as well as demand for reused items, including strengthening the reuse sector
- influencing behaviours, including through education and communications such as last year's food waste prevention campaign.

Landfill gas is the main waste related contributor to our territorial greenhouse gas emissions. In 2012, the Scottish Parliament passed the Waste (Scotland) Regulations 2012. These regulations introduced measures to transform how waste and recyclables are processed in Scotland. Specific measures introduced by the regulations include:

- a requirement for businesses to present dry recyclables (metals, plastics, paper, card and glass) and food waste for collection;
- a requirement on local authorities to provide householders with a collection service for dry recyclables and food waste;
- a ban on materials collected separately for recycling going to landfill or incineration; and
- a ban on biodegradable municipal waste going to landfill by the end of 2020.

These regulations will progressively change both the amount and composition of waste going to landfill, and largely eradicated CH_4 producing bio-degradable material from landfill

3.11.4 Waste in Northern Ireland

The Waste Framework Directive 2008 requires that by 2020, the preparing for re-use and the re-cycling of household waste shall be increased to a minimum of 50%. The Waste Regulations (Northern Ireland) 2011 (S.R.2011 No.127) enshrines this target in Northern Ireland legislation.

The revised Northern Ireland Waste Strategy was published on 25 October 2013 and places the emphasis on resource efficiency. Policy proposals include challenging targets for recycling (including the EU target), introducing a restriction on the land filling of separately collected food waste and the development of a Waste Prevention Programme.

3.11.5 Waste in Wales

The Welsh government is providing support for alternative treatment of Local Authority Municipal Waste via the Waste Infrastructure Programme which has the aim of supporting groups of local authorities that are working together to develop sustainable long term solutions for

- food waste management
- residual (black bag) waste management.

[114] http://www.scotland.gov.uk/Publications/2013/10/6262

[115] http://www.resourceefficientscotland.com/

Assistance is given to all groups of authorities and there are seven hubs and groups of local authorities involved in food treatment procurement. The first to be built is in Gwynedd, commissioning later this year. Two hubs are in procurement for residual treatment, others are considering options and configuration of the hubs.

Prosiect Gwyrdd is a procurement hub comprising five local authorities in South East Wales. The project will receive over £4.2 million of Welsh government funding each year to divert non-recyclable waste from landfill over a 25-year period. The project also received Welsh government support throughout its procurement process.

The waste treatment solution will provide an annual net benefit predicted carbon saving of 51,392 tonnes CO_2e in comparison to continued landfill. If these benefits were replicated for other residual waste treatment groups across Wales, there would be an annual net benefit of approximately 180,000 tonnes CO_2e in comparison to continued landfill.

The Collaborative Change Programme supports local authorities to evaluate their waste management performance and produce robust business cases, with a view to ensuring that all local authorities optimise their potential to operate sustainable waste management services. Twelve local authorities have been assisted by the programme since it's inception in late 2011, and the Welsh government aims to work with a further four in 2013-14.

The option appraisals, which are undertaken with authorities as part of the business plans process, identify potential carbon savings. The actual savings made will be dependent upon the waste service configuration that an authority chooses to implement. This data will become available as the programme progresses.

3.11.6 Energy from waste

The incineration of energy from waste (EfW) is supported under the RHI through the biomass tariff and so links to the energy supply section. The RHI pays a tariff for the proportion of heat generated from the biomass in municipal solid waste (MSW), which is typically 50% or higher. Currently, other types of waste, such as commercial and industrial waste are excluded. However, other types of waste are supported under the Renewables Obligation (RO).

Energy from waste has the dual benefit of producing renewable energy and avoiding harmful CH_4 emissions when the biodegradable proportion of this waste decays in landfill. The main input fuels for incineration are currently waste collected by local authorities (typically referred to as MSW), commercial and industrial waste, and in some cases construction and demolition waste.

MSW, being the only waste stream eligible under the RHI, provides a significant barrier to companies wanting to build EfW plants. Waste contracts will often include other types of waste and it is rarely viable to run a plant purely on MSW. Furthermore, the RO supports the incineration of other wastes so there is merit in being consistent, given that EfW businesses will often deal with both incentives.

We wish to align the RO with the RHI and not present additional barriers to participants already complying with the RO requirements. We will therefore extend support under the RHI to energy from commercial and industrial wastes where not more than 90% of the waste is, or is derived, from fossil fuel (i.e. waste has a biomass content of at least 10%). Participants will receive support only on the biomass proportion of their waste and will therefore have to demonstrate what proportion of the waste is biomass.

3.12 Policies to promote sustainable development in developing countries and emerging economies

3.12.1 Sustainable development dialogues

Defra led the cross-governmental Sustainable Development Dialogues (SDD) with China, India, Brazil, Mexico and South Africa, through which UK departments collaborated with these rapidly growing economies to exchange skills and knowledge and trial new sustainable development methodologies. Projects implemented under the dialogues have left lasting legacies, including on climate change mitigation. For example our work with China on sustainable agriculture that began under the SDDs includes a strand on the impacts of climate change.

When the dialogues reached their end date, the UK government recognised the need to continue engaging with key countries on sustainability issues, including climate change, and the time was right for a new approach, focused on closer strategic engagement at a higher level. For example, the UK initiated and participated in constructive discussions around Rio+20 and the post-2015 development framework, with the aim of influencing thinking and decision-making on sustainability issues of global importance, including climate change.

3.12.2 International Sustainable Development from Wales

The Welsh Government has put at its heart a commitment to sustainable development, recognising the need to focus on future as well as current generations.

The Minister for Natural Resources and Food attended the 19th Conference of the Parties in Warsaw in November and spoke at a NRG4SD event emphasising the Importance of Implementing Climate Action on the basis of territorial cooperation and how effective sub-national government climate strategies can and must closely link mitigation and adaptation measures within their specific territorial context.

In 2012 the Welsh government Environment and Sustainable Development Minister participated in the 18th Conference of the Parties in Doha in. Whilst at the conference, the Minister contributed to a high level Network of Regional governments for Sustainable Development event – highlighting the work of Wales and illustrating Wales as an exemplar for other nations.

3.12.3 Trade and investment flow

The UK is strongly committed to ensuring that trade policies promote long-term sustainable development and aims to support the long-term benefits from reduction or elimination of tariffs on some products exported by developing countries. Ensuring that potential negative environmental impacts of trade liberalisation are addressed is essential for the long-term sustainability of benefits reaped by developing countries from improved market access.

The UK is strongly committed to liberalising environmental goods and services through the WTO, thus promoting a low carbon future in a pro-development dialogue. In addition, the UK is also strongly committed to provide Aid for Trade to developing countries, and especially the poorest among them, to help build their capacity to trade, integrate into global markets while also addressing any adjustment costs that might arise from more liberalisation, within the context of sustainable development. The UK spends £1 billion a year on Aid for Trade projects.

The UK is also encouraging private sector investments in low carbon programmes in developing countries through its five-year £3.87 billion International Climate Fund (described in Chapter 6). A key objective of this fund is to catalyse greater private investment in climate action by helping address the market barriers to such investments, including by helping to reduce the risks such investors face. The ICF does this both at a global level (such as through its £130 million

investment in the Climate Public-Private Partnership programme) and in individual countries (such as the GETFit programme in Uganda) which are described in Chapter 6.

3.12.4 Forestry

The UK supports the fight against global deforestation by a number of supply- and demand-side measures in particular to combat the trade in illegally harvested timber. The UK has supported capacity building in timber producing countries to increase their ability to develop legality assurance systems to ensure only legally harvested timber is exported, including through the £79 million Forest Governance, Markets and Climate (FGMC) fund. The UK government has also introduced legislation to implement EU Regulations on the trade in illegal timber, the EU Timber Regulation and the Forest Law Enforcement, Governance and Trade (FLEGT) Regulation which came into force on 20 February 2012. The Timber and Timber Products (Placing on the Market) Regulations entered into force on 3 March 2013.

As well as these practical measures, the UK continues to support the promotion of sustainable forest management, including the use of forests for carbon emission reductions, through various international fora including the UN Forum on Forests, and within the European Union through the development of the EU Forest Strategy which includes proposed actions on the mitigation potential of forests as well as measures to increase the adaptive capacity and resilience of forests.

3.13 Monitoring and evaluation

3.13.1 Carbon budget management

The UK government's approach to managing carbon budgets centres on a series of annually published reports:

- the annual statement of emissions which shows what emissions were in the past year and why
- the CCC's annual report on progress against carbon budgets
- government's response to the CCC's annual progress report
- the updated energy and emissions projections which assess the impact of our policies on future emissions trends.

Meeting these statutory and non-statutory reporting duties is the primary accountability mechanism for progress against carbon budgets.

3.13.1.1 Annual emissions statement

The annual statement of emissions required under Section 16 of the Climate Change Act 2008 sets out the steps taken to calculate the "net UK carbon account". This is compared against the carbon budgets to determine whether they are being met, and must not exceed the level of the carbon budget at the end of each budgetary period. Annual statements must be produced by 31 March each year.

Final statements for each budgetary period – which will combine the results of each annual statement must be produced by 31 May in the second year following the end of the budgetary period. This will determine whether the budget has been met.

3.13.1.2 CCC's annual progress report and the government's response

The CCC published its 5th Annual Progress Report on 26 June, 2013.[116] The government published its response on 10 October 2013.[117]

3.13.2 Progress report – Scottish Climate Change Act

The Committee on Climate Change (CCC) published their second report on the progress and activities of the Scottish government towards meeting Scottish climate change targets in March 2013. The report acknowledges the underlying progress Scottish government policies have made to emissions abatement.

This is an annual statutory requirement of the Climate Change (Scotland) Act 2009, and one of the main mechanisms by which Scottish ministers are held publically to account for their climate change duties.

The Act requires Scottish ministers to set annual targets for emissions at least 12 years in advance. In October 2010, the Scottish Parliament passed legislation setting the first batch of annual targets for the years 2010 to 2022. One year later, the Scottish Parliament passed subsequent legislation setting the second batch of annual targets for the years 2023 to 2027.

The Act requires that, as soon as reasonably practicable after setting a batch of annual targets, ministers publish a report setting out proposals and policies for meeting those targets. The second report on proposals and policies (RPP2) was published in June 2013, and lays out how Scotland can deliver annual targets for reductions in emissions from 2013 to 2027.

In support of this, through its updated Government Economic Strategy, the Scottish government has established a new strategic priority, the "Transition to a Low Carbon Economy" emphasising the central importance of low carbon to Scotland's future economic success.

The Scottish Climate Change Act includes a mandatory provision for Scottish ministers to develop and publish an Energy Efficiency Action Plan. This plan must be revised at least every three years and be reported on annually to the Scottish Parliament. The plan sets out the actions that the Scottish government is taking to improve energy efficiency across all sectors in Scotland and the contribution that this will play in meeting the overall Climate Change Act target.

3.14 Discontinued policies

3.14.1 Consumer Engagement and The Climate Change Initiative

The Climate Change initiative and the Act on CO_2 campaign were reviewed as part of the post-election communication freeze across government in 2010. Taking account of the change in emphasis in DECC's priorities and the need to reassess the focus of our communication. A move away from general behaviour change towards the more delivery focused stage in 2010, DECC decided to refocus marketing effort towards the Green Deal and more earned rather than paid-for channels. In addition, after having completing a communication review, DECC identified the need for an attitudinal change campaign and work on this began in 2013.

[116] Meeting Carbon Budgets – 2013 Progress Report to Parliament | Committee on Climate Change

[117] Government response to the Fifth Annual Progress Report of the Committee on Climate Change: Meeting the Carbon Budgets - Publications - GOV.UK

3.14.2 Common Agricultural Policy – abolition of set-aside

In the most recent reform of the Common Agricultural Policy (CAP), which will run from 2013-2020, the EU has abolished the arable "set-aside" policy in response to concerns over food security. Previously, farmers had been leaving some land fallow to prevent production surpluses accumulating, but that land will now be eligible to be used for production under the new CAP rules.

The UK government view is that direct payments will neither directly reduce nor not increase GHG emissions by farmers provided that they are decoupled from production as they are in England. It is possible that the new 'greening' requirements may have a beneficial effect, for instance through the retention of permanent grassland and by taking some land out of production and thus reducing inputs, although it is too early to attempt to quantify this.

3.14.3 Regional Development Agencies and Localism

The closure of the Regional Development Agencies (RDAs) was announced in the Budget in June 2010. Along with the creation of Local Enterprise Partnerships, the closure of the RDAs implemented the Coalition Agreement commitment to change the local economic delivery landscape, and contributed to the commitment to reduce the number of public bodies.

The Coalition Agreement commitment to change the local economic delivery landscape, also led to the ending of the framework of Multi-Area Agreements, Regional Assemblies, Regional Spatial Strategies, Sub National Review and Single Regional Strategies.

3.14.4 UK Environmental Transformation Fund (ETF)

The ETF ran from 2008 until 2010 and distributed £800 million of funding for policies both in the UK and internationally. The International Climate Fund has now replaced the ETF and will provide £3.87 billion from 2011 to 2016 to support international poverty reduction by helping developing countries to adapt to climate change, take up low carbon growth, and address deforestation. Further information on the ICF can be found in Chapter 6.

Chapter 4:
Projections of GHG emissions, scenario 'with measures'

4.1 Key developments

- In 2011, UK emissions of the basket[118] of six greenhouse gases (GHGs) covered by the Kyoto Protocol were estimated to be 553 million tonnes of carbon dioxide equivalent ($MtCO_2e$), 29% lower than the 1990 level of 775 $MtCO_2e$ UK emissions of the basket are projected to fall to 438 $MtCO_2e$ (43% below the 1990 level) by 2020 and 399 $MtCO_2e$ by 2030 (48% below the 1990 level).
- Emissions of carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) are projected to be 39, 63 and 52% respectively, below 1990 levels by 2020. Emissions of the fluorinated GHGs (Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6)) are collectively projected to be 32% below their 1990 level in 2020.
- Since the 5th National Communication, the UK has announced further policies, for example a major reform of the Electricity Market, the Renewable Heat Incentive for business and new measures to improve the energy efficiency of domestic buildings (The Green Deal and ECO) to help meet its EU effort sharing, renewable energy and energy efficiency targets, and the targets for the first three Carbon Budgets[119] (2008-12, 2013-17 and 2020-22) set under the 2008 Climate Change Act.[120] Policies adopted in the period between 2009 and 2013 are projected to deliver emissions savings of 122 $MtCO_2e$ by 2020 and 143 $MtCO_2e$ by 2030 and these savings are included in the projections. The UK's most recent national projections indicate that it will meet its first three carbon budgets. A new much tighter target, equivalent to 390 $MtCO_2e$ in 2025, was also set in 2011 for the fourth carbon budget (2023-27) and a range of future policy options to meet this target identified.[121]

[118] The basket of greenhouse gases covered by the Kyoto Protocol consists of six gases: carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride

[119] http://www.legislation.gov.uk/uksi/2009/1259/article/1/made

[120] http://www.legislation.gov.uk/ukpga/2008/27/contents

[121] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48080/1685-ia-fourth-carbon-budget-level.pdf

4.2 Introduction

In this chapter the UK presents its GHG emissions projections, in a scenario 'with measures', along with its assumptions and methodology. Section 4.3 describes the UK overall GHG projections and how these are derived from the UK's most recent annual GHG projection. Section 4.4 then provides a sectoral decomposition of these projections and the gases emitted in each sector and a discussion of the trends. Section 4.5 provides an alternative decomposition by GHG and for each gas an analysis of emissions sources and a discussion of the trends. Section 4.6 describes the overall contribution to emissions abatement from policies adopted from 2009 onwards, introduced to meet the UK's nationally established Carbon Budgets. Section 4.7 discusses how the UK produces its projections and the methodology used for the different sector and gases. This includes coverage of assumptions, QA/QC and assessment of the strengths and weaknesses of the methodology. Section 4.8 documents the alternative scenarios and sensitivities that the UK has performed on its projections while Section 4.9 presents the results of a Monte Carlo simulation which simultaneously varies 10 key model parameters. Finally Section 4.9 describes how this projection differs from that in the UKs previous National Communication.

4.3 Overall projections of greenhouse gas emissions

The current UK projections, which were published in September 2013,[122] provide the basis for this national communication, and include the emission reductions expected from climate change abatement policies that were introduced in the UK Climate Change Programme 2000,[123] UK Climate Change Programme 2006,[124] the Energy White Paper 2007[125], the Low Carbon Transition Plan 2009[126] and The Coalition: Our Programme for Government 2010.[127]

The UK updates its national emissions projections for CO_2 and the other GHGs annually, to take account of new data including revisions to policy savings estimates,[128] fossil fuel prices, carbon price projections, growth projections and cost estimates for the power sector. There are also improvements to the underlying energy and emissions projection model.

Table 15 sets out the UK's historic emissions to 2011 and *with measures* projections from 2015 to 2030, by GHG. The historic emissions set out in this chapter are based on the UK GHG inventory 1990-2011 published and submitted to the UNFCCC in April 2013.[129] The current emissions projections up to 2030 are consistent with this 2011 inventory. The UK's GHG inventory and National System are discussed in Chapter 2.

[122] https://www.gov.uk/government/publications/updated-energy-and-emissions-projections-2013

[123] http://webarchive.nationalarchives.gov.uk/20110523172013/http:/www.decc.gov.uk/en/content/cms/what_we_do/change_energy/tackling_clima/programme/programme.aspx

[124] http://webarchive.nationalarchives.gov.uk/20110523172013/http:/www.decc.gov.uk/en/content/cms/what_we_do/change_energy/tackling_clima/programme/programme.aspx

[125] http://webarchive.nationalarchives.gov.uk/20121205174605/http:/www.decc.gov.uk/assets/decc/publications/white_paper_07/file39387.pdf

[126] http://webarchive.nationalarchives.gov.uk/20100509134746/http://www.decc.gov.uk/Media/viewfile.ashx?FilePath=White Papers/UK Low Carbon Transition Plan WP09/1_20090724153238_e_@@_lowcarbontransitionplan.pdf&filetype=4

[127] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/78977/coalition_programme_for_government.pdf

[128] These are policies and measures that were 'firm and funded' at the time the projections were produced, which includes polices that are 'implemented' or 'adopted'

[129] http://uk-air.defra.gov.uk/reports/cat07/1305301238_ukghgi-90-11_main_chapters_Issue3.pdf

The tables of emissions in this chapter are reported on the basis of UNFCCC coverage[130]. UNFCCC coverage is wider than the coverage used by the UK for Carbon Budgets purposes, for which its national published projections are produced The difference in coverage was 0.4% in the 2011 inventory. The UK has therefore added new projections for those overseas territories not covered in its published September 2013 national projections to make due allowance for this difference.

The projections show that, including the impact of implemented and adopted measures,[131,132] but excluding any use of flexible mechanisms such as EU Emissions Trading System (EU ETS) emissions trading or Joint Implementation (JI)/ Clean Development Mechanism (CDM)[133] credits, UK GHG emissions including LULUCF are expected to be 43% below 1990 levels in 2020 and 48% below in 2030. For estimates excluding LULUCF the percentages are very similar. LULUCF emissions are reported in full, consistent with the Inventory Convention reporting and not restricted to just those allowed under Articles 3.3 and 3.4 of the Kyoto Protocol.

Table 15: UK greenhouse gas emissions (UNFCCC coverage)

$MtCO_2e$	Inventory						Projection			
Gas	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2015**	**2020**	**2025**	**2030**
GHG excluding LULUCF										
Carbon dioxide	590.4	552.9	555.2	559.5	504.2	464.6	444.6	360.7	346.6	327.4
Methane	99.1	85.2	65.0	48.5	43.0	42.0	39.8	36.2	33.6	31.3
Nitrous oxide	67.4	57.2	45.7	40.5	35.3	34.2	34.2	32.6	32.6	32.3
Hydrofluorocarbons	11.4	15.3	9.3	12.1	14.4	14.7	11.0	8.6	6.3	5.2
Perfluorocarbons	1.4	0.5	0.5	0.3	0.2	0.3	0.2	0.2	0.2	0.2
Sulphur hexafluoride	1.0	1.2	1.8	1.1	0.7	0.6	0.6	0.6	0.6	0.6
Total	**770.8**	**712.3**	**677.5**	**661.9**	**597.8**	**556.5**	**530.4**	**438.9**	**420.0**	**397.1**
Change from 1990		-8%	-12%	-14%	-22%	-28%	-31%	-43%	-46%	-48%
GHG including LULUCF										
Carbon dioxide	593.5	555.3	554.8	556.1	499.9	460.7	442.4	359.8	347.1	329.2
Methane	99.2	85.2	65.0	48.5	43.0	42.1	39.9	36.3	33.7	31.3
Nitrous oxide	68.3	58.0	46.5	41.2	35.9	34.8	34.8	33.0	33.0	32.6
Hydrofluorocarbons	11.4	15.3	9.3	12.1	14.4	14.7	11.0	8.6	6.3	5.2
Perfluorocarbons	1.4	0.5	0.5	0.3	0.2	0.3	0.2	0.2	0.2	0.2
Sulphur hexafluoride	1.0	1.2	1.8	1.1	0.7	0.6	0.6	0.6	0.6	0.6
Total	**774.8**	**715.6**	**677.9**	**659.3**	**594.1**	**553.1**	**528.9**	**438.5**	**421.0**	**399.2**
Change from 1990		-8%	-13%	-15%	-23%	-29%	-32%	-43%	-46%	-48%
Net LULUCF Emissions										
Carbon dioxide	3.2	2.4	-0.4	-3.4	-4.3	-3.9	-2.1	-1.0	0.5	1.8
Methane	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
Nitrous oxide	0.8	0.9	0.8	0.7	0.6	0.6	0.6	0.5	0.4	0.3
Total	**4.0**	**3.3**	**0.4**	**-2.6**	**-3.7**	**-3.3**	**-1.5**	**-0.4**	**0.9**	**2.2**

Notes: Percentage changes and emission estimates may differ slightly due to rounding.
This table uses historical data from the inventory published in 2013.
Emissions exclude those from International bunker fuels.

[130] This includes, as well as the United Kingdom , the Crown Dependencies of Guernsey, Jersey and the Isle of Man, and the dependant Overseas Territories that have signed up to the UK's instrument of ratification to the UNFCCC and the Kyoto Protocol (Bermuda, Cayman Islands, Falkland Islands, Gibraltar and Montserrat).

[131] See Biennial Report Table 3.

[132] This includes the estimated impact of the carbon price on emissions from installations covered by the EU emissions trading system but not the trading of EU Allowances (EUA).

[133] JI (Joint Implementation) enables industrialized countries to carry out joint implementation projects with other developed countries, while the CDM (Clean Development Mechanism) involves investment in sustainable development projects that reduce emissions in developing countries.

4.4 Projections by sector

The following tables set out historic and projected 'with measures' emissions by economy sector.

Table 16 shows how historical and projected GHG emissions are distributed across the UK economy. In this *by source* classification emissions from the energy supply sector are shown separately. Energy supply includes emissions from power stations, refineries, energy extraction and distribution (including fugitive emissions), and the production of coke and patent solid fuels.

Table 16: Greenhouse gas emissions by source (UNFCCC coverage)

Total greenhouse gas emissions ($MtCO_2e$)

$MtCO_2e$	Inventory						Projection			
	1990	**1995**	**2000**	**2005**	**2010**	**2011**	**2015**	**2020**	**2025**	**2030**
Energy supply	273.1	234.8	219.3	228.5	205.3	192.1	172.6	106.1	94.0	72.7
Business	115.4	110.3	114.0	108.3	92.0	89.2	79.3	70.3	65.6	63.7
Industrial processes	54.7	45.1	24.7	18.8	11.7	10.2	10.1	9.8	9.4	9.1
Transport	122.2	122.6	127.2	131.0	120.8	119.1	113.9	107.7	106.4	103.4
Residential	80.9	82.5	90.4	88.1	90.2	69.9	80.4	78.0	80.3	84.9
Public	13.1	12.8	11.5	11.1	8.4	7.1	9.1	7.8	6.9	6.7
Agriculture	64.0	62.8	59.4	55.7	51.4	51.4	49.5	45.5	44.9	44.9
LULUCF (net)	4.0	3.3	0.4	-2.6	-3.7	-3.3	-1.5	-0.4	0.9	2.2
Waste management	47.5	41.5	30.9	20.5	18.0	17.4	15.5	13.7	12.5	11.7
Total net GHG emissions	**774.8**	**715.6**	**677.9**	**659.3**	**594.1**	**553.1**	**528.9**	**438.5**	**421.0**	**399.2**
Memo: International Bunkers										
Aviation	15.6	20.3	30.4	35.2	31.7	33.0	33.0	36.8	38.8	40.6
Shipping	8.8	8.2	6.9	7.9	8.8	9.9	10.0	10.0	10.0	10.0

Note: Percentage changes and emission estimates may differ slightly due to rounding.

4.4.1 Energy supply emissions

The 'with measures' projections of emissions from the energy supply industry, in Table 17, show that emissions are expected to be 61% lower than 1990 levels by 2020 and 73% below by 2030. Between 1990 and 2000, energy supply sector emissions fell sharply, mainly as a result of fuel switching to gas and higher output from nuclear plants. Growth in demand for both electricity and oil products drove up CO_2 emissions in 2005, but this was reversed during the sharp economic contraction in 2008-9, which shows in the lower emissions in 2010 and 2011, combined with the early impact of emissions reductions policies.

The slow economic recovery following the recession in 2008-9 is starting to drive up demand, but policy measures are expected to more than counteract this increase.

The UK projections show a reduction in the electricity supplied from coal plants by 2020 for three main reasons: firstly, due to the impact of the Industrial Emissions Directive, which means that plants that have opted out of retro-fitting pollution abatement equipment are limited as to their remaining operating hours; secondly through natural ageing and replacement of plants with different fuelled technology, and thirdly, due to the less favourable economic position of the remaining coal fired plants as a result of the Carbon Price Support Floor.

UK projections after 2020 are based on a continued displacement of unabated gas generation by a combination of renewables, Carbon Capture and Storage (CCS) and nuclear in the electricity supply industry as a result of the government's Energy Market Reform programme.[134]

Generation from renewables is projected to grow significantly, initially as a result of the economic incentives provided by the Renewable Obligation (RO). The RO will then be replaced from 2017 by Contracts for Difference, which also provides a mechanism for the support of new nuclear and CCS low-carbon generation. This growth will more than offset the impact of the expected retirement of existing nuclear plant from the system.

Emissions from the oil and gas extraction industry are projected to continue to fall as the sector contracts. Current projections do not include any contribution from non-conventional oil and gas ('fracking').

Table 17: Greenhouse gas emissions from energy supply industry by gas, (UNFCCC coverage)

$MtCO_2e$	Inventory						Projection			
Gas	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2015**	**2020**	**2025**	**2030**
Carbon dioxide	242.2	210.8	203.9	217.4	196.4	183.3	163.5	97.8	86.9	67.4
Methane	28.9	22.2	13.8	9.4	7.6	7.3	7.3	6.8	5.6	4.1
Nitrous oxide	2.1	1.8	1.6	1.7	1.4	1.5	1.8	1.5	1.5	1.1
Total GHG emissions	**273.1**	**234.8**	**219.3**	**228.5**	**205.3**	**192.1**	**172.6**	**106.1**	**94.0**	**72.7**
Change from 1990 levels for row above		-14%	-20%	-16%	-25%	-30%	-37%	-61%	-66%	-73%

Note: Percentage changes and emission estimates may differ slightly due to rounding.

4.4.2 Residential energy emissions

Emissions from the **residential** sector, in Table 18, are projected to be 4% lower than 1990 levels by 2020 but 5% above 1990 levels by 2030. The principal long-term driver of emissions is household numbers; which is increasing over the whole period both as the UK population grows and due to the disproportionate increase in smaller, older households. Historic emissions include the effect of annual variations in weather, which partly explains the below trend emissions in 2011. The projections assume the continuation of past average temperatures patterns.

Up to 2020 the secular increases in population and housing CO_2 projections are offset by the impact of existing energy (and CO_2 emission) reduction policies, for example, through the improved insulation of homes. Additional policies to offset the increase in emissions between 2020 and 2030 are being considered but have not yet reached adopted status.

Hydrofluorocarbons use in this sector is mostly as the delivery gas for metered-dose inhalers and aerosol use, where the historic growth per head is expect to stabilise, but emissions increase due to population growth.

[134] https://www.gov.uk/government/policies/maintaining-uk-energy-security--2/supporting-pages/electricity-market-reform. Energy Market Reform is covered in Chapter 3.5.4.

Table 18: Greenhouse gas emissions from the residential sector by gas (UNFCCC coverage)

$MtCO_2e$	Inventory						Projection			
Gas	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2015**	**2020**	**2025**	**2030**
Carbon dioxide	79.1	81.0	87.3	84.5	86.8	66.6	76.9	74.5	76.7	81.3
Methane	1.5	0.8	0.7	0.4	0.5	0.5	0.6	0.6	0.6	0.6
Nitrous oxide	0.3	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Hydrofluorocarbons	0.0	0.4	2.3	3.0	2.7	2.7	2.8	2.8	2.9	2.9
Total GHG emissions	**80.9**	**82.5**	**90.4**	**88.1**	**90.2**	**69.9**	**80.4**	**78.0**	**80.3**	**84.9**
Change from 1990 levels for row above		2%	12%	9%	11%	-14%	-1%	-4%	-1%	5%

Note: Percentage changes and emission estimates may differ slightly due to rounding.

4.4.3 Transport energy emissions

Domestic **transport** emissions, in Table 19, are projected to be 12% lower than 1990 levels by 2020 and 15% lower by 2030. The underlying growth in road transport use, which was interrupted by the economic recession from 2008, is projected to resume. However, measures to improve vehicle efficiency, such as the EU tailpipe emissions targets for new cars and vans, or to directly reduce emissions, such as mandating greater use of biofuels and providing incentives to encourage the adoption of electric vehicles are expected to reduce annual emissions between 2011 and 2030.

Historically, the fall in CH_4 emissions were due to the spread of oxidation catalysts and then 3-way catalysts in the vehicle fleet. Increasing N_2O emissions are due to the increased penetration of vehicles with three-way catalysts, which reduce NO_X but increase N_2O.

Emissions related to fuel combustion from aviation and shipping engaged in international transport are included as a Memo item and in accordance with the UNFCCC's reporting guidelines are not included in the UK's historic or projected emissions. Emissions from aviation fuel loaded in the UK and its overseas territories onto international flights had increased at an average rate of around 4.9% per annum between 1990-2007, but fell in the recession and is now projected to increase by 1.1% per annum through to 2030. This lower rate of growth is partly explained by constraints on UK airport capacity, and on improvements in fuel efficiency in the aircraft fleet. The Department for Transport also project a modest growth in use of bio-kerosene.

The UK is working to establish an international method for allocating these emissions to national inventories and is working through the International Civil Aviation Organisation to encourage development, and with the EU, implementation of emissions trading at the international level.

Table 19: Greenhouse gas emissions from transport by gas (UNFCCC coverage)

$MtCO_2e$	Inventory						Projection			
Gas	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2015**	**2020**	**2025**	**2030**
Carbon dioxide	120.2	120.4	125.4	129.6	119.8	118.1	112.6	106.2	104.9	101.9
Methane	0.6	0.5	0.3	0.2	0.1	0.1	0.1	0.0	0.0	0.0
Nitrous oxide	1.3	1.8	1.5	1.2	0.9	1.0	1.2	1.4	1.5	1.5
Total GHG emissions	**122.2**	**122.6**	**127.2**	**131.0**	**120.8**	**119.1**	**113.9**	**107.7**	**106.4**	**103.4**
Change from 1990 levels for row above		0%	4%	7%	-1%	-2%	-7%	-12%	-13%	-15%
Memo: International Bunkers (aviation and shipping)										
Carbon dioxide	24.2	28.2	36.9	42.7	40.1	42.4	42.6	46.3	48.3	50.1
Methane	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nitrous oxide	0.2	0.3	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.5
Total Bunker GHG Emissions	**24.4**	**28.5**	**37.3**	**43.2**	**40.5**	**42.9**	**43.0**	**46.8**	**48.8**	**50.6**
Total aviation bunkers	**15.6**	**20.3**	**30.4**	**35.2**	**31.7**	**33.0**	**33.0**	**36.8**	**38.8**	**40.6**
Total shipping bunkers	**8.8**	**8.2**	**6.9**	**7.9**	**8.8**	**9.9**	**10.0**	**10.0**	**10.0**	**10.0**

Note: Percentage changes and emission estimates may differ slightly due to rounding.

4.4.4 Industrial process emissions

Emissions from **industrial processes**, which include process emissions from cement and lime production, glass manufacture, steel production, and chemicals manufacture, in Table 20, having fallen sharply by 81% in the period up to 2011. Emissions are then projected to stabilise, only falling to 82% below 1990 levels by 2020 and 83% below by 2030.

Process emissions of CO_2 have fallen in 2010 and 2011 due to the recession in the energy intensive heavy industries that produce process emissions. Although industrial growth has now resumed, emissions in the industrial process sector will continue to fall, as it is expected that the industrial growth will be largely concentrated in other sectors, such as pharmaceuticals and engineering.

Large reductions in emissions of N_2O and HFCs were achieved through the introduction of abatement equipment to control fugitive emissions from adipic acid, and more recently nitric acid and subsequently by the cessation of adipic acid manufacture in the UK. Similarly, the use of abatement technology and a shift to lower GWP refrigerants in the 1990's led to a large reduction in emissions of HFC-23 emissions from HCFC-22 manufacture.

Table 20: Greenhouse gas emissions from industrial processes by gas, (UNFCCC coverage)

$MtCO_2e$	Inventory						Projection			
Gas	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2015**	**2020**	**2025**	**2030**
Carbon dioxide	16.6	15.2	15.0	14.8	9.9	9.5	9.6	9.3	8.9	8.6
Methane	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Nitrous oxide	24.7	14.9	5.6	3.0	1.4	0.2	0.1	0.1	0.1	0.1
Hydrofluorocarbons	11.4	14.0	2.6	0.4	0.1	0.1	0.1	0.1	0.1	0.1
PFCs	1.3	0.4	0.3	0.2	0.2	0.2	0.1	0.1	0.1	0.1
Sulphur hexafluoride	0.4	0.4	1.1	0.3	0.1	0.1	0.1	0.1	0.1	0.1
Total GHG emissions	**54.7**	**45.1**	**24.7**	**18.8**	**11.7**	**10.2**	**10.1**	**9.8**	**9.4**	**9.1**
Change from 1990 levels for row above		-18%	-55%	-66%	-79%	-81%	-82%	-82%	-83%	-83%

Percentage changes and emission estimates may differ slightly due to rounding

4.4.5 Business emissions

Projected emissions from **business** (industry and commercial services) are presented in Table 21.

Emissions from CO_2 (and related CH_4 and N_2O emissions) in this sector are attributable to combustion, both to heat buildings and in manufacture. While economic activity in the sector has continued to rise, emissions in this sector have fallen as the energy intensity of the sector has fallen. This fall was accentuated in 2010 and 2011 because of the recession, which contributed to a total reduction of 23% between 1990 and 2011. Emissions are then projected to fall further to 39% below 1990 levels by 2020, and to 45% below by 2030.

Projected CO_2 emission include the impact of policies that encourage energy efficiency and/or reduce emissions, such as more stringent Building Regulations, minimum energy efficiency standards for new products and economic measures such as the Carbon Reduction Commitment, the non-domestic Green Deal and the Renewable Heat Incentive. These are discussed in Chapter 3: Policies and Measures.

The rapid growth of HFC use since 1995 is expected to reverse, in the future as EU F-Gas regulations require that HFC's are phased out in favour of other gases (e.g. ammonia, CO_2, hydrocarbons) or HFCs with lower GWPs.

Table 21: Greenhouse gas emissions from business by gas (UNFCCC coverage)

$MtCO_2e$	Inventory						Projection			
Gas	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2015**	**2020**	**2025**	**2030**
Carbon dioxide	112.8	106.7	107.0	97.1	78.5	75.6	69.3	62.5	60.0	59.2
Methane	0.3	0.3	0.3	0.3	0.2	0.2	0.3	0.3	0.3	0.3
Nitrous oxide	1.6	1.5	1.3	1.3	1.0	0.9	1.1	1.2	1.3	1.3
Hydrofluorocarbons	-	0.9	4.5	8.6	11.6	11.8	8.1	5.7	3.4	2.2
Perfluorocarbons	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Sulphur hexafluoride	0.6	0.8	0.7	0.9	0.6	0.5	0.5	0.5	0.5	0.5
Total GHG emissions	**115.4**	**110.3**	**114.0**	**108.3**	**92.0**	**89.2**	**79.3**	**70.3**	**65.6**	**63.7**
Change from 1990 levels for row above		-4%	-1%	-6%	-20%	-23%	-31%	-39%	-43%	-45%

Note: Percentage changes and emission estimates may differ slightly due to rounding.

4.4.6 Public services emissions

Projected emissions from the **public** services sector are presented in Table 22. This covers emissions from central and local government, defence, education, health and social work. It includes the provision of these services by the private sector. Emissions in the public services sector have been declining through the historical period falling to 46% below 1990 levels by 2011 despite continued growth in the sector due to the implementation of energy efficiency measures and a switch from coal and oil to gas heating systems.

These projections assume that there is still scope to improve this increase in energy efficiency and to continue to drive down emissions. Projections also include the effect of a planned contraction in the sector (due to government cost cutting and efficiency policies) and policy measures that encourage improved energy efficiency and emissions reductions, such as more stringent Building Regulations, minimum energy efficiency standards for new products and economic measures such as the Carbon Reduction Commitment and the Renewable Heat Incentive.

Consequently total GHG emissions are expected to fall to 40% below 1990 levels by 2020 and to 49% below by 2030.

Table 22: Greenhouse gas emissions from public services by gas (UNFCCC coverage)

$MtCO_2e$	Inventory						Projection			
Gas	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2015**	**2020**	**2025**	**2030**
Carbon dioxide	13.0	12.7	11.5	11.0	8.4	7.1	9.1	7.8	6.9	6.7
Methane	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nitrous oxide	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total GHG emissions	**13.1**	**12.8**	**11.5**	**11.1**	**8.4**	**7.1**	**9.1**	**7.8**	**6.9**	**6.7**
Change from 1990 levels for row above		-3%	-12%	-16%	-36%	-46%	-31%	-40%	-47%	-49%

Note: Percentage changes and emission estimates may differ slightly due to rounding.

4.4.7 Land use, land use change and forestry management emissions

The main trends in UK sources and sinks from the **land use, land use change and forest management** (LULUCF) sector are presented in Table 23 and 24.

The UNFCCC basis for reporting of emissions includes all human-induced changes to land-based carbon stocks i.e. all anthropogenic sources and sinks of GHGs.

The Kyoto Protocol basis for reporting of, and accounting of, emissions includes LULUCF emissions and removals associated with mandatory activities under Article 3.3 of the Kyoto Protocol – afforestation plus reforestation minus deforestation (ARD) – since 1990. In addition, since the UK has chosen to account for forest management under Article 3.4 of the Kyoto Protocol, the Kyoto basis also indicates removals up to the level of the cap agreed for the UK as part of the Marrakech Accords,[135] since the actual uptake by forests is projected to exceed the cap in most years. In accordance with Article 3.7 of the Kyoto Protocol, and subsequent Conference of the Parties (COP) decisions, a small base year allowance of 0.33 $MtCO_2e$ related to deforestation emissions in 1990 is added to the UK base year as LULUCF was a net source of emissions in the UK in 1990.

From 1990-2011, the amount of carbon stored in UK trees has been increasing, with the accumulation rate reaching a net sink of 3.7 $MtCO_2$/year in 2010. However, the UK's experts expect this balance to change in the projection period as forests mature (in mature forests carbon uptake is reduced) and more are felled and by 2020 the accumulation rate will have fallen to 0.4 $MtCO_2$/year. The LULUCF sector is expected to be a net source of emissions of 2.2 $MtCO_2$/year in 2030.

The Forest Land, Cropland and Grassland categories dominate the trend. Forest Land is a shrinking net sink (due to a combination of forest management and decreasing age class distribution – discussed in more detail in the UK's National Inventory report).[136]

Greenhouse gas emissions from wetlands are a small component of the LULUCF sector and no detailed assumptions have been made. The settlement category is projected to have slowly increasing emissions from 2012 onwards, driven by steady rates of land use conversion to settlement.

[135] http://unfccc.int/cop7/documents/accords_draft.pdf

[136] https://www.gov.uk/government/publications/uk-greenhouse-gas-inventory, NIR 2011, page 90-91, Chapter 2, Section 2.3.5

Table 23: Greenhouse gas emissions and removals from land use, land use change and forestry, on a Convention basis (UNFCCC coverage)

($MtCO_2e$)	Inventory						Projection			
Gas	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2015**	**2020**	**2025**	**2030**
Carbon dioxide	3.2	2.4	-0.4	-3.4	-4.3	-3.9	-2.1	-1.0	0.5	1.8
Methane	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
Nitrous oxide	0.8	0.9	0.8	0.7	0.6	0.6	0.6	0.5	0.4	0.3
Total GHG emissions	**4.0**	**3.3**	**0.4**	**-2.6**	**-3.7**	**-3.3**	**-1.5**	**-0.4**	**0.9**	**2.2**

Table 24: Greenhouse gas emissions and removals from land use, land use change and forestry, on a Kyoto basis

($MtCO_2e$)	Base Year	1990	1995	2000	2005	2010	2011	2015	2020	2025	2030
Article 3.3		0.31	0.03	-0.84	-1.52	-2.42	-2.51	-2.36	-3.07	-3.89	-4.57
Article 3.4† (capped at -0.37 MtC)		-1.36	-1.36	-1.36	-1.36	-1.36	-1.36	NE	NE	NE	NE
Article 3.7	0.37										
Total GHG Emissions		**-1.05**	**-1.33**	**-2.20**	**-2.88**	**-3.78**	**-3.87**	**-3.72**	**-4.43**	**-5.25**	**-5.93**

Note: Percentage changes and emission estimates may differ slightly due to rounding.

Note †: The Article 3.4 allowed emissions are capped. The values presented above refer to the annual cap for the first commitment period (2008-2012). Values between 2015 and 2030 will be estimated once a final approach to Article 3.4 has been agreed for each respective commitment period.

4.4.8 Waste and waste management emissions

Annual emissions from **waste management**, in Table 25 have fallen by 63% compared to 1990 levels in 2011and are expected to fall to 71% below 1990 levels by 2020 and by 75% by 2030. The historic fall can largely be attributed to a reduction in CH_4 emissions from landfill sites due to increased collection of landfill gas for energy recovery and flaring for environmental control. Future emissions are also expected to reduce through increased recycling and/or the direct combustion of wastes to generate energy. This shift is being encouraged through an increasing tax on landfill of decomposable waste.

Table 25: Greenhouse gas emissions from waste management by gas, $MtCO_2e$ (UNFCCC coverage)

$MtCO_2e$	Inventory						Projection			
Gas	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2015**	**2020**	**2025**	**2030**
Carbon dioxide	1.3	0.9	0.5	0.4	0.3	0.3	0.3	0.3	0.3	0.4
Methane	45.0	39.3	29.1	18.9	16.4	15.8	13.8	11.9	10.6	9.7
Nitrous oxide	1.2	1.2	1.3	1.2	1.3	1.3	1.4	1.5	1.5	1.6
Total GHG emissions	**47.5**	**41.5**	**30.9**	**20.5**	**18.0**	**17.4**	**15.5**	**13.7**	**12.5**	**11.7**
Change from 1990 levels for row above		-13%	-35%	-57%	-62%	-63%	-67%	-71%	-74%	-75%

Note: Percentage changes and emission estimates may differ slightly due to rounding.

4.4.9 Agricultural emissions

Emissions projections from the **agriculture** sector, in Table 26 show reductions of 20% by 2011 which reflects declining livestock numbers and a reduction in the amount of synthetic fertiliser used.

Emissions are expected to fall further to 29% below 1990 levels by 2020 and to 30% below by 2030.

The fall in CO_2 emission is largely related to fewer emissions from mobile machinery.

A projected decrease in CH_4 emissions is driven by further decreases in livestock numbers, but this is partly offset by an increase in N_2O emissions from agricultural soils due to an expected increase in the production of wheat and oilseed rape (Table 4.12).[137]

Table 26: Greenhouse gas emissions from agriculture by gas, $MtCO_2e$ (UNFCCC coverage)

$MtCO_2e$	Inventory						Projection			
Gas	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2015**	**2020**	**2025**	**2030**
Carbon dioxide	5.2	5.3	4.8	4.6	4.1	4.2	3.3	2.3	2.0	1.9
Methane	22.6	21.8	20.6	19.2	18.1	18.0	17.8	16.4	16.4	16.4
Nitrous oxide	36.2	35.7	34.1	31.9	29.2	29.2	28.4	26.8	26.6	26.6
Total GHG emissions	**64.0**	**62.8**	**59.4**	**55.7**	**51.4**	**51.4**	**49.5**	**45.5**	**44.9**	**44.9**
Change from 1990 levels for row above		-2%	-7%	-13%	-20%	-20%	-23%	-29%	-30%	-30%

Note: Percentage changes and emission estimates may differ slightly due to rounding.

4.5 Projections by gas

The following tables summarise projections organised by gas. Projections are broken down by source for CO_2, CH_4 and N_2O, and by market sector for the F gases.

4.5.1 Carbon dioxide

Carbon dioxide emissions (Table 27) are declining slowly as energy efficiency, alternative fuels and decline in heavy industry off-sets increasing population, transport demand and renewed economic growth.

The largest change expected is the continued and accelerating decline in CO_2 from energy supply as the power station sector is decarbonised. In the 1990's this was driven by the replacement of coal by natural gas in power stations, this is now being supplemented by a planned growth –driven by policy measures - in the use of renewables, use of CCS on coal and gas power stations and the replacement of existing nuclear power stations by new nuclear power plants.

In the energy using sectors growth in GDP and population is offset by policy measures intended to improve energy efficiency and to increase the use of renewables.

The decline in CO_2 emissions in Agriculture is largely due to a continued decline in the use of off-road transport.

The most important sources of CO_2 are fuel combustion in the energy supply, business, transport and residential sectors. Emissions trends will follow energy efficiency and fuel switching actions (see energy supply, business and residential) and transport policies (see Transport above) as well as actions to decarbonise electricity production (see Energy Supply above).

[137] Defra project SFF0601. Baseline projections for agriculture and implications for emissions to air and water.

Table 27: Carbon dioxide emissions by source, $MtCO_2e$ (UNFCCC coverage)

$MtCO_2e$	Inventory						Projection			
Sector	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2015**	**2020**	**2025**	**2030**
Energy supply	242.2	210.8	203.9	217.4	196.4	183.3	163.5	97.8	86.9	67.4
Business	112.8	106.7	107.0	97.1	78.5	75.6	69.3	62.5	60.0	59.2
Industrial processes	16.6	15.2	15.0	14.8	9.9	9.5	9.6	9.3	8.9	8.6
Transport	120.2	120.4	125.4	129.6	119.8	118.1	112.6	106.2	104.9	101.9
Residential	79.1	81.0	87.3	84.5	86.8	66.6	76.9	74.5	76.7	81.3
Public	13.0	12.7	11.5	11.0	8.4	7.1	9.1	7.8	6.9	6.7
Agriculture	5.2	5.3	4.8	4.6	4.1	4.2	3.3	2.3	2.0	1.9
LULUCF (net)	3.2	2.4	-0.4	-3.4	-4.3	-3.9	-2.1	-1.0	0.5	1.8
Waste management	1.3	0.9	0.5	0.4	0.3	0.3	0.3	0.3	0.3	0.4
Total net CO_2 Emissions	**593.5**	**555.3**	**554.8**	**556.1**	**499.9**	**460.7**	**442.4**	**359.8**	**347.1**	**329.2**
Change from 1990 levels for row above		-6%	-7%	-6%	-16%	-22%	-25%	-39%	-42%	-45%

Note: Percentage changes and emission estimates may differ slightly due to rounding.

4.5.2 Methane

Methane emissions (Table 28) have already fallen significantly, by 58%, between 1990 and 2011 and are projected to continue to decline more modestly, by a further 10% by 2030 as a result of expected reductions in landfill waste, agriculture livestock numbers and coal mining.

Waste disposal on land (landfill and sewage sludge decomposition) was the largest source of CH4 in 1990, and it is projected to fall further due to the policy-driven diversion of solid wastes to recycling and combustion for energy.

Agriculture, which was the second largest source of CH_4 in 1990, is now already the largest and is expected to stay so. Further reductions are expected as a result of falling livestock numbers and better management, led by the industry-led Agricultural Action Plan.[138]

Coal mining, which was a major source of emissions in 1990, is now much smaller and so can contribute less to future savings, although it will continue to decline.

Fugitive emissions from natural gas distribution have already been reduced due to replacement of the UK's gas pipe infrastructure and it is projected that this will continue.

Emissions from other fuel combustion for energy have decreased by 66% between 1990 and 2011, driven by the switch away from coal as a fuel, however, it is now expected to increase modestly up to 2025 as the economy grows.

Projected wastewater treatment emissions remain flat in the absence of evidence that they will change.

[138] http://www.ahdb.org.uk/projects/GreenhouseGasActionPlan.aspx

Table 28: Methane emissions by source, $MtCO_2e$ (UNFCCC coverage)

$MtCO_2e$	Inventory						Projection			
Sector	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2015**	**2020**	**2025**	**2030**
Waste disposal on land	43.5	37.9	27.6	17.4	15.1	14.5	12.5	10.6	9.3	8.4
Agriculture	22.6	21.8	20.6	19.2	18.1	18.0	17.8	16.4	16.4	16.4
Coal mining	18.3	12.6	6.8	3.2	2.1	2.0	2.0	2.0	1.2	0.4
Natural gas distribution	8.0	7.1	5.4	4.9	4.1	3.9	3.7	3.3	2.9	2.5
Offshore oil and gas	2.4	2.4	1.5	1.1	1.2	1.3	1.2	1.1	1.0	0.9
Fuel combustion	2.7	1.9	1.5	1.0	1.0	0.9	1.2	1.4	1.5	1.3
Wastewater treatment	1.4	1.4	1.5	1.5	1.3	1.3	1.3	1.3	1.3	1.3
Other	0.3	0.2	0.2	0.2	0.1	0.1	0.2	0.2	0.1	0.1
Total Methane	**99.2**	**85.2**	**65.0**	**48.5**	**43.0**	**42.1**	**39.9**	**36.3**	**33.7**	**31.3**
Change from 1990 levels for row above		-14%	-34%	-51%	-57%	-58%	-60%	-63%	-66%	-68%

Note: Percentage changes and emission estimates may differ slightly due to rounding.

4.5.3 Nitrous oxide

Nitrous oxide emissions, both inventory and projected, are shown in Table 29.

The largest source of N_2O in 1990 was agriculture (fertilisation of soils) and although abatement activities, such as implementation of the Nitrates and Water Framework Directive have and will continue to reduce emissions, the projected emissions reductions are modest and we expect agriculture to remain the largest source in 2030.

Industrial processes were the second largest source in 1990, but plant closures (e.g. adipic acid is no longer manufactured in the UK) and investment in best practice abatement equipment has already reduced emission to negligible levels by 2011.

Elsewhere in the economy some growth is projected, both as a result of increased economic activity and in transport, as a result of the increased use of catalytic converters.

Table 29: Nitrous oxide emissions by source, $MtCO_2e$ (UNFCCC coverage)

$MtCO_2e$	Inventory						Projection			
Sector	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2015**	**2020**	**2025**	**2030**
Energy supply	2.1	1.8	1.6	1.7	1.4	1.5	1.8	1.5	1.5	1.1
Business	1.6	1.5	1.3	1.3	1.0	0.9	1.1	1.2	1.3	1.3
Industrial processes	24.7	14.9	5.6	3.0	1.4	0.2	0.1	0.1	0.1	0.1
Transport	1.3	1.8	1.5	1.2	0.9	1.0	1.2	1.4	1.5	1.5
Residential	0.3	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Public	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Agriculture	36.2	35.7	34.1	31.9	29.2	29.2	28.4	26.8	26.6	26.6
LULUCF	0.8	0.9	0.8	0.7	0.6	0.6	0.6	0.5	0.4	0.3
Waste management	1.2	1.2	1.3	1.2	1.3	1.3	1.4	1.5	1.5	1.6
Total N_2O Emissions	**68.3**	**58.0**	**46.5**	**41.2**	**35.9**	**34.8**	**34.8**	**33.0**	**33.0**	**32.6**
Change from 1990 levels for row above		-15%	-32%	-40%	-47%	-49%	-49%	-52%	-52%	-52%

Note: Percentage changes and emission estimates may differ slightly due to rounding

4.5.4 The fluorinated gases

Inventory trends and projections for the fluorinated gases are shown in Table 30. The trends and projections are by market sector.

4.5.4.1 Hydrofluorocarbons (HFCs)

The largest source of HFCs emissions in the 1990s was as a by-product of the manufacture of HCFC-23, used as a propellant and refrigerant. Manufacture of hydrochlorofluorocarbons (HFCF) declined rapidly once its ozone depletion and GWP properties were recognised and as a result this reduced emissions of HFC.

However, use of HFCs increased as HFCs replaced HCFC as HCFC were phased out as a propellant and in refrigeration and air conditioning from 1995 onwards.

UK projections anticipate that HFCs will be phased out in these applications because of their high GWP in response to legislation, in particular the 2006 MAC and F-Gases Directives.

UK projections include a persistent demand for HFC in fire fighting, metered dose inhalers and precision cleaning, where viable low GWP alternatives have yet to emerge.

4.5.4.2 Perfluorocarbons (PFCs)

Historically the largest source of PFCs has been as an by-product at carbon anodes in primary aluminium manufacture. However this has reduced as it has become increasingly possible to minimise the mode of operation that leads to PFC formation.

There is then a significant drop in 2012 as the larger of the two remaining primary aluminium smelters in the UK closed. The projection shows a continued use in electronics and other uses.

4.5.4.3 Sulphur hexafluoride (SF_6)

The major uses of SF_6 are as a magnesium cover gas, in high-voltage electrical switch gear, and as an insulator and in semiconductor manufacture.

Emissions have declined throughout the period 1990-2011 for use as a cover gas due to declining industrial demand. UK projections expect that SF_6 use will now stabilise at its current level. The projections show SF_6 will continue to be used as an insulator and for other minor uses including electronics.

Table 30: Fluorinated gas emissions by market sector, $MtCO_2e$ (UNFCCC coverage)

$MtCO_2e$	Inventory						Projection			
Sector	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2015**	**2020**	**2025**	**2030**
HFCs										
Refrigeration/air conditioning	-	0.77	4.25	8.02	10.97	11.22	7.45	5.03	2.87	1.72
Foams (excluding OCF)	-	-	0.06	0.25	0.30	0.31	0.34	0.30	0.16	0.14
General aerosols and OCF	0.01	0.57	1.45	1.57	1.11	1.11	1.11	1.11	1.11	1.11
Metered dose inhalers	0.00	0.00	0.90	1.59	1.59	1.61	1.65	1.71	1.77	1.82
HFC-23 from HCFC-22 manufacture and fugitive losses from HFC manufacture	11.37	13.98	2.62	0.44	0.08	0.07	0.07	0.07	0.07	0.07
Precision cleaner	-	-	0.00	0.05	0.11	0.11	0.11	0.11	0.11	0.11
Fire fighting	-	0.00	0.06	0.20	0.21	0.21	0.22	0.23	0.24	0.24
Magnesium cover gas	-	-	-	0.00	0.01	0.01	0.02	0.02	0.02	0.03
Total HFC emissions	**11.39**	**15.33**	**9.34**	**12.11**	**14.39**	**14.65**	**10.97**	**8.58**	**6.35**	**5.24**
Perfluorocarbons										
Electronics	0.08	0.18	0.09	0.07	0.07	0.08	0.10	0.12	0.12	0.08
Aluminium production	1.33	0.29	0.25	0.10	0.11	0.16	0.00	0.00	0.00	0.00
Other uses	0.09	0.03	0.11	0.04	0.09	0.12	0.12	0.12	0.12	0.09
Total PFC emissions	**1.40**	**0.46**	**0.46**	**0.30**	**0.22**	**0.33**	**0.21**	**0.23**	**0.25**	**0.25**
Sulphur hexafluoride										
Magnesium cover gas	0.43	0.43	1.09	0.25	0.13	0.07	0.08	0.08	0.08	0.08
Electrical insulation	0.6	0.8	0.62	0.52	0.51	0.51				
Electronics	0.01	0.01	0.02	0.01	0.02	0.02	0.51	0.50	0.52	0.52
Other uses	0	0	0.06	0.32	0.04	0.01				
Total SF_6 emissions	**1.03**	**1.24**	**1.8**	**1.11**	**0.69**	**0.61**	**0.58**	**0.58**	**0.60**	**0.60**
Total UK emissions of Fluorinated Gases	**13.82**	**17.03**	**11.60**	**13.52**	**15.30**	**15.59**	**11.76**	**9.39**	**7.19**	**6.08**
Change from 1990 levels for row above		**23%**	**-16%**	**-2%**	**11%**	**13%**	**-15%**	**-32%**	**-48%**	**-56%**

Note: Percentage changes and emission estimates may differ slightly due to rounding.

4.6 Assessment of total effect of policies and measures

The projections presented here (the 'with measures' scenario) include the impact of all the UK's implemented and adopted policies and measures. These policies and measures and their projected CO_2e savings are detailed in Annex 2.

Since the 5th Communication, the UK has announced further policies to help meet its EU effort sharing and renewable energy targets, and the targets for the first three carbon budgets[139] set under the 2008 Climate Change Act.[140] Details of these policies are in Chapter 4.

The UK treat the policies adopted before 2009, when Carbon Budgets were set at the time of the 2009 Budget as part of the baseline. Figure 41 and Table 31 below show the estimated emissions savings and the effect on projected emissions attributable to policies adopted between April 2009 and the September 2013, as published in our latest UK national projections.

[139] http://www.legislation.gov.uk/uksi/2009/1259/article/1/made

[140] http://www.legislation.gov.uk/ukpga/2008/27/contents

Figure 41: Projected impact of policies adopted in the period 2009-13

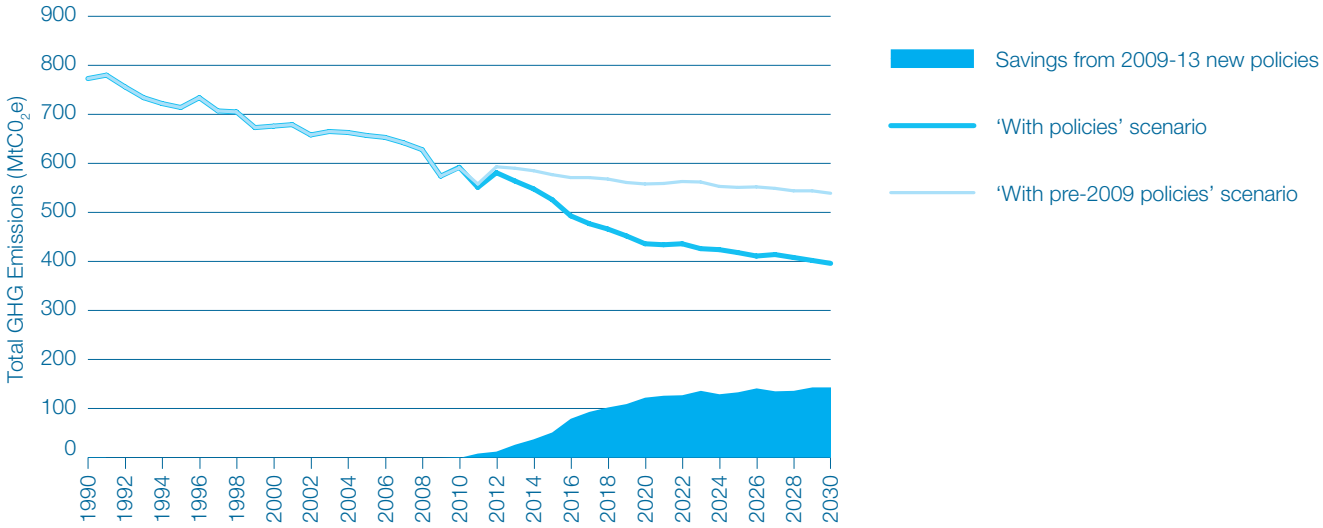

Table 31: Projections of total net GHG emissions in the 'with measures' scenario

$MtCO_2e$	Inventory						Projection			
	1990	1995	2000	2005	2010	2011	2015	2020	2025	2030
Emissions including measures adopted before 2009	775	716	678	659	593	561	579	561	554	542
Savings from measures adopted 2009-13	-	-	-	-	-1	8	51	122	133	143
Emissions including all implemented or adopted measures	775	716	678	659	594	553	529	438	421	399

Note: Percentage changes and emission estimates may differ slightly due to rounding.

4.7 Projections methodology

4.7.1 Carbon dioxide and combustion-related other GHG

Projections of the UK's emissions of CO_2 and combustion-related emissions of other greenhouses gases (CH_4 and nitrous oxide) have been largely derived from the DECC Energy and Emissions Projections model. This is made up of a set of interlocking sub-models of the UK energy market including final user energy sectors and the electricity supply sector. It is a top down demand model, based on econometrically estimated relationships between energy demand, energy supply, economic activity and energy prices and a bottom-up supply side model. The sector classification source, and the principal source of energy statistics, is the Digest of UK Energy Statistics (DUKES).[141]

Energy use projections are converted to emissions projections using the same fuel emissions factors used to produce the UK National Inventory, with some additional calibration to take account of any energy uses not captured in the DUKES. Industry Process emissions are calibrated by relating inventory emission to production.

The DECC model makes projections based on prospects for fossil fuel prices, carbon prices and economic growth and demographics.

The source of these projections is described in the Key Assumptions section, below.

[141] https://www.gov.uk/government/organisations/department-of-energy-climate-change/series/digest-of-uk-energy-statistics-dukes

These projections included scenarios for three fossil fuel price assumptions, for three GDP growth rates and a baseline including only pre-2009 policies and measures. The projections presented in this chapter are based on the reference scenario which uses the UK's reference scenario assumptions as to fossil fuel prices and economic growth.

The projections start from a baseline econometric Business as Usual Projection, from which savings due to Policies and Measures are then subtracted. The projections include all firm and funded government environmental policy measures as most recently evaluated. These are all considered to be adopted policies and do not include those that only have planned status e.g. EU Eco-design energy efficiency standards where the proposals have not yet been voted on, or the proposed Building Regulations 2014 as its content has not yet been finalised.

GHG projections from LULUCF are produced by the Centre for Ecology and Hydrology (CEH) using methods consistent with the inventory estimates. The projections[142] take account of the dynamics of carbon stocks in the relevant pools and the latest projections assume that a mid-point balance is struck between trajectories that maximise either food production or carbon sequestration.

4.7.2 Sectoral methodologies

Projections in the UEP model are based around an energy balance model which uses the energy-use sectors defined in the DUKES, not the emissions sectors defined for National Communications or the IPCC categories used for the Inventory.

Growth in each sector is based on econometric models that estimate sectoral growth, energy use and emissions consistent with the key assumptions and calibrated against sectoral GVA, tonnages, reported energy use and the inventory.

The overall modelling approach is similar to that used in the 5th National Communication, although there have been numerous improvements in each sector.

4.7.2.1 Residential sector

In the residential sector separate equations are used for each fuel. The primary driver of demand is household number, however there are fuel price, seasonal temperature (heating degree day) and income effects. For gas the penetration of central heating systems is also taken account of.

Energy efficiency improvements are largely seen as policy driven.

4.7.2.2 Commercial services

The primary driver of total energy demand in Commercial Services is sectoral GVA, although the elasticity is less than 1. There are also fuel price and seasonal temperature (heating degree day) effects. Fuel share models are then used to decompose this into demands for the individual fuels.

Additional energy efficiency improvements are policy driven.

4.7.2.3 Public services

The primary driver of electricity and heating fuel demand in Public Services is sectoral employment. There are also seasonal temperature (heating degree day) effect and an observed time trend in improving energy intensity per employee. As with commercial services as with Commercial services a fuels share model is then used to decompose this heating energy into demand for the individual fuels.

[142] The approach used is described in Inventory and projections of UK emissions by sources and removals by sinks due to land use, land use change and forestry. Annual Report July 2008. Available at http://nora.nerc.ac.uk/5956/

4.7.2.4 Industry

Industry energy demand and process emissions are projected on a final use sub-sectoral basis. The sub-sectors are based on those used in the DUKES, with some aggregation for the non-energy intensive sub-sectors. Sub-sectors are Iron & steel (including coke manufacture); non-ferrous metals; chemicals & pharmaceuticals; non-metallic minerals (including non-energy mining & quarrying), pulp, paper & printing; engineering and vehicles; textiles, leather & clothing; other manufacturing (including waste & water treatment); and unclassified.

In each sub-sector the primary driver is GVA, except iron & steel where a steel tonnage driver for basic oxygen and electric arc processes has been used.

Sub-sector GVAs are estimated from econometric equations that include UK GDP elasticities, World GDP elasticities, effective exchange rate elasticities and time trends.

The modelling then allows for price drivers and historical trends in energy intensity, although in the majority of cases the intensity has been observed to be constant.

Having estimated total energy demand in the sector fuel share models are used to decompose this into demands for the individual fuels. Fuel share models are logit models and include cross-price elasticities and time trends.

Process Emissions of CO_2 are stoichiometric (assuming no major changes to the processes used) and are derived from sub-sectoral output drivers.

4.7.2.5 Transport

Separate models are used for Road Transport, Rail, Aviation and Shipping.

The **road transport model** is an econometric response surface model that is calibrated against the DfT's National Transport Model.

The econometric model is multi-modal (cars, light good vehicles (LGV), heavy goods vehicles (HGV), and public service vehicles (PSV)) and includes a population driver for Cars and a manufacturing GVA driver for HGV as well as price, motor spirit/diesel engine share and fuel efficiency and biofuel substitution effects.

Most energy efficiency improvements are policy driven e.g. by EU new car emissions intensity targets, biofuel content targets and complementary measures such as lower rolling resistance tyres for HGVs.

The **rail model** is based on DfT's projected traffic growth, electrification of existing track and the construction of new lines, such as Crossrail and HS2.

The **commercial aviation projections** both international and domestic are based on the projections in the DfT's National Aviation Model.

National navigation is projected to remain largely static.

4.7.2.6 Agriculture

Agriculture is a small user of energy in the UK and therefore simple trend models are used for this sector.

4.7.2.7 Energy supply

Energy supply comprises of electricity & heat generation; oil refining; energy extraction and distribution; and Manufacture of solid fuels (coke ovens and patent fuels).

For the **electricity generation sub-sector** DECC has a sub-model – the Dynamic Despatch Model (DDM) to project investment and generation. This is a market based model that simulates in detail the operation of the electricity market and the investment decision of the market participants. It is a profit-maximisation model.

This represents a significant change from the model used in the 5th National Communication which was a cost minimisation model.

The reason for the change was the need to be able to model the effect of government policies that incentivise through market mechanisms. One example would be the use of contracts for difference to incentivise investment in nuclear, renewable and low-carbon technologies.

This is supplemented by the Combined Heat and Power (CHP) model which models investment in and the supply of heat and electricity from Combined Heat and Power plant, mostly in Industry.

The primary driver of **oil refining** energy use is domestic demand for oil products and an import/export adjustment as the UK has surplus refining capacity for some oil products - motor spirit and fuel oil; and a deficit of others – kerosene and diesel/gas oil.

Energy use in **energy extraction and distribution** is largely driven by extraction of oil and gas in the North Sea, where production has already peaked. Coal mining continues at a low level and is now predominantly opencast. For energy extraction we use projections from DECC's Energy Development Unit. In these projections the UK is not yet assuming any unconventional onshore oil or gas extraction (fracking).

Although there is scope for reducing **fugitive emissions**, both in energy extraction and across the distribution network, in these projections the UK government conservatively assume no reduction.

Energy use in **coke manufacture** is driven by demand for metallurgical coke for making iron and steel.

4.7.3 Other greenhouse gas emissions

The emissions projections of the other GHGs covered by the Kyoto Protocol; CH_4, N_2O, HFCs, PFCs and SF_6, but excluding combustion-related emissions of these gases and LULUCF are produced by the inventory team in DECC, and are broadly consistent with the assumptions underlying the projections in the DECC Energy and Emissions Projections model.

The projections have been developed to the same level of sectoral detail included in the emissions inventory and are based on a range of data sources. These include consultation with experts and stakeholders from UK government departments, industry and other organisations; technical literature; and incorporating results of studies undertaken for DECC.

Projections have been calculated using a bespoke projections system which complements the national inventory system. The projections system includes spreadsheets to pre-process data, and to feed the projections database which is linked to the national greenhouse gas emissions database. This projections system calculates emissions based on forecast activity statistics, emissions factors and various other sector specific assumptions for each of the main sources of emissions. Greenhouse gas emission projections are disaggregated by sector and are calculated for each year from 2005 to 2050. These are then aggregated to provide an estimate of total projected emissions. The projections system has been designed to be transparent, flexible and easy to update.

The UK has a range of measures to reduce emissions of the non-CO_2 gases. For waste disposed to landfill, emissions of CH_4 to air are controlled through the IPPC Directive,[143] implemented via the Environmental Permitting Regulations 2008, and through the Landfill Directive.[144] The Landfill Directive states that landfill gas must be treated and used, and if the gas cannot be used to produce energy, it must be flared. The IPPC Directive also controls industrial emissions from all major industrial installations. Emissions from the manufacture of nitric acid have been mitigated based under site specific decisions regulated via IPPC, following the principles of BAT (best available technology). Emissions of N_2O from agriculture are being limited both now and will be limited in the future through the Nitrate Directive.[145] This Directive requires a mandatory Action Programme of measures for the purposes of tackling nitrate loss from agriculture. Many commercial, industrial and public sector organisations in the UK have obligations under the EC regulation on certain fluorinated GHGs[146] and this regulation will limit emissions of F-gases, especially from refrigeration and air conditioning equipment.

In accordance with the mechanism for producing the projections of CO_2, the non-CO_2 GHG projections are based on the 'with measures' scenario, which takes into account currently adopted and implemented policies and measures.

Projections are verified by comparing trends in actual historic emissions against future emission estimates. If there is a significant deviation between the trend in historic data and future emission estimates, projection methodologies and assumptions are revised accordingly.

4.7.4 Land use, land use change and forestry management

Land use, land use change and forestry (LULUCF) emissions projections[147] are produced by the Centre for Ecology and Hydrology under contract to DECC.

The LULUCF sector (sector 5 in the national GHG inventory) is divided into six land use types for reporting of emissions/removals: 5A Forest Land, 5B Cropland, 5C Grassland, 5D Wetlands, 5E Settlements, 5F Other Land. Net carbon stock changes from Harvested Wood Products are reported in 5G Other.

Emissions of GHG to the atmosphere are expressed as positive quantities, and removals of CO_2 as negative quantities. Emissions of all three GHG can be combined together into total CO_2e, using standard GWPs. The net LULUCF emission is the balance of emissions and removals across the seven categories (5A-5G): the net total is smaller than most of the category totals.

Projections are made for net emissions and removals of GHGs to 2050, arising from LULUCF activities reported in the latest (1990-2011) GHG inventory. These projections are available online.[148] The UK has produced four initial policy scenarios: Business As Usual (BAU), High emissions, Mid emissions and Low emissions. The Low emission scenario emphasises bioenergy crop production and woodland creation. In the High emission scenario the policy priority is to increase food production, and there is less focus on bioenergy crops and forestry (exploring the highest level of emissions that the sector might produce). The mid emission

[143] Council Directive 96/61/EC of 24 September 1996 concerning integrated pollution prevention and control

[144] Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste

[145] Council Directive 91/676/EEC of 19 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources

[146] Regulation (EC) No 842/2006 of the European Parliament and of the Council of 17 May 2006 on certain fluorinated greenhouse gases

[147] http://uk-air.defra.gov.uk/reports/cat07/1304300925_Projections_of_emissions_and_removals_from_the_LULUCF_sector_to_2050_2011i_UK-FINAL-VERSION.pdf

[148] http://uk-air.defra.gov.uk/reports/cat07/1304300925_Projections_of_emissions_and_removals_from_the_LULUCF_sector_to_2050_2011i_UK-FINAL-VERSION.pdf

scenario uses land use change, afforestation and deforestation rates midway between the high and low scenario rates. The Business-As-Usual (BAU) scenario continues the afforestation rate from 2010 out to 2050. The projections presented here are based on the Mid emissions scenario. The UK's experts believe that this scenario is likely to best reflect future policy choices.

4.7.5 Overseas territories

The UK's dependant overseas territories are not included in the projections that the UK produces annually to monitor progress against its own Carbon Budgets. For this National Communication the UK has therefore supplemented its annual projection with new projections for these overseas territories, consistent with their 2011 Inventory.

Emissions in the Overseas Territories are only a small proportion of UK emissions. GHG emissions in these territories were collectively 0.4% of the UK's UNFCCC coverage emissions.

In the absence of more detailed information about economic and demographic growth and policy measures for the Overseas Territories, the UK has produced simple trend projections for GHGs within each national communication sectors:

- for CO_2, CH_4 and N_2O emissions a continuation of the log- linear trends observed in the period 1990-2011.
- for fluorinated gases the same pattern of emissions is projected for the rest of the UK since reductions in emissions of these gases is driven much more by substitution with less harmful gases than locally specific changes in uses.

4.7.6 The UK's Kyoto base year definition

The base year chosen for the purposes of assessing progress towards the Kyoto Protocol target uses estimates of emissions from 1990 for CO_2, CH_4 and N_2O and estimates of emissions from 1995 data for HFCs, PFCs and SF_6. This National Communication uses the estimate of base year emissions used to fix the UK's Assigned Amount,[149] which was based on the 1990-2004 GHG inventory, this was finalised following an in-country review of the inventory in 2007 and communicated to the UNFCCC in the form of the UK's Initial Report under the Kyoto Protocol.

The calculation of the UK's base year for reporting under the Kyoto Protocol includes a small allowance (0.33 $MtCO_2$) representing emissions from deforestation in 1990. This allowance is calculated in accordance with rules associated with Article 3.7 of the Kyoto Protocol. Annex 6 provides a table comparing the UNFCCC and Kyoto Protocol coverage.

4.7.7 Key assumptions

The projections presented in this Chapter are based on the UK energy projections detailed in the September 2013 publication of energy and emission projections.[150] Key assumptions for the projections are given in this section.

Updated Energy and Emissions Projections (UEP) are now published annually. The latest energy and emissions projections were published in September 2013.

This uses the economic and demographic assumptions and projections produced for the UK government by the Office for Budget Responsibility (OBR)[151] for the March 2013 Budget[152] and the July 2013 Fiscal Sustainability Report.[153]

[149] http://unfccc.int/files/national_reports/initial_reports_under_the_kyoto_protocol/application/pdf/report_final.pdf

[150] https://www.gov.uk/government/organisations/department-of-energy-climate-change/series/energy-and-emissions-projections

[151] http://budgetresponsibility.org.uk/

[152] http://budgetresponsibility.org.uk/economic-and-fiscal-outlook-march-2013/

[153] http://budgetresponsibility.org.uk/fiscal-sustainability-report-july-2013/

The OBR's population projections are provided by the UK's Office of National Statistics.[154] The OBR's March 2013 growth and workforce projections used the low-migration variant of the 2010 baseline projection.

Household projections are based on those produced by the Department for Communities and the devolved administrations, which combine ONS population projections with household formation propensities. The Department for Communities' latest projection to 2030[155] is based on the principal projection on an earlier, 2008-baseline and has therefore been scaled by DECC to match that assumed by the OBR.

World UK GDP is based on the IMF October 2012 World Economic Outlook[156] and the January 2013 World Economic Outlook update,[157] but extended beyond 2017 by its own estimates.

Updated social economic growth assumptions are shown in Table 32.

Table 32: Growth assumptions

	Actual		Projection			
% per annum	**2010**	**2011**	**2015**	**2020**	**2025**	**2030**
UK GDP	1.7%	1.1%	2.3%	2.8%	2.5%	2.5%
World GDP	5.1%	3.9%	4.4%	4.5%	4.3%	4.3%
UK Population	0.7%	0.7%	0.7%	0.6%	0.5%	0.4%
UK Households	1.1%	1.0%	1.1%	0.9%	0.8%	0.7%

The fossil fuel prices projections[158] and carbon prices projections[159] are updated annually by analysts in DECC and are subject to peer review. They are also used more widely across government.

In the March 2010 Budget, the government announced a policy to guarantee a floor for the carbon price for fuel used for Electricity generation, to be achieved by imposing a levy equal the projected difference between the EU ETS price and an intended trajectory.

Key fossil fuel and carbon price values are set out below in Table 33.

Table 33: Central fossil fuel and carbon prices

		Actual		Projection			
2013 prices	**Units**	**2010**	**2011**	**2015**	**2020**	**2025**	**2030**
Oil (Brent dated)	$/bbl	84	105	113	120	127	135
Gas (NBP)	p/therm	45	58	70	74	74	74
Coal (Rotterdam fob)	$/tonne	98	126	104	123	123	123
EU ETS Carbon Price	£/tCO_2	11.7	6.4	3.7	4.9	5.5	6.2
Electricity Generation Carbon Price	£/tCO_2	11.7	6.4	19.0	32.7	54.5	76.2

[154] http://www.ons.gov.uk/ons/rel/npp/national-population-projections/2010-based-extra-variants/index.html

[155] http://webarchive.nationalarchives.gov.uk/20121108165934/http://www.communities.gov.uk/documents/housing/xls/table401.xls

[156] http://www.imf.org/external/pubs/ft/weo/2012/02/weodata/index.aspx

[157] http://www.imf.org/external/pubs/ft/weo/2013/update/01/

[158] https://www.gov.uk/government/publications/fossil-fuel-price-projections-2013

[159] https://www.gov.uk/government/publications/traded-carbon-updated-short-term-values-used-for-modelling-purposes

Key exchange rates, in Table 34, are assumed not to change from those applying in the most recent historic year, 2012.

Table 34: Key exchange rates, against Sterling

		Actual		Projection			
Currency	**Units**	**2010**	**2011**	**2015**	**2020**	**2025**	**2030**
US Dollars	$ per £	1.546	1.604	1.587	1.587	1.587	1.587
Euros	€ per £	1.165	1.153	1.175	1.175	1.175	1.175

4.7.8 QA/QC procedures

Energy projections and the energy-related emission projections are produced in the DECC by a small team (the 'UEP modelling team') whose sole task is the production of energy and emissions projections and the communication of results. This team also puts together the overall projections and quality assures the inputs from the other teams.

Non-energy non-CO_2 projections are produced in the DECC within the Inventory team.

LULUCF projections are produced under contract by the Centre for Ecology & Hydrology.

Transport modelling by the modelling team is based on and calibrated against the detailed models for Road, Rail and Air used within the DfT and which are in turn subject to quality assurance within DfT.

Policy savings are prepared and submitted by analytical teams in the relevant policy areas and are based on the Impact Assessments prepared for that policy. Impact assessments are prepared following central guidance to make sure energy use and GHG emissions are valued consistently across government. To ensure the quality of these appraisals, the Interdepartmental Analysts' Group (IAG) on Energy and Climate Change offers a cross-government multi-disciplinary peer review forum for policy appraisals and other analysis.[160]

Policy savings are submitted using a standard template and are checked by the modelling team for any unaccounted overlaps and for internal consistency between energy and emissions savings. Model savings are also confirmed with the submitting teams and departments.

Changes and major updates to projections methodology are generally submitted for peer review through presentation to the Interdepartmental Analyst Group, which also appoint a reviewer, the reviewer reports to the IAG and resolves any issues with the projections team responsible.

The UK's national emissions projections are updated on an annual cycle so as to inform the UK's progress against its Carbon Budgets.

Changes are made to the model incrementally and then quality assured to confirm that the change has face validity. Results from the electricity generation sub-sector modelling are quality assured independently by the team responsible for the DDM.

Both interim and final results are presented to a steering group and also circulated to stakeholders.

The annual published projections are formally reviewed by the independent CCC[161] and its staff.

[160] https://www.gov.uk/government/policies/using-evidence-and-analysis-to-inform-energy-and-climate-change-policies/supporting-pages/policy-appraisal

[161] http://www.theccc.org.uk/

4.7.9 Strengths and weaknesses of the projection methodology

4.7.9.1 Strengths

The UK's modelling methodology has the following strengths:

- the Initial starting points for the projections are the latest actuals from the Inventory and DUKES. These projections are based on 2011 Inventory and 2012 energy statistics, both published in 2013.
- they are updated annually for the UK, as part of our monitoring against UK national Carbon Budgets.
- it uses authoritative national and international sources for socio economic projections.
- rolling programme of review and update of the projection methodologies and econometric models. Models are tested by backcasting[162] to see if they explain what has happened in the recent past.
- the projections distinguish between 'business as usual' and the reductions in emissions as a consequence of mitigating policies and measures.
- estimates of savings from policies and measures in the projections are taken from the impact assessments for those policies applying a common methodology across government for GHG mitigation measures.
- the model use econometric methodologies that capture long-running relationships between economic activity, energy consumption and emissions. We have a detailed model of the operation of the electricity generation sector that captures both sort-run fuel switching and long-term investment strategies.

4.7.9.2 Weaknesses

The UK's modelling methodology has the following weaknesses:

- the modelling generally assumes that historic relationships will continue to apply in the future. It can fail to capture structural changes and new technologies where these fall outside the scope of included policies and measures.
- there is considerable, recognised uncertainty in the economic and social projections that we take from external sources.
- econometric modelling is subject to estimation errors and the possibility of incorrect identification of drivers of energy use.

4.8 Sensitivity analysis

The model runs for the UK's National September 2013 projections included the following variant scenarios/sensitivities:

- low and high fossil fuel prices.
- low and high UK GDP rates.

[162] In backcasting we fit a model to some observations and then use this to predict the values of other known observations. Typically we fit the model to the earlier part of a historic time series and then project the most recent data.

4.8.1 Fossil fuel prices

The fossil fuel prices scenarios used were as follows:

Table 35: Variant Fossil fuel Prices Scenarios

		Actual	Projection			
Fossil fuel	**2013 Prices**	**2011**	**2015**	**2020**	**2025**	**2030**
Low Fossil Fuel Prices						
Oil (Brent dated)	$/bbl	115	93	86	81	75
Gas (NBP)	p/therm	58	49	42	42	42
Coal (Rotterdam fob)	$/tonne	126	89	93	93	93
High Fossil Fuel Prices						
Oil (Brent dated)	$/bbl	115.2	132.0	150	171	195
Gas (NBP)	p/therm	58	91	103	105	105
Oil (Brent dated)	$/tonne	126	113	139	166	166

These scenarios were produced applying a fundamental analysis of the drivers of the wholesale prices of the main fossil fuel prices available to the UK within the European energy market.[163] They are not sensitivities to the overall level of fossil fuel prices and do not maintain fuel cross-price ratios.

4.8.2 Growth sensitivities

The UK GDP growth sensitivities, set to be +/- 0.25% per annum with respect to the reference scenario, were:

Table 36: Variant UK GDP growth sensitivities

		Actual	Projection			
Currency	**Units**	**2011**	**2015**	**2020**	**2025**	**2030**
Low UK GDP Growth	% pa	1.1%	2.15	2.95	2.75	2.75
High UK GDP Growth	% pa	1.1%	2.55	3.05	2.75	2.75

4.8.3 Total GHG emissions using variant assumptions

These parameter variants give us 4 variant emissions projections:

Table 37: Total 'with measures' GHG emissions in variant scenarios, including LULUCF

	Actual	Projection			
$MtCO_2e$	**2011**	**2015**	**2020**	**2025**	**2030**
Reference scenario	553	529	438	421	399
Variant Scenarios					
Low Fossil Fuel Prices	553	501	435	427	408
High Fossil Fuel Prices	553	525	439	418	392
Low UK GDP Growth	553	527	433	415	391
High UK GDP Growth	553	531	443	429	407

The apparently perverse lower emissions in 2015 and 2020 in the low fossil fuel price scenario is because in this scenario natural gas is relatively cheaper than coal causing some fuel switching in the power station sector from coal to the lower emissivity natural gas.

[163] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/212521/130718_decc-fossil-fuel-price-projections.pdf

4.9 Overall uncertainty

Fossil fuel prices, policy impact, economic and demographic growth are all subject to modelling error and natural variation driven by factors such as temperature.

In order to model this, randomly selected trajectories of values drawn from the uncertainty ranges for 10 key parameters, including GDP, population, fossil fuel prices, annual temperatures and policy savings were combined in a 500 run Monte Carlo simulation[164] to assess the overall uncertainty range for the UK's emissions projections. Figure 42 shows the results of this probabilistic analysis.

Figure 42: Uncertainty fan chart for UK Total GHG Emissions, including LULUCF ($MtCO_2e$)

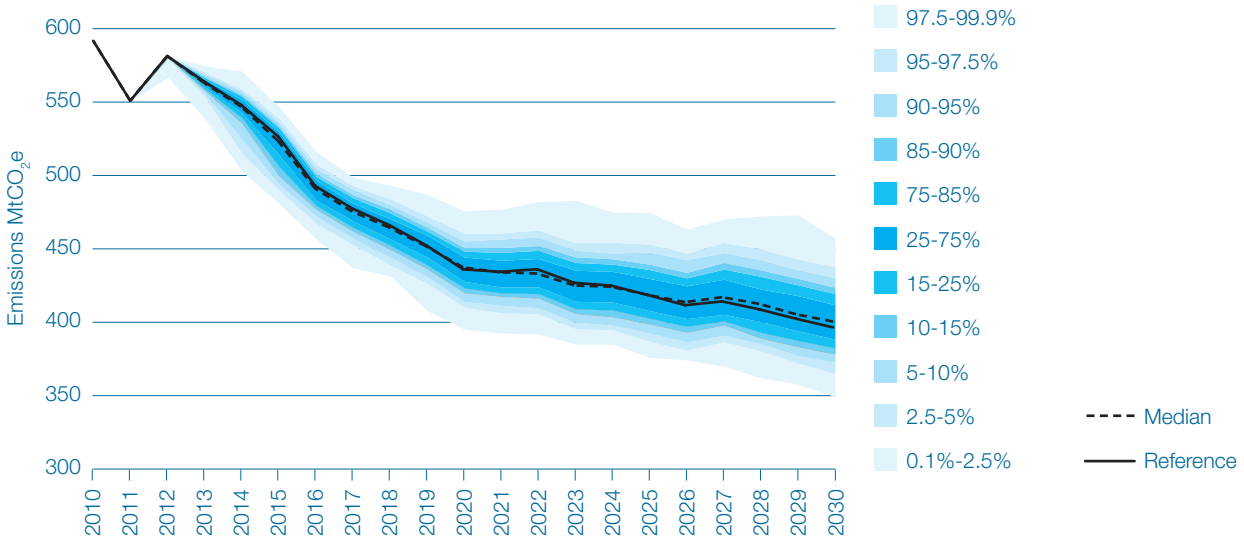

Table 38: Ninety five% confidence Interval for total 'with measures' GHG emissions from Monte Carlo simulation, including LULUCF

$MtCO_2e$	Inventory		Projection			
	1990	2011	2015	2020	2025	2030
Upper 2.5 Percentile	775	553	541	463	456	441
Reference projection	775	553	529	438	421	399
Lower 2.5 Percentile	775	553	492	413	390	368
Upper 2.5 percentile, diff as% of Ref.	-	-	2%	6%	8%	10%
Lower 2.5 percentile, diff as% of Ref.	-	-	-7%	-6%	-7%	-8%
Upper, as% of 1990 values	-	-29%	-30%	-40%	-41%	-43%
Reference, as% of 1990 values	-	-29%	-32%	-43%	-46%	-48%
Lower, as% of 1990 values	-	-29%	-36%	-47%	-50%	-53%

This analysis projects that in 2020, UK emissions of GHGs will be between 40% and 47% below 1990 levels, with the central estimate 43% below.

[164] A problem solving technique used to approximate the probability of certain outcomes by running multiple trial runs, called **simulations**, using random variables.

4.10 Differences from the 5th National Communication

The table below summarises the differences between the projections in the fifth and sixth National Communications.

The main differences between the two projections include additional implemented and adopted polices, some re-estimations of the impact of policies, improved modelling, revised fossil fuel price assumptions and lower economic growth.

The projections have also been updated to take into account improvements to the historic inventory, such as updates to refinery emissions and in the allocation of emissions between national navigation and international marine bunkers and other improvements to methods, emission factors and activity data. The effect of changes to the inventory are summarised in Chapter 2.9.

The net effect of these changes is to reduce projected emissions in 2020 from 26% below 1990 levels in the 5th National Communication to 43% below 1990 levels in the 6th National Communication. Of the projected reduction of 133.5 $MtCO_2e$, between the two projections 122.3 $MtCO_2e$ is attributable to a projected reduction in CO_2 emissions.

Table 39: Differences in 'with measures' projections between the fourth and fifth national communications, $MtCO_2e$. Including LULUCF

	Fifth National Communication			Sixth National Communication		
Gas	**1990**	**2020**	**Projected Change**	**1990**	**2020**	**Projected Change**
Carbon Dioxide	593.5	482.1	-19%	593.5	359.8	-39%
Methane	103.7	43.4	-58%	99.2	36.3	-63%
Nitrous oxide	63.9	38.7	-39%	68.3	33.0	-52%
Hydrofluorocarbons	11.4	6.9	-39%	11.4	8.6	-25%
Perfluorocarbons	1.4	0.2	-86%	1.4	0.2	-84%
Sulphur hexafluoride	1.0	0.7	-30%	1.0	0.6	-43%
Total GHG	**774.9**	**572.0**	**-26%**	**774.8**	**438.5**	**-43%**

Note: Percentage changes and emission estimates may differ slightly due to rounding.

Chapter 5: Vulnerability assessment, climate change impact, and adaptation measures

5.1 Key developments

- **Government Action** – Since the publication of the 5th National Communication (2009), the UK has passed a number of major milestones, including the publication of the country's first Climate Change Risk Assessment and the National Adaptation Programme (NAP). In 2011 the Environment Agency's (EA's) Climate Ready Support Service was established in England. This service assists businesses, the public sector, and other organisations in adapting to climate change.
- **UK Climate Projections** – The latest UK climate projections were released in summer 2009. These projections relate to current and future climate change up to 2100 for three emissions scenarios. Projections are provided on a 25km spatial scale for a range of climate variables (temperature, precipitation, air pressure, cloud and humidity), including seasonal averages, daily averages and daily maxima. The scenarios were the first for the UK that included an assessment of uncertainty, making them suitable for risk based assessments. They were used in the first UK Climate Change Risk Assessment published in January 2012.
- **UK Climate Change Risk Assessment 2012** – In January 2012 the UK published the first Climate Change Risk Assessment, a requirement of the Climate Change Act 2008. This identified over 700 risks to the UK from a changing climate and focused on around 100 of them to determine their severity and likelihood in the short, medium and long term.
- **The National Adaptation Programme (NAP)** – On 1 July 2013 the first NAP report was published covering England and non-devolved climate adaptation matters, as required by the Climate Change Act 2008. The NAP sets out actions and commitments from the UK government, industry, local authorities and civil society to build up UK resilience to climate change. The over-arching aim of the NAP is to shape a society which makes timely far-sighted and well-informed decisions to address the risks and opportunities posed by a changing climate.
- **Environment Agency (EA) Climate Ready Support Service** – The EA's Climate Ready Support Service for England was established in October 2011. This service provides advice and support to businesses, the public sector and other organisations to enable them to adapt to the changing climate. The Service covers England only, but the products generated are available for use across the UK and elsewhere. The service aims to help organisations build their own capacity to adapt by incorporating climate risk management into their plans and decision making.

- **Local Action** – In 2012, the Local Government Association (LGA) established the Climate Local initiative, a sector-led initiative that provides councils with a voluntary framework for taking locally driven action on climate change. The framework allows councils to publically share plans, commitments and experiences and learn from others. To date, over 70 councils across England have signed up to Climate Local and their action plans are publically available.
- **UK action overseas** – Through the Department of Energy & Climate Change (DECC) and the Department for International Development (DFID), the UK is working internationally on adaptation through the United Nations Framework Convention on Climate Change (UNFCCC) and bilateral agreements. Projects include providing up to £150 million for the Adaptation for Smallholder Agriculture Programme which will work in 40 developing countries, helping smallholder farmers adapt to climate change, and investing £73 million in the Chars Livelihoods Programme in Bangladesh between 2009 and 2016. The programme is working to help those living in extreme poverty, especially women, build livelihoods that are more resilient to climate change.

5.2 Introduction

The UK has made a strong start on adaptation and this is already making us better equipped to cope with higher temperatures, increased rainfall and other potential changes. This chapter describes how the UK is continuing to develop adaptation strategies to deal with the unavoidable impacts of climate change and their economic, environmental and social costs. The ongoing work that the UK is undertaking in relation to adaptation is underpinned by Part 4 of the UK Climate Change Act 2008[165] ("the Act") (Section 3.3.6).

The Act sets out a framework for building the UK's ability to adapt to climate change, by establishing that:

- A UK-wide Climate Change Risk Assessment (CCRA) must take place every five years;
- A National Adaptation Programme (NAP) must be put in place and reviewed every five years to address the most pressing climate change risks;
- The government has the power to require public authorities and statutory undertakers (for example, water and energy utility companies) to report on how they have assessed the risks of climate change to their work, and what they are doing to address these risks;
- The government is required to publish a strategy outlining how this new power will be used, and to provide guidance on what reporting authorities need to do; and that
- The Committee on Climate Change's Adaptation Sub-Committee was established to oversee progress on the government's climate change adaptation programme. This includes advising on the Risk Assessment and evaluating the success of the NAP.

In July 2013 the UK government published the NAP which set out the UK's vision for "a society which makes timely, far-sighted and well-informed decisions to address the risks and opportunities posed by a changing climate."

The NAP provides an overview of the work of the UK government on adapting to climate change, covering the implementation of commitments made in the Climate Change Act and other legislation including work on non-devolved matters. The devolved administrations (DAs) of Scotland, Wales and Northern Ireland are carrying out their own adaptation work. The NAP sets

[165] http://www.legislation.gov.uk/ukpga/2008/27/contents.

out how the UK is adapting to projected climate change impacts based on information provided by the UK Climate Projections 2009 and the findings of the Climate Change Risk Assessment 2012.

This chapter goes on to describe a range of adaptation actions designed to address these impacts, combining those laid out in the NAP, with others carried out by the DAs. The chapter also describes the work of the UK government internationally on adapting to climate change.

5.3 Climate ready programme for England/UK reserved matters

In 2006, the UK government established the Adapting to Climate Change programme led by the Department for Environment, Food and Rural Affairs (Defra), which became the 'Climate Ready' programme in 2012.[166] The Climate Ready programme is responsible for the co-ordination of the UK government's work on adaptation in England, and throughout the UK on reserved matters.[167] The devolved administrations in Scotland, Wales and Northern Ireland are each responsible for considering how climate impacts will affect their jurisdictions.

Whilst adaptation is mainstreamed within key policy areas across UK government, the Climate Ready programme coordinates cross-cutting action required under the Act. In accordance with the Act, the first UK Climate Change Risk Assessment (CCRA) was published in January 2012 beginning the 5-year policy cycle set out in the Act. The risks identified in the UK CCRA in turn informed the development of the UK's first NAP, published in July 2013, which sets out the actions to address the risks identified in the CCRA.

It also oversees the Strategy for the Adaptation Reporting Power of the Act which enables Ministers to direct certain organisations, for example those with responsibilities for critical national infrastructure, to prepare reports on the steps they are taking and will take to deal with the risks from a changing climate. The Defra Climate Ready programme leads for the UK at EU level and coordinates adaptation action with the other UK Administrations, although adaptation policy itself is devolved. In addition, it sponsors the Environment Agency (EA)'s Climate Ready Support Service for England and the ASC.

Since its creation in 2009, the ASC has published annual progress reports assessing the UK's preparedness for climate change. These progress reports will be used to inform the ASC's first statutory report on implementation of the NAP in 2015. In 2016, the ASC will then provide advice to the government, informing the preparation of the second UK CCRA which will be laid before parliament in January 2017, starting the cycle again.

5.3.1 The climate ready support service

The UK government has appointed the EA to provide the Climate Ready support service for England.[168] The service provides advice and support to businesses, the public sector and other organisations to help them adapt to a changing climate. The support service complements the existing roles and responsibilities the EA has on flood risk and coastal erosion, safeguarding water resources, and protecting the water and wetland environment. The EA is experienced in considering longer term climate risks in these areas and the support service has been developed closely with the NAP.

[166] https://www.gov.uk/government/policies/adapting-to-climate-change.

[167] Reserved matters are those policy decisions affecting Scotland, Wales, Northern Ireland and the regions of England that are still taken by the UK Parliament at Westminster.

[168] www.environment-agency.gov.uk/climateready.

The service is split into two priority areas:

- A digital service providing adaptation tools, guidance and information for key users;
- A targeted approach providing both direct and indirect support to priority services and sectors.

The service provides online advice, a help desk and tailored support to help organisations adapt to extremes of weather and the changing climate. The EA works with local authorities, other government bodies, business sectors and civil society, and partners such as the Local Government Association and the nine Climate Change Partnerships across England. Support is tailored to key themes: business and services, infrastructure, built environment, healthy and resilient communities, natural environment, agriculture and forestry and local government, which reflects the approach set out in the NAP Report.

Priority actions for each theme of the Climate Ready Support Service are set out below.

Infrastructure

- Facilitate discussion and information sharing across the sector on climate risk and interdependencies.
- Work with organisations in a position to influence or direct infrastructure operators (such as regulators), helping them use their influence to ensure operators take account of climate change.

Healthy and Resilient Communities

- Promote adaptation planning by local Health and Wellbeing Boards and those who support their interests. Communicate the benefits of action across the health, public health and social care system.
- Work to promote community resilience and emergency preparedness as part of the local response to the impacts of climate change.

Built Environment

- Improve resilience in the built environment by influencing the planning process.
- Support development and signposting of adaptation guidance, data, assessment tools and training materials for the built environment sector.
- Build capacity of key partners so they can promote adaptation to key stakeholders in the built environment sector.

Local Government

- Support the Local Government Association's (LGA) Climate Local initiative.
- Deliver the national roll out of the Severe Weather Impacts Monitoring System (SWIMS) to help Local Authorities build a local business case for action.
- Work with partners to disseminate examples of work that embeds adaptation across council services.

Business and Services

- Raise awareness and understanding amongst businesses about climate change risks.
- Increase the extent to which businesses are actively considering climate change impacts and taking appropriate action.
- Help businesses better understand and manage climate change risks to their supply chains.

Agriculture and Forestry

- Work with RASE, NFU and AHDB to ensure adaptation action is included within the industry led "on-farm demonstration" portal.
- Work with the sectors to develop and promote adaptation good practice, by integrating climate resilience into advisory services such as the Farming Advice Service (FAS).

Natural Environment

- Support a landscape-scale approach to conservation management through working with Local Nature Partnerships, Nature Improvement Areas, and bodies such as National Parks and Areas of Outstanding Natural Beauty (AONBs).
- Provide strategic join-up of policies and activities by key organisations that have an interest in adaptation in the natural environment.

The Climate Ready programme takes account of the global impacts of climate change which may in turn impact the UK. Examples include global supply chains and international health risks. The UK actively supports adaptation action beyond the UK; this is demonstrated by the work of the Department for International Development which is detailed in section 5.7.

5.3.2 Providing the evidence

To be able to take effective decisions on how to adapt, individuals and organisations need a reliable understanding about the likely consequences of climate change. A wide range of work has been carried out to provide the evidence base on which adaptation decisions can be taken. Along with the UK Climate Projections and the CCRA, Climate Ready will continue to develop its evidence base, building on work undertaken by the UK's Met Office Hadley Centre, the UK Climate Impacts Programme and other work funded by government, UK Research Councils and other bodies.

Recent research includes:

- Economics of Climate Resilience;[169]
- Macroeconomics of Climate Change;[170]
- PREPARE – Programme of research on preparedness, adaptation and risk.[171]

The UK Climate Projections (released summer 2009, UKCP09)[172] provide an estimate of the degree of certainty in projections, allowing for a more risk-based approach to decision making.

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[169] http://randd.defra.gov.uk/Default.aspx?Module=More&Location=None&ProjectID=18016.

[170] http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=18639.

[171] http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&ProjectID=18552.

[172] UK Climate Projections was delivered by UKCIP, The Met Office Hadley Centre, British Atmospheric Data Centre and Newcastle University.

5.3.3 Raising awareness of the need to take action now, and helping others to take action

A comprehensive evidence base is essential, but it is only effective if it is well used. Individuals and organisations need to know that there is an issue that needs to be addressed, how to find the information that they need, and how to use it.

In developing the NAP and now through its implementation, the Climate Ready Programme works with a range of organisations from the public, private and voluntary sectors to:

- Raise awareness of the need for action;
- Provide and promote the information and tools needed to take action;
- Build capacity and capability within organisations to understand the impacts of climate change and take action.

5.3.4 Action at the local level

The impacts of climate change will vary, even within a relatively local area, and action will need to be taken at the most appropriate level. This will often be regional and local, rather than national. In addition, many of the actions that need to be taken early but have a long-term impact are delivered at local and regional level. These include spatial planning and investments in schools, houses, hospitals and roads, and the provision of a wide range of essential public services.

The NAP sets out the important role that local government plays in supporting local adaptation action within local communities and businesses. The Local Government Association's Climate Local initiative is a sector-led initiative which supports council action to increase resilience to a changing climate. In signing up, councils make a public commitment to act on a set of local priorities. Defra has established a Local Adaptation Advisory Panel for England comprising of a wide range of councils and partners to support dialogue on adaptation between central and local government.

5.3.5 Ensuring and measuring progress

There are two main ways in which adaptation progress is monitored and measured.

Measuring successful adaptation – indicators of success

The Act established the Adaptation Sub-Committee (ASC) of the CCC to evaluate how the UK is preparing for climate change. The ASC is responsible for evaluating the implementation of the NAP and through its annual reports are developing a range of performance indicators for climate change adaptation.

The Adaptation Reporting Power under the UK Climate Change Act

The Act introduced a power for the Secretary of State to direct "reporting authorities" in England to prepare reports on how they are adapting to climate change, referred to as the Adaptation Reporting Power. Reports need to include an assessment of climate change risks faced by the reporting authority, and a programme of measures to address the risks and opportunities presented by the changing climate.[173] In the first reporting round (2010-2011) over 100 organisations from the water, energy, transport and public sectors submitted reports to government.

[173] Full details can be found at: https://www.gov.uk/government/policies/adapting-to-climate-change/supporting-pages/adaptation-reporting-power.

On 1 July 2013 the government published its strategy[174] for the second round of reporting under the Adaptation Reporting Power. During a public consultation there was overwhelming support for a voluntary approach to reporting. On this basis organisations which reported in the first round (from the energy, transport, water and public sectors) will be invited to update their reports. Several new organisations will also be invited to report.

5.3.6 Government policy and process: embedding adaptation

It is important that when UK government policies and investment decisions are planned, the risks from climate change to public policy objectives and to the efficient use of public resources are taken into account. Whilst adaptation policy within the UK government is led by Defra, it is embedded across all key government policies. The Domestic Adaptation Board works to ensure a coordinated government response and also includes the Devolved Administrations to coordinate UK action.

The NAP sets out the roles of the key government departments and their respective delivery bodies and partners. Examples of the areas in which UK government departments will take action are included in section 5.6.

5.3.7 Civil contingencies

The Government works with devolved administrations, emergency responders and others to enhance the UK's ability to prepare for, respond to, mitigate against and recover from emergencies caused by natural hazards and by malicious threats. The Civil Contingencies Act (2004) requires a coherent framework for emergency planning and response from local to national level.

5.4 Adaptation in the UK administrations

Climate adaptation policy is a devolved matter. Scotland, Wales and Northern Ireland have established their own adaptation programmes while Defra leads for adaptation policy in England and UK reserved matters. The UK Administrations are committed to working closely together to share best practice and develop UK wide initiatives where appropriate.

5.4.1 Scottish government programme

Scotland has made good progress in promoting the need to adapt to a changing climate.[175] Scotland's Climate Change Adaptation Framework,[176] published in 2009, set out the Scottish government's approach to adapting and building resilience to the future impacts of climate change. It established 12 key sector action plans identifying the climate change issues and challenges for each sector, providing a list of planned work to strengthen resilience to the impacts of climate change. The 12 sectors are; water resource management, agriculture, forests and forestry, business and industry, emergency and rescue services, health and wellbeing, transport, biodiversity and ecosystem resilience, marine and fisheries, spatial planning and land use, the built environment and local authorities.

Although it had no statutory requirement, the framework acted as a forerunner for the statutory obligations set out in the Climate Change (Scotland) Act 2009.

Publication of the UK CCRA, as required by the Climate Change Act, brings into force section 53 of the Climate Change (Scotland) Act 2009 which requires Scottish Ministers to lay a programme before the Scottish Parliament, setting out their objectives in relation to

[179] https://www.gov.uk/government/publications/adapting-to-climate-change-2013-strategy-for-exercising-the-adaptation-reporting-power

[175] http://www.scotland.gov.uk/Topics/Environment/climatechange.

[176] http://www.scotland.gov.uk/Topics/Environment/climatechange/scotlands-action/adaptation/AdaptationFramework.

adaptation to climate change and their proposals and policies for meeting these objectives. The programme must address the risks identified in the CCRA for Scotland, relating to all matters within Scottish Ministers' devolved competence.

Publication of the Scottish Climate Change Adaptation Programme brings into force the adaptation requirement of the public bodies duties introduced by section 44 of the Act. This requires public bodies, within the definition of the Act, to act in the best way possible to help deliver the Scottish government's adaptation programme.

The Programme sets the long-term framework for building Scotland's resilience to climate change and sets out how the Scottish government will achieve its national adaptation objectives not only through integrating adaptation within Scottish government policies and strategies, but through encouraging and facilitating partnership working across Scotland.

The objectives set the longer term direction (to 2050) for climate change adaptation in Scotland, while the policies and proposals provide the focus for the lifetime of the Programme and will evolve and develop with each programme, providing the flexibility needed in order to adjust to new understanding and information as it becomes available.

The Act requires Scottish Ministers to provide an annual report on progress towards achieving the objectives and implementing the policies and proposals set out in the programme.

The Act also establishes the requirements to independently assess the Scottish government's progress towards achieving the objectives and implementing the actions. The first independent assessment must be commissioned within two years of the programme being laid in the Scottish Parliament.

5.4.2 Welsh government programme

The Welsh government has committed to playing a lead role in tackling climate change.[177] The Climate Change Strategy for Wales and associated Emission Reduction and Adaptation Delivery Plans, published in 2010, set out the areas where they will act and how they will work with their partners, to reduce greenhouse gas emissions and support effective adaptation to a changing climate.

They aim to create a low carbon, resource efficient and socially inclusive Wales, as well as improve the long term resilience of their economy, communities and their natural resources. The recent increase in severe weather incidents such as flooding has highlighted this importance.

Climate change adaptation feeds into the Welsh government's approach to sustainable development based on considering the effect on the long term economic, social and environmental wellbeing of Wales, the likely effect on each aspect and the overlap between them. Climate change impacts will not distinguish between these areas and as such any adaptation response needs to recognise this. Adaptation must also factor in long-term thinking and consideration of the likely impacts on future generations. By considering the long-term it is then possible to focus on prevention and the early interventions that can most effectively generate long term benefits.

The Welsh government has been looking to strengthen the framework for sustainable development in Wales through its forthcoming Future Generations Bill. This will aim to enable public service organisations across Wales to put in place measures that lessen the likelihood and impact of major intergenerational challenges such as climate change.

[177] http://wales.gov.uk/topics/environmentcountryside/climatechange.

The Climate Change Strategy for Wales sets out an Adaptation framework to present a national, coordinated approach to ensure that Wales understands the risks and opportunities that climate change presents, and is well placed to adapt in a sustainable way. The Welsh government is building resilience in Wales through sectors, organisations and places across Wales.

Sectoral Adaptation Plans (SAPs) are currently being developed in Wales across five key sectors (Natural Environment, Infrastructure, Health, Communities and Business and Tourism) which will look to:

- Identify the risks and opportunities for sectors from a changing climate;
- Analyse the current policy response;
- Identify any gaps and barriers to effective action;
- Put in place programmes for embedding climate change into delivery across the sectors.

The Welsh government has published Parts 1-5 of Preparing for a Changing Climate statutory guidance which helps organisations in Wales to assess, prepare and act on risks from a changing climate. The guidance sets out a five-part, cyclical risk assessment approach for building resilience and developing a planned response to the threats and opportunities from climate change. The guidance has been developed in response to the Climate Change Act requirements.

Alongside the development of the Sectoral Plans and the adaptation guidance, as part of the Adaptation Knowledge Transfer Programme, the Welsh government is releasing further tools and resources to support individuals, organisations and sectors in their adaptation planning.

Progress on the Welsh government's approach for building resilience and acting on climate change will be updated in its annual Climate Change Strategy Progress Reports with the next one due in December 2013.

5.4.3 Northern Ireland government programme

In Northern Ireland, the Department of the Environment (DOE) takes the lead on climate change issues.[178] It works closely with Defra and the Devolved Administrations of Scotland and Wales.

A Northern Ireland Climate Change Adaptation Programme is being developed, as required by section 60 of the UK Climate Change Act 2008. It will contain the response of the Northern Ireland government to the risks and opportunities identified in the Northern Ireland Climate Change Risk Assessment, which was produced in January 2012 as part of the overall UK CCRA.

The NICCAP will focus on three adaptation principles:

- Integrating adaptation into relevant key policy areas;
- Developing the evidence base;
- Communication and cooperation.

To take account of cross cutting issues in the government's response to the climate change risks and opportunities being brought forward in the NICCAP, four priority areas for action have been identified. These are:

- Flooding;
- Water;

[178] http://www.doeni.gov.uk/index/protect_the_environment/climate_change.htm.

- Natural environment;
- Agriculture and forestry.

The NICCAP is an iterative process that is required every five years and it will contain the first steps in ensuring Northern Ireland's preparedness for the impacts of climate change.

Climate Northern Ireland has been set up primarily to increase the understanding of the impacts of climate change in Northern Ireland and promote action to address climate change adaptation. The partnership brings together members from a range of key sectors to share best practice and promote positive action to address the impacts of a changing climate.

The Partnership provides an overall delivery model for adaptation advice and support in Northern Ireland, since its formation Climate Northern Ireland has provided strategic support and helped promote climate change adaptation to external stakeholders.

5.5 Impacts of a changing climate in the UK

The UK has a well-established foundation for assessing the impacts of climate change, and progressing understanding, guidance and action on adaptation. The UK Climate Impacts Programme was set up in 1997 to advance stakeholder-led assessments of climate impacts.

Current climate projections suggest that, even with significant global reductions in greenhouse gas emissions, increases in temperature are expected over coming decades. Without mitigation policy the current best evidence suggests global temperature increases of several degrees are likely. The UKCP09 projections produced by the Met Office Hadley Centre provide information on a UK spatial scale and include an assessment of the degree of certainty in the result. These projections were used in the first UK CCRA.

The UKCP09 projections suggest that the most likely increase in summer temperatures under a medium high emission scenario is around 3 to 4°C in summer and 2 to 3°C in winter, but with spatial variations. It also projects a trend of changing rainfall, with decreases in the summer and increases in the winter, but little annual change. It is important to emphasise that on top of these trends there will be annual variability so that, for instance, there will still be some cold wet summers, although their frequency will be different to that of today.

With these changing climatic conditions, UKCP09 indicates that we might expect to experience the following in future years:

- Periods of continuously high temperatures longer than we are used to and higher peak temperatures – the summer heatwave experienced in 2003 is likely to become a normal event by the 2040s and be considered cool by the 2080s.
- Decreased seasonal rainfall in summer, perhaps leading to drought, lower river flow and increased water stress.
- More frequent periods of heavy rainfall, especially in winter which may lead to increased flooding.
- Continuing global sea level rise – by 2100 sea levels could have risen by around 80cm around some parts of the UK coast, and even larger increases cannot be ruled out although have only a small probability.
- Increased frequency of coastal flooding by surge events is also expected, primarily as a result of the rising mean sea level. At some locations an extreme water level with a 50 year return period today may occur more frequently than once per decade by the end of the century.

The impacts of these changes will vary from place to place, just as weather and the effect it has on society varies across the country. For example, UKCP09 suggest that by the 2080s, under a medium emissions scenario, mean summer temperatures in parts of southern England will increase by 4.2ºC (50% probability with 10% and 90% probability levels of an increase of 2.2ºC to 6.8ºC respectively) whereas in the Scottish islands the increase may only be 2.5ºC (1.2 to 4.1ºC for the 10% and 90% probability levels).

Winter precipitation is projected to increase under the same scenarios up to +33% (+9 to +70%) along the western side of the UK, but decreases of a few per cent (–11 to +7%) are projected over parts of the Scottish Highlands. In contrast summer precipitation is projected to decrease by about –40% (–65 to –6%), in parts of the far south of England, with changes close to zero (–8 to +10%) over parts of northern Scotland.

The CCRA assessed climate risks for the UK using the UKCP09 for three time periods – 30-year periods centred on the 2020s, 2050s and 2080s and three emission scenarios. The CCRA classified risks and opportunities into three broad impact classes, 'low', 'medium' and 'high' and also identified those risks that are highly uncertain and difficult to quantify. The results of the assessment are presented under five themes:

- Agriculture and forestry;
- Business;
- Health and wellbeing;
- Buildings and infrastructure;
- Natural environment.

Climate change risks in each theme are presented in terms of the range of potential magnitude of the risk, how magnitude varies over time and the overall confidence in the findings of the assessment. The method focused attention on risks where decisions need to be made in the near future (i.e. in the next 5 years).

The key climate risks and opportunities identified in the UK CCRA 2012 include:

Agriculture and Forestry

- Higher summer soil moisture deficits, increasing demand for irrigation to maintain crop yields and quality.
- Increased competition for water resources in the summer owing to reduced summer rainfall and the need to address unsustainable abstraction.
- Crop losses and other impacts on high quality agricultural land due to flooding and agricultural land lost to coastal erosion.
- Large areas of forests at increased risk from existing and new tree diseases and insect pests, resulting in reduced timber production, tree mortality and declining woodland condition.
- Drier conditions and any increase in the frequency of drought will reduce agriculture and timber yield and affect woodland condition.
- Changes in forest productivity with consequences for species selection if timber yields are to be maintained.
- More frequent wildfires due to warmer and drier conditions.

- Increased agricultural yields resulting from longer growing seasons and CO_2 fertilisation, where water or nutrients are not limiting factors.
- Opportunities to grow new crops as a result of warmer climate and longer growing seasons.
- Increased timber yields where water is not limiting to tree growth.
- Opportunity to plant a range of timber species previously not considered suitable for forestry in the UK.

Business

- Possible decrease in output for UK businesses due to an increase in supply chain disruption as a result of extreme events.
- Risk of increase in monetary losses as a result of interruption to business from flooding.
- Greater variability in the availability of water.
- Potential loss of staff hours due to high internal building temperatures (of particular relevance to the health, education and retail sectors, which have large workforces).
- Possible increase in market opportunities such as tourism and leisure industry.
- Opportunities in domestic and overseas markets for businesses offering adaptation goods and services.
- Delivery of adaptive measures (products and services) as part of the move to a low carbon economy.

Health and Wellbeing

- Increased summer temperatures may lead to increased risk of mortality and morbidity due to heat.
- Increased flooding would increase the risk of deaths, injuries and people suffering from mental health effects as a result of the impacts of flooding.
- Increased ozone levels by the end of the century could lead to an increased risk of mortality and respiratory hospital admissions.
- Increased summer temperatures combined with increased periods of time spent outdoors may lead to an increased risk in the number of skin cancer cases and deaths.
- Increased sea temperatures may lead to increased marine pathogens and harmful algal blooms with a consequent negative effect on human health.
- Increased temperatures and changed rainfall patterns may lead to an increased health risk from water, vector and foodborne diseases.
- Increased summer temperatures combined with increased periods of time spent outdoors could increase vitamin D levels and help to improve physical and mental health of people.
- Increased winter temperatures may lead to decreased levels of mortality and morbidity due to cold.

Buildings and Infrastructure

- Energy Infrastructure at significant risk of flooding.
- Higher energy demand for cooling.
- Heat damage/disruption to energy infrastructure.
- Increased water demand for energy generation.
- Buildings at risk of flooding.
- Road and railways at significant risk of flooding.
- Scouring of road and rail bridges.
- Reduced energy demand for heating.
- Shorter shipping routes and reduced transportation costs due to less arctic ice. It is possible there will be competition for access to arctic waters as resources become accessible for the first time.

Natural Environment

- Low water levels and reduced river flows having a direct impact on biodiversity, ecological resilience, and ecosystem services.
- Low water levels and reduced river flows leading to increased concentration of pollutants from agriculture, sewage and air pollution damaging freshwater habitats and other ecosystem services.
- Soil moisture deficits and erosion impacting biodiversity and soil carbon and increasing risk of wildfires.
- Increased prevalence of invasive non-native species, pests and pathogens impacting on animal, plant and human health provisioning services (such as fisheries) and biodiversity.
- Melting sea ice and thermal expansion of water is causing sea level to rise, increasing the risk of coastal flooding and enhancing rates of coastal erosion.
- The Atlantic Meridional Overturning Circulation, which transports ocean heat from near the equator towards the UK, is very likely to slow this century but not shut down completely.
- Warmer rivers, lakes and seas impacting on biodiversity and the productivity and functioning of aquatic and marine ecosystems.
- Flooding and coastal erosion impacting on key coastal habitats and other ecosystem services (including the extent of beaches and nature sites for tourism).
- Loss of climate space, with species unable to track climate change especially resulting from habitat fragmentation (due to cumulative impact of risks and policy decisions taken in other sectors).
- Possibility of algal blooms, low oxygen, ocean acidification and species range shifts impacting on marine habitats, species and ecosystem services.
- Negative impact on commercial shellfish species due to ocean acidification. North Sea pH may be reduced by between 0.2 and 0.5 units by 2100.

- Negative impact on some commercial fish species (e.g. cod and haddock) in terms of 'year-class strength' (the number of fish or shellfish of a given age group that survive from egg production to be exploited by fisheries), but a positive effect on others (e.g. plaice and sole). Shifts in commercial fish species will have implications for agreeing international quotas.
- Changes in timing of seasonal events and migration patterns can result in mismatches between species such as predator-prey/host relationships. Top predators such as seabirds, marine mammals and fish are being affected by a change in the abundance of prey species.
- Higher temperatures leading to increase in some provisioning services for example, agriculture and forestry (assuming that water availability is not a constraint).
- Changes in habitat range for some generalist species e.g. southerly insects and plants or warm water fish. While species may extend their range towards the poles, they may also retreat in the south due to rising temperatures.
- Reductions in the extent of Arctic sea-ice may allow animals to transit between the North Pacific and Atlantic as well as providing further opportunities for the use of polar transit routes by commercial ships.

5.6 Examples of adaptation in the UK

There are numerous examples of adaptation in practice in the UK. The following examples of adaptation actions are taken from the NAP and the work of the Devolved Administrations. The NAP focuses on the highest order risks from the CCRA and those highlighted in subsequent consultation with Defra partners. Prioritisation was guided by the magnitude, confidence, and urgency scores assigned during the analysis which underpinned the CCRA.

The adaptation actions below are designed to address the impacts outlined in section 5.5. The UK government NAP (covering England/UK reserved matters), Scottish Climate Change Adaptation Programme, Northern Ireland Adaptation Programme, Climate Change Strategy for Wales and the Welsh government's Sectoral Adaptation Plans should be referred to for a complete overview of UK adaptation actions.

5.6.1 Water resources

In 2011, in the Water White Paper[179] the UK government set out the long term priorities for a sustainable, resilient and customer focused water sector and its agenda for delivering substantial improvements in the health of our rivers through improving water quality and tackling unsustainable abstraction. This set out the evidence and made the case for change to plan now to protect the resilience of future water supplies. This planning should take into account climate change, population growth, patterns of demand and the need for resilience to hazards such as drought and flooding.

The Welsh government is developing a water strategy which will deal with all aspects of the water sector.[180] In recent years the impact on water quality of land management practices in rural and urban areas in Wales has become increasingly apparent. As well as these factors, the strategy will also take account of anticipated population growth, improved living standards (accompanied by increased water use) and the predicted impacts of climate change.

[179] http://www.official-documents.gov.uk/document/cm82/8230/8230.pdf.

[180] http://wales.gov.uk/topics/environmentcountryside/epq/waterflooding/publications/water-strategy/?l.

The recently passed Water Resources (Scotland) Act 2013, places a duty on Scottish Ministers to develop the value of Scotland's water resources. It updated legislation to enable more proactive management of water catchments, and modernised the framework for dealing with water shortages.

In Scotland, the National Flood Risk Assessment published in December 2011 means that for the first time there is a national picture of flood risk across Scotland. It represents a key milestone towards Scotland being able to target efforts to plan and invest in reducing impacts in areas most vulnerable to flooding.

5.6.2 The built environment

Flooding and Coastal Management

The NAP objective on flooding and coastal risk management is shared with the National Flood and Coastal Risk Management Strategy for England. The Strategy provides a framework for communities to develop local partnerships and solutions to the flood and coastal erosion risks they face. It includes long-term planning, avoidance of inappropriate development in high risk areas, improved flood management infrastructure, increased public awareness, and improved flood detection and warnings. The strategy will be implemented by Defra and the EA.

Case Study – Drain London

Drain London is a £3.2 million multi-year programme to manage surface water flood risk in London. It is managed by the Greater London Authority on behalf of the London boroughs and aims to:

- Understand where surface water flooding may present a risk to people and property
- Build the capacity of boroughs to manage surface water flood risk
- Create pilot projects that demonstrate the financial and quality of life benefits from proactive flood risk management
- Create a pipeline of projects to secure significant investment in London to understand the 'gap' between the level of rainfall that London's drainage systems can cope with today and the level that London may need to cope with in the future.

The Department for Work and Pensions is doing work to assess the flood risk of all its buildings. This involves assessing the risk in terms of business continuity to ensure that Jobcentres, Pensions offices, and other important facilities can continue to provide the services to society's most vulnerable.

A number of specific actions have been taken to implement improved flood risk management in Wales:

- In March 2013 the Welsh government updated their Development Advice Maps, which identify areas of flood risk that need to be taken into account in proposing the location and type of new development.
- The Development Advice Maps support the policy objectives set out in Planning Policy Wales and Technical Advice Note 15, which in the first instance seeks to avoid developing in areas at risk of flooding.

In 2012/13 the Welsh government invested over £54 million on flood and coastal risk management including more than £25 million in an on-going programme of flood and coastal risk improvement schemes improving protection to over 1500 properties.

All improvement schemes are future proofed and include adaptability to take account of forecast increases in rainfall and sea level rise due to climate change.

Case Study – Flood Awareness Wales

Flood Awareness Wales began as a project in June 2010. Through a range of engagement methods a team of Officers work directly with individuals, communities and businesses at flood risk across Wales to raise awareness of local flood risk and encourage practical actions that can be taken to make them more resilient to the impacts of flooding.

Since the project began significant outputs include:

- Knocking over 64,000 doors and influencing over 20,000 people to take practical actions;
- Working in over 203 communities across Wales (including urban, rural, and areas of deprivation);
- Developing flood plans which protect over 40,664 people (plus reducing the economic and social impact of flooding as these cover schools businesses and caravan parks).

Guidance published in April 2010, supporting the building standards in Scotland increases the resilience of new buildings to the possible effects of climate change through:

- Referring to the Scottish Environment Protection Agency flood risk maps;
- More control of surface water at source;
- Encouraging the use of greywater recycling;
- Emphasising flood risk assessments and flood design strategy;
- Providing information on flood resilient construction.

These changes should ensure that the capacity to adapt to changes in climate is considered in more detail during the building design and construction process. Amended Building Regulations and technical guidance came into force on 1 October 2010.

Planning and Construction

The purpose of the spatial (land use) planning system in England is to help deliver sustainable development, with the Local Plan prepared by local councils at the heart of this. The need for adaptation is embedded in national planning policy which informs local planning and is a material consideration in deciding planning applications for individual developments.

The Department for Communities and Local Government (DCLG) has:

- published the National Planning Policy Framework 2012 which recognises the important role of the planning system in helping to shape places that minimise vulnerability and provide resilience to the range of impacts of climate change. The Framework is clear that local planning authorities, working closely with their communities, should proactively plan to mitigate and adapt to climate change, taking account of flood risk, coastal change, water supply and demand considerations;
- published simpler, easier to use and understand web-based planning practice guidance (currently in beta test mode), including guidance on climate change adaptation, to support local planning authorities in implementing the Framework;

- Worked closely with the EA to ensure the Agency's guidance, in particular, on development and flood risk, complements the government's new planning practice guidance;
- Worked with other government departments to ensure that national policy statements on major infrastructure are consistent with national planning policy, including adaptation policy;
- Introduced higher standards for building new affordable housing – Level 3 of the Code for Sustainable Homes which sets an independently assessed standard of 105 litres of water use per person per day;
- Changed planning rules, so that householders who wish to pave-over their front gardens (where the surface area exceeds five square metres) will need to obtain specific planning permission to do this, unless they use a permeable surface which can absorb surface water;
- Published revised guidance on the energy efficiency provisions in Part L of the Building Regulations to raise awareness of the importance of insulating hot water pipes to address heat loss in common parts of flats – a significant contributor to many cases of observed overheating in homes.

The Welsh government aims to improve the planning system to ensure it supports sustainable development. To take forward the planning reform agenda the Welsh government will introduce a Planning Reform Bill to the National Assembly for Wales during 2014. As part of the evidence base for the Planning Reform Bill, an Independent Advisory Group was established and in its 2012 report to the Welsh government, entitled Towards a Welsh Planning Act: Ensuring the Planning System Delivers, it considered options for delivering the planning system in the future.

The Welsh government will be asking for views on the Planning Reform Consultation Paper and draft Planning Reform Bill at the end of 2013 and these will inform the final Planning Reform Bill.

In Northern Ireland, Planning Policy Statement 15: Planning and Flood Risk also aims to minimise flood risk to property and promotes the use of sustainable urban drainage systems.

5.6.3 Infrastructure

Energy

DECC have made a number of commitments in the NAP to ensure that the UK energy sector is resilient to climate change. When implementing the Energy Security Strategy or developing new infrastructure DECC will consider the impacts of climate change.

A major part of the Electricity Market Reform is the Capacity Market. This will help adapt the energy system to intermittent sources of generation and future weather conditions. It provides both generation and non-generation capacity providers with predictable revenue streams for delivering reliable capacity, and imposes financial penalties if they fail to do so. If put into place the Capacity Market will factor in the likely change of demand brought about by a changing climate when determining the amount of capacity.

The government will also consider promoting climate resilience through the Strategy and Policy Statement for Ofgem, subject to passage of the second session energy bill. Ofgem will ensure adaptation principles are inherent in its undertaking of its price review process and review its guidance on impact assessments to ensure climate resilience is reflected in its decision making.

Transport

The Department for Transport (DfT) works to deliver a transport system that balances the needs of the economy, society and the environment. The changing climate could have a range of impacts on transport networks; to take account of this DfT is working with industry to increase climate resilience in the planning and design of transport infrastructure while also continuing to build adaptation into their major plans and strategies.

The NAP illustrates how the adaptation challenge is being addressed and highlights good practice from transport organisations. The NAP sets actions for the next 5 years for both the DfT and the transport sector as a whole.

The 2013 Aviation Policy Framework[181] which balances the costs and benefits of aviation, including the need for climate change adaptation, and the Higher Level Output Specification 2012 which informed the Network Rail Strategic Business Plan for 2014-19[182] are two examples of factoring adaptation into current plans and strategies. The latter includes the need to future proof critical infrastructure against the impacts of changing weather by allocating funds to protect tracks and bridges from flooding and heatwaves, further analysis of climate change impacts, and other actions.

The Highways Agency is also carrying out a programme of activities to future proof designs and increase asset resilience to help avoid the economic costs associated with weather and climate impacts.

The Wales Transport Strategy, which is a statutory document, was published in 2008. It includes clear objectives to reduce greenhouse gas emissions from transport and for climate change adaptation in the transport system.

The Climate Change Strategy for Wales and its associated Emission Reduction and Adaption Action Plans set out the specific action being taken in transport. The Welsh government also continues to embed adaptation measures in its road infrastructure projects by building in measures to prevent or minimise road deformation caused by increased temperatures and rainfall.

Interdependencies

- While the CCRA focussed on specific infrastructure risks, there is also the potential for climate change impacts on one sector to have an impact on others in a 'cascade failure'. An example of this is extreme flooding in 2009 which caused the Northside highway bridge to collapse in Workington, this lead to communities losing power and services.
- The EA and Energy UK will undertake a joint project looking at the risks related to the dependency of the energy sector on water resources.
- The Infrastructure Transitions Research Consortium and Infrastructure UK will both carry out activities to enhance systems thinking around interdependencies, and how the associated climate change risks can be managed.

[181] https://www.gov.uk/government/publications/aviation-policy-framework.

[182] http://www.networkrail.co.uk/publications/strategic-business-plan-for-cp5/.

Water

The government has published a Strategic Policy Statement and Social and Environmental Guidance to Ofwat (The Water Services Regulation Authority). These documents will inform the price review process and include consideration of climate risks. The Water White Paper sets out more detail about the government's expectations of how water companies should consider climate risks.

Ofwat will work with the EA to provide guidance on the principles for resilience planning and the Water Resource Management Planning Guide. This will continue to set direction on climate resilience in the regulated water sector.

5.6.4 Healthy and resilient communities

While climate change may have some health benefits, such as a projected decline in winter mortality rates, these are likely to be outweighed by a range of negative effects. The Department of Health is the lead government department responsible for addressing the health risks from climate change.

Local risk assessments overseen by the local health and wellbeing boards across England provide an important potential vehicle to highlight climate risks to health, for example the mental health impacts of flooding or the risks from overheating.

Public Health England and the Sustainable Development Unit for the National Health Service, public health and social care system play key roles in addressing the health risks associated with climate change, for example, through the implementation of the Heatwave Plan and Cold Weather Plan for England and the promotion of adaptation within wider Sustainable Development Management Plans.

The Department of Health will work with the National Health Service to promote and implement the wider NHS Emergency Planning Guidance 2005, and the NHS Emergency Planning Guidance on planning the psychological and mental health care of people affected by major accidents and disasters 2009.

The NHS Premises Assurance Model will help NHS Trusts ensure their assets and estates are resilient to floods and temperature extremes.

The Strategic Health Asset Planning and Evaluation toolkit will be used to help map flood risk to health and social care infrastructure and maintain healthcare facilities resilient to flooding and extreme temperatures.

The emergency services are also addressing climate risks. For example, Local responders and Local Resilience Forums are promoting community resilience to severe weather events which are associated with climate change.

Using their Integrated Risk Management Plan process the Fire and Rescue Service are reviewing the risk of severe wildfire and their capability to deal with it, while for the Ambulance Service the Association of Ambulance Chief Executives is collating information on their resilience to climate change.

Case Study – Building Resilient Communities

In December 2012 Defra awarded grants to nine Local Resilience Forums to fund projects that will build and strengthen community resilience to the potential impacts of climate change.

Projects included:

- A series of children's books which raise awareness about community resilience and the impacts of climate change; these are available to read online and have been distributed to all Hampshire schools and libraries;
- New dedicated Community Resilience web portals and a common framework to help communities prepare for the impacts of climate change;
- A new model for climate change adaptation and community resilience planning in a rural setting.

In Wales a Climate Change and Health Working Group was established in autumn 2007 to consider the health effects and risks of climate change. In 2009 the Working Group produced a publication "Tackling the health effects of climate change: an adaptation action plan", which provided the health input to the Welsh government's Climate Change Strategy for Wales.

This document recognises that climate change is a significant and emerging threat to public health and well-being, and details adaptation priorities and objectives for action to ensure efficient and robust measures are in place to deal with:

- Weather related impacts (such as heatwaves, flooding etc.);
- The potential increase of foodborne related illnesses;
- Ensuring the continued safety of drinking and recreational bathing waters;
- Air quality issues;
- Potential threats from new infectious diseases.
- Ensuring NHS healthcare facilities remain resilient.

One of the key priorities in the Health Adaptation Action Plan was the development of a Heatwave Plan for Wales in the summer of 2009.

Case Study – Heatwave Plan for Wales

The "Heatwave Plan for Wales: A Framework for Preparedness and Response" was first introduced in Summer 2009 and at that time the then Minister for Health and Social Services asked NHS Bodies, Local Health Boards, Local Authorities and all other stakeholder agencies in Wales to incorporate this guidance into their own plans, setting out clearly the specific preparations and actions they should take in the event of a heatwave or conditions of extreme heat in Wales. The Plan has been in place for the summer months in successive years. It aims to enhance resilience in the event of a heatwave and to reduce the risks to health associated with extreme heat by alerting appropriate health, social and other care staff and members of the public (especially vulnerable groups) to the dangers of excessive heat. It outlines a framework to support co-ordinated action in response to extreme heat and heatwave conditions in Wales. It provides guidance for multi-agency preparedness and response in respect of warnings of periods of extreme heat occurring.

5.6.5 Agriculture and forestry

Agriculture

The NAP identifies effective water management, including both availability and quality, as a major aspect of increasing climate resilience in the UK agricultural sector. The Water Bill, announced in the Queen's Speech in May 2013, will introduce reforms enabling farmers and other potential suppliers to enter the competitive water supply market. The Bill also supports the use of on-farm reservoirs and other water storage facilities by allowing farmers and landowners to sell excess water from them.

The Water White Paper[183] set out how Defra is considering legislation to reform the water abstraction management system early in the next parliament. This will increase the system's resilience to the challenges of climate change and population growth and which will better protect the environment. The new system will give clearer signals on water availability and be created through closely working with stakeholders in designing the new system. A national advisory group has been established to guide the process.

To further increase effective water management the government will work with the Association of Drainage Authorities and other interested parties to explore their contribution to water management within catchment areas. The government's Catchment Sensitive Farming initiative already delivers support for farmers and land managers to reduce diffuse water pollution from agriculture. Defra has invested in catchment-scale research sites, called Demonstration Test Catchments, to increase understanding of diffuse pollution and how best to mitigate it.

Beyond water based activities, Defra are also embedding adaptation within the UK Agri-Tech Strategy, the Sustainable Intensification Platform, and the Rural Development Programme for England 2014-2020. The Agri-Tech Strategy will drive innovation and promote the development of new technology which can be beneficial to UK adaptation. The new Payment for Ecosystem Services approach provides a means of rewarding farmers for delivering important services, including adaptation measures, which benefit wider society.

Case Study – Natural England Farm Resilience Planning

Farm resilience planning is an approach to assessing the threats and opportunities posed by climate change at individual farm level. Existing studies have considered threats, opportunities and adaptation responses at the landscape scale, so this project led by Natural England seeks to conduct a similar exercise at the farm level. In doing so it is hoped that this will enable farmers to consider both farming systems and the natural environment and to identify adaptation actions that benefit both. An initial pilot project was conducted on ten farms in the North West England and Natural England are hoping now to work with interested stakeholders to develop the approach for wider adoption.

The Natural Environment White Paper[184] outlines the government's intention to ensure all soils are managed sustainability, with degradation threats tackled, by 2030. This will be of direct benefit to climate resilience in both the agricultural and forestry sectors and in the wider environment.

Farming Futures,[185] which has benefited from Defra funding and is now part of the Centre of Excellence for UK Farming, gives practical advice to farmers on how and why they need to adapt to climate change and reduce their greenhouse gas emissions. In February 2010,

[183] http://www.official-documents.gov.uk/document/cm82/8230/8230.asp

[184] http://www.official-documents.gov.uk/document/cm80/8082/8082.asp

[185] www.farmingfutures.org.uk.

40% of farmers surveyed in England as part of a Farming Futures project said they were already affected by climate change and nearly 60% expected to be affected in the next ten years.

The draft Department of Agriculture and Rural Development Strategic Plan 2012-2020 recognised the challenges presented by climate change in Northern Ireland and acknowledges that adapting to climate change will ensure a more sustainable future. There are a number of actions included within the Strategic Plan that will make the Northern Ireland agriculture sector more resilient to climate change.

The Scottish government is currently funding a large programme of research on climate change adaptation with results forming the evidence base for the practical advice given to farmers through advisory services such as 'Farming for a Better Climate' and 'Future Proofing Scotland's Farming'. This specialist advice includes treatment strategies for outbreaks of liver fluke, encouraging natural flood management and alleviating soil damage. The research results are also shared with industry, for example to support advances in plant and animal breeding.

Pests and Diseases

An increase in pests and diseases as a result of climate change and other factors is a significant threat to the agriculture and forestry sectors. In order to address this the Secretary of State for the Environment commissioned an independent Tree Health and Plant Biosecurity Expert Task Force to investigate ways of preventing pests and diseases entering the country in the future and how to best manage those already present. The Task Force reported in May 2013 to which the government responded in September 2013.

The Tree Health and Plant Biosecurity Action Plan is also being implemented. It aims to strengthen import control activities and protocols, improve our surveillance strategy, and raise the public's and professionals' awareness of them.

To protect wider biodiversity and animal health, Defra will be reviewing the Invasive Non-native Species Framework for Great Britain (2008) and strengthening surveillance and monitoring systems for exotic and endemic animal diseases in partnership with agencies and industries. Defra also aim to improve the evidence base for the direct effects of climate change on the livestock sector.

Forestry

Forestry research and international policy are reserved issues while domestic forestry policy is devolved to country administrations. By agreement with the devolved administrations, the Forestry Commission (the government department responsible for forestry in England and Scotland) develops and implements Plant Health Regulations at EU and Great Britain level through its Plant Health Service.

A revised UK Forestry Standard[186] was published in November 2011, including a new guideline on Forests and Climate Change.[187] The requirements for climate change adaptation include consideration of climate change in forest planning, adaptive management, tree and shrub species selection, landscape ecology and environmental protection. In England[188] and Scotland,[189] comprehensive internet-based guidance has been published to support implementation of the UKFS Forests and Climate Change Guidelines.

[186] http://www.forestry.gov.uk/UKFS.

[187] http://www.forestry.gov.uk/forestry/infd-8bvevv.

[188] http://www.forestry.gov.uk/forestry/INFD-8M6E9E.

[189] http://www.forestry.gov.uk/forestry/INFD-94WL7M.

The Forestry Commission has established a comprehensive climate change research programme, largely undertaken by its Forest Research Agency. The research programme has funded the development of the Ecological Site Classification[190] (ESC) decision support tool. ESC Version 3 gives guidance for current conditions and a range of climate projections for 57 species (including near and non-native) and all native woodland types. The decision support system is supported by detailed 'species notes' to ensure appropriate species selection as part of diversification strategies when planting new woodlands and restocking existing woodlands.[191] Research Notes on the likely impacts of climate change – and adaptation strategies to address those risks – have also been published for Scotland, England and Wales. In Wales, field guidance[192] has been published on species diversification to support climate change adaptation and plant health objectives. The guidance covers both timber production, in many cases using non-native species, and also native woodland.

Forest Research has recently established 'Research Forests' in Wales[193] and Scotland[194] to complement the existing Alice Holt Research Forest in England.[195] Monitoring the impacts of climate change and demonstrating/evaluating adaptation options are key objectives of the initiatives.

An independent study (the Read Report: combating climate change – a role for UK forestry),[196] commissioned by the Forestry Commission, was published in 2009 and evaluated the role of forests and harvested wood products in greenhouse gas balance, the likely impacts of climate change on forests in the UK and strategies for adaptation.

The Forestry Act (Northern Ireland) 2010 promotes afforestation and sustainable forestry. Its accompanying Delivery Plan sets out a range of activities that raise awareness of the potential impact of climate change on forests and the role of forestry in adaptation.

In England, the Forestry Commission has published an analysis[197] of the likely impacts of climate change on the ability to carry out its responsibilities and functions under the terms of the Adaptation Reporting Power of the Climate Change Act 2008. As well as assessing risks and barriers to adaptation, the report sets out an adaptation plan covering research, a Climate Change Action Plan for Public Forest Estate, proposed changes to grants and regulations to support adaptation and a communications plan for engaging and enabling the sector.

Alongside changing species suitability and negative impacts of drought on timber production, the forestry sector report of the UK CCRA[198] highlighted pest and disease outbreaks as a high priority climate change risk. Defra and the Forestry Commission have developed a Tree Health and Biosecurity Action Plan[199] to help address these risks.

Under the NAP the forestry sector has committed to publish a Climate Change Action Plan which will include commitments from key organisations. The government's Forestry and Woodlands Policy Statement[200] sets out a clear hierarchy of protecting, improving, and

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[190] http://www.forestry.gov.uk/fr/esc.

[191] http://www.forestry.gov.uk/fr/treespecies.

[192] http://www.forestry.gov.uk/forestry/INFD-8LMJF7.

[193] http://www.forestry.gov.uk/fr/dyficatchment.

[194] http://www.forestry.gov.uk/website/forestresearch.nsf/ByUnique/INFD-8S6CZR.

[195] http://www.forestry.gov.uk/website/forestresearch.nsf/ByUnique/INFD-6V6FEX.

[196] http://www.tsoshop.co.uk/gempdf/Climate_Change_Main_Report.pdf.

[197] http://www.forestry.gov.uk/website/forestry.nsf/byunique/infd-8sekpy.

[198] http://randd.defra.gov.uk/Document.aspx?Document=CCRAfortheForestrySector.pdf.

[199] http://www.defra.gov.uk/publications/2011/10/18/tree-health-action-plan/.

[200] https://www.gov.uk/government/publications/government-forestry-policy-statement.

expanding our woodland assets which will increase their resilience to climate change and the increasing threat of pests and diseases.

Woodland management is essential for developing resilience through planning for the future, restructuring for diversity, encouraging natural regeneration and evolutionary adaptation and controlling pests, diseases and invasive species. The UK CCRA and the ASC have noted that the lack of active management on England's woodlands increases the vulnerability of the sector. This risk is being addressed through a range of measures aimed at increasing the level of management, including through the Rural Development Programme and the sector-led Grown in Britain[201] initiative.

Woodland creation also contributes to climate change adaptation, through: expanding and buffering existing ancient woodland; increasing landscape permeability to promote species migration; providing opportunities to create more diverse and resilient woodland including the use of species and origins better adapted to the future climate; and, through targeted planting, helping society and biodiversity to adapt to climate change through, for example, flood alleviation, urban cooling and provision of riparian shade to maintain freshwater thermal regimes. The Woodland Carbon Code[202] has been developed to provide confidence in and attract private funding to woodland creation projects, and complements wider initiatives in all four countries of the UK, including through the work of the Woodland Carbon Task Force[203] in England.

Case Studies

The Woodland Carbon Code, launched in July 2011, will help encourage and attract investment in new woodland creation. The Woodland Carbon Code is an independently audited standard, devised by a group led by the Forestry Commission and including UK, Scottish and Welsh governments and industry partners, to certify woodland creation projects that can measure and account for the capture and storage of atmospheric carbon.

The Plant Scheme, a joint project between the Welsh government, Natural Resources Wales and Coed Cadw (The Woodland Trust in Wales) enabling the planting of a tree for every child born or adopted in Wales has now supported the planting of over 200,000 native broadleaf trees since it began in 2007.

In Scotland, the Scottish Forestry Strategy (2006)[204] identifies climate change as one of its seven key themes. The theme's primary purpose in relation to adaptation is to ensure that Scotland's woodlands and the forestry sector meet their full potential in facilitating ecological, economic and social adaptation to climate change. It sets out three key actions:

- Improve understanding of climate change impacts on woodland ecosystems and silviculture, and implement precautionary measures, such as forest habitat network creation.
- Maintain preventative measures and ensure readiness for pests, diseases and other threats, such as fire and wind.
- Increase the role of forestry in environmental protection including sustainable flood and catchment management, and soil protection.

[201] http://www.growninbritain.org/

[202] http://www.forestry.gov.uk/forestry/carboncode.

[203] http://www.forestry.gov.uk/england-wctf.

[204] http://www.forestry.gov.uk/sfs.

Early in 2013 Forestry Commission Scotland published a Climate Change Programme[205]. The programme describes climate change predictions for Scotland, it explains what Forestry Commission Scotland will do to increase the contribution of forestry to Scotland's climate change response, and focuses on what needs to be done both as early actions and to increase future preparedness. The focus for adaptation is to:

- Plan and manage forests and woodlands in a way that minimises future risks from climate change, for example through the creation of forest habitat networks, and using different timber species, including hardwoods, or silvicultural systems.
- Assist in environmental protection such as helping to tackle slope instability, reducing riverbank erosion, contributing to natural flood management and increasing the contribution of trees and woodland to climate control in urban areas.

In order to ensure that forest management planning supports resilience-building in Scotland's forests, Forestry Commission Scotland developed RESILIENT FORESTS, web-based resources for forest managers to raise their awareness to climate risks and opportunities. A variety of demonstration actions and adaptive management approaches are also being developed at the Scottish Research Forest at Queen Elizabeth Forest Park.

In Wales, responding to climate change is one of the key themes in the forestry strategy, Woodlands for Wales.[206] This aims to increase the diversity (species, structure and genetics) of woodlands in Wales to make them more resilient to pests, diseases and drought. It also recognises that trees and the products they produce can be a way of reducing the effects of, and risks resulting from, climate change. Trees also provide shade and can be beneficial in reducing the effects of climate change in urban and rural areas.

The Welsh government has also set a target to create 100,000 hectares of new woodland in Wales by 2030 which will achieve multiple objectives such as mitigating the impacts of climate change, by locking up carbon emissions and reducing run-off after heavy rain.

5.6.6 The natural environment

The natural environment is both vulnerable to the impacts of climate change and valuable for addressing those impacts. A major element of ensuring the natural environment's resilience to climate change comes from increasing its wider resilience, interconnectivity, and the size and overall condition of protected sites.

Polices focused on joining up the management of the landscape at a larger scale, referred to as a 'landscape scale approach' are especially important. Defra, Natural England, and the EA are supporting landscape scale partnerships such as Local Nature Partnerships and Nature Improvement Areas to imbed adaptation in their work. The government will also promote landscape scale activity in their response to 'Making Space for Nature'.

The economic benefits provided by the natural environment's regulating and provisioning services are likely to increase, potentially creating new markets if these services can be given a market value. There is on-going work in Defra to embed adaptation into Payments for Ecosystem Services and the business case for investing in natural solutions. An example of the value of ecosystem services is the Natural Environment White Paper's identification of protecting peatlands as a priority area due to their role in water purification, carbon sequestration, flood risk management, and habitat creation. The Adaptation Sub-Committee's Managing the Land in a Changing Climate report, published in July 2013,[207] also highlighted the importance of peatlands and their vulnerability to climate change.

[205] http://www.forestry.gov.uk/pdf/fcs-climate-change-programme.pdf/$FILE/fcs-climate-change-programme.pdf.

[206] http://www.forestry.gov.uk/wwstrategy.

[207] http://www.theccc.org.uk/publication/managing-the-land-in-a-changing-climate/.

Case Study – Adaptation in Nature Improvement Areas

The adaptation to climate change in Nature Improvement Areas (NIAs) project aims to test ways of delivering climate change adaptation advice for practitioners and evaluate the effectiveness of Natural England's information and tools through engagement with NIAs. The project has assessed the use of workshops and published guidance in communicating climate change adaptation information. A key objective is to get a better understanding of the extent to which adaptation is already built into NIA plans and whether providing further advice, information and tools makes a difference to the extent to which climate change is addressed. This project was funded by Defra and the steering group consisted of Natural England, the EA, the Forestry Commission and Defra. The final report will be published in late 2013.

There are several areas in the Natural Environment where it is still necessary to improve the knowledge base. The UK Ocean Acidification research programme and continued publication of the Marine Climate Change Impacts Report Cards will continue to develop the understanding of climate change's impacts on the marine environment and potential necessary actions to protect it.

Defra has commissioned new research to feed into the Biodiversity Impacts of Climate Change Observation Network and along with its agencies has also worked with the Living With Environmental Change (LWEC) partnership to develop biodiversity and water 'Climate Change Impact Report Cards'.

The Report Cards are designed to provide a summary of the latest scientific research on the impacts of climate change on the UK in an accessible and engaging way for policy makers, businesses, conservationists, local authorities and others at national and local level. A key feature of a Report Card is that it is represents the consensus of the academic community, provides clarity around levels of confidence in the evidence and identifies significant knowledge gaps. The report cards identified above summarise changes which can be attributed to climate change that have already been observed and what is expected in future decades. Natural England were responsible for leading the development of the terrestrial biodiversity report card, published by LWEC with project management from EA, and will be working with partners to develop future updates.

Natural England have also developed a series of research projects to test their understanding of the factors that contribute to the resilience of species and ecological communities to climate change, working with the academic community. Results are influencing their approach to ecological networks in conservation practice.

The Scottish government's 2020 Challenge for Scotland's Biodiversity sets out how Scotland will meet its international obligations (EU and UN) to halt biodiversity loss and the degradation of ecosystems by 2020.

Scotland's first Land Use Strategy was published March 2011. It takes a strategic approach to the challenges facing land use in Scotland. The Strategy sets out principles for sustainable land use and outlines proposals which contribute to greenhouse-gas emission reduction and climate change adaptation.

Climate change and NCAs (pilots and profiles)

National Character Areas (NCAs) divide England into 159 distinct natural areas. Each is defined by a unique combination of landscape, biodiversity, geodiversity and cultural and economic activity. Their boundaries follow natural lines in the landscape. Originally developed in 2000, Natural England is currently renewing these profiles and as part of that process is considering the implications of climate change as a driver of landscape change. Rather than use detailed projection in assessing vulnerability to climate change, Natural England is using simplified trajectories such as an increase in extreme events, or increase in temperatures to look at the vulnerability of landscape features or ecosystem services and how they might change as a result. The assessments are based on more detailed climate change studies undertaken on twelve NCAs and a growing body of evidence that Natural England is developing on particular habitats, landscape features and ecosystem services.

In April 2013 Natural Resources Wales (NRW)[208] was established and brought together the work of the Countryside Council for Wales, EA Wales and Forestry Commission Wales, as well as some functions of Welsh government.

Its purpose is to ensure that the natural resources of Wales are sustainably maintained, enhanced and used, now and in the future. It is the principal adviser to the Welsh government on the environment, enabling the sustainable development of Wales' natural resources for the benefit of people, the economy and wildlife

The Welsh government is currently scoping an Environment Bill due to be published early in 2014. The Bill will focus primarily on addressing the powers and functions of Natural Resources Wales; and the key elements of legislation relevant to the effective management of resources that will have a practical and beneficial effect. This will ensure that NRW is fully equipped with relevant powers and requirements that enable it to sustainably manage our land, air, water and biodiversity in support of Wales' long-term wellbeing.

Alongside the Environment Bill is the Natural Resource Management Programme which has been created to deliver the Welsh government's policy commitments. Natural resource management is about managing our natural environment in a joined up way that delivers real outcomes for the environment, people, the economy and our communities while safeguarding and building the resilience of natural systems to continue to provide these benefits in the long term.

5.6.7 Business

The government aims for UK businesses to be resilient to extreme weather and prepared for the future risks and opportunities associated with climate change.

The support of small and medium sized enterprises (SMEs) is one area in which the government is helping the business sector adapt to climate change. A pilot climate resilience training programme for SMEs aims to raise their awareness of the impacts of climate change. Tools and guidance, such as the Business Resilience Health Check tool, are also available to help SMEs adapt.

The Institute for Environmental Management and Assessment are helping build business resilience by developing professional standards for environmental and sustainability professionals and guidance on how to build the business case for adaptation.

[208] http://naturalresourceswales.gov.uk/.

Through the Environment Agency's Climate Ready Support Service businesses across England are being supported through the issues they need to consider to increase resilience to severe weather and a changing climate with the use of tools and guidance. This ranges from simple factsheets outlining practical things to do, to more sophisticated risk assessment methods for larger more complex aspects, such as supply chains.

Specific areas of work include:

- Workshops with the Chartered Insurance Institute (CII) which will train advisors to use and pass on the Business Resilience Health Check Tool to their clients. Attendees will also receive a recognised qualification upon successful completion;
- Engaging with the Continuity Forum and British Standard Institute to help make business continuity and risk management standards appropriate for managing climate risks and encouraging their use;
- Publishing supply chain guidance to help organisations identify risks from extreme weather and climate change both domestically and internationally and testing this with a major supermarket chain;
- Creation of an adaptation qualification and supporting its incorporation into continuing professional development.

5.6.8 Local government

Local councils will play a pivotal role in leading, supporting and driving delivery of actions relating to climate change adaptation.

In May 2012 the government committed to work with the Local Government Association to develop a framework for action that sets out a clear narrative on ways in which councils can build climate resilience.[209] The NAP, which included input from local councils, industry and other non-government organisations, sets out the key role played by local government to support local communities and businesses in addressing climate risks.

The Local Adaptation Advisory Panel for England has been set up to provide advice to central government from a local perspective. It provides a forum to champion adaptation activity across local government, identifying best practice and providing expert input to the development of tools and support available under the Climate Ready programme.

The Local Government Association's Climate Local initiative[210] is supporting councils to reduce carbon emissions and improve resilience to the impacts of the changing climate. The initiative provides a framework through which councils can showcase their local commitments, ambitions and achievements in addressing climate change based on local priorities, and a forum for peer-to-peer learning.

The NAP also sets out an ambitious 'cities commitment' from the largest cities within England in recognition of the specific adaptation issues that cities face from climate change. London Councils, the Greater London Authority and the Core Cities Group[211] (councils from 8 major English cities outside London) have committed to working together to increase the resilience of their city spaces.

[209] http://www.local.gov.uk/climate-change/-/journal_content/56/10180/3589399/ARTICLE.

[210] http://www.local.gov.uk/web/guest/the-lga-and-climate-change/-/journal_content/56/10180/3574359/ARTICLE.

[211] http://www.corecities.com/.

In Wales 2012/13 was the third year of the current set of outcome agreements between the Welsh government and the 22 local authorities in Wales. Outcome agreements contain ten themes of which three are looking to directly address the causes, and effects, of climate change. Every local authority has included at least one of these themes in its outcome agreement.

The outcome agreement sets out the annual actions the Council will pursue against these objectives and the targets against performance indicators that it will take to measure success.

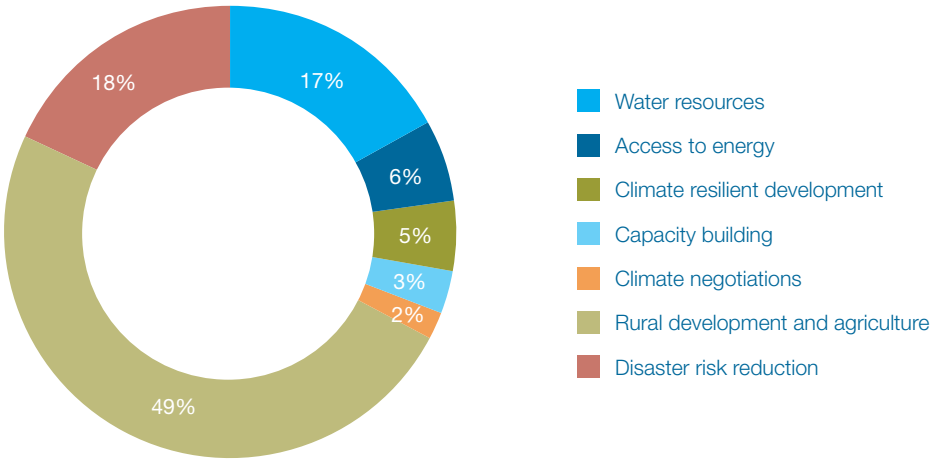
Local authorities in Wales are also designated as key reporting authorities under the Climate Change Act 2008 and as such must have regard for the Welsh government's Preparing for a Changing Climate statutory guidance which helps organisations in Wales to assess, prepare and act on risks from a changing climate.

5.7 International cooperation on adaptation

5.7.1 International adaptation action

Through DECC and DFID, the UK is working internationally on adaptation through the UNFCCC and bilateral agreements. The UK aims to spend 50% of its International Climate Fund on adaptation activities to help the most climate vulnerable people in the world adapt. The diagram below shows the breakdown of UK government funding.

Figure 43 – Distribution of committed UK Bi-lateral Adaptation Funds (2011-present)



Source: Department for International Development.

Note: The chart above only covers bi-lateral International Climate Fund support.

Some example actions are detailed below.

Adaptation for Smallholder Agriculture Programme (ASAP)

The UK government is providing up to £150 million to the International Fund for Agricultural Development's Adaptation for Smallholder Agriculture Programme.[212] ASAP will work in 40 developing countries, helping smallholder farmers adapt to climate change, for example, through small scale water-harvesting and storage, flood protection, irrigation systems, agroforestry, and conservation agriculture. The UK's support is expected to directly help 6 million smallholder farmers cope with the impacts of climate change and at the same time increase their incomes.

[212] http://www.ifad.org/climate/asap/.

South Asia Water Governance (SAWG) Programme

The UK government is providing £23.5 million from 2012 to 2017 to the SAWG Programme.[213] The programme is jointly funded by the UK, Australia, Norway, the World Bank, and the International Centre for Integrated Mountain Development. The SAWG Programme is helping countries work together to manage the Himalayan rivers on which 500 million climate vulnerable people depend.

Chars Livelihoods Programme

In Bangladesh, the UK government is investing £73 million in the Chars Livelihoods Programme between 2009 and 2016. The programme is working to help those living in extreme poverty, especially women, build livelihoods that are more resilient to climate change. Between 2009 and 2013, the programme has helped to raise 67,000 homes onto earth platforms, protecting hundreds of thousands of people and their possessions from severe monsoon floods.

5.7.2 Contributions to International Climate Change Adaptation Funds

The UK government also contributes to international adaptation funds that work to help developing countries adapt to climate change.

Some funding examples include:

Pilot Programme for Climate Resilience (PPCR)

The UK is providing £325 million to the PPCR. The PPCR supports vulnerable countries to adapt by adopting drought resistant crops, improved irrigation systems, and water storage infrastructure, and flood protection. It pilots new approaches to adaptation in some of the most vulnerable countries in the world. For example: in Nepal, UK funding is developing weather warning systems for vulnerable communities that lessen the impact of climate-related disasters; in Niger over 700,000 people are being supported to sustainably manage and control water resources for increased food production; and in Bangladesh 3.5 million people will benefit from a project that will improve coastal infrastructure and reduce flooding from sea-level rise and storms surges.

Least Developed Countries Fund

The UK has provided £30 million to the Least Developed Countries Fund. The fund helps vulnerable countries prepare and implement National Adaptation Programmes of Action that help the poorest and most vulnerable adapt to their immediate climate change needs. A £2.2 million project in Bhutan to reduce the hazards of glacial lake outburst floods, an imminent climate change risk in the country, has allowed for development of disaster management plans in 104 of 150 target groups of villages and the preparation of disaster plans at district levels. In addition a draft Disaster Management Bill was approved by the National Assembly and the National Council in 2012, contributing towards a suitable policy environment for long term disaster risk management in the country.

Adaptation Fund

The UK has contributed £10 million to the Adaptation Fund. A £5.6 million project in Senegal has supported the construction of a 3,300 meter anti-salt dyke to reclaim lands in an area affected by salinity which was forcing women to abandon rice fields where rice cultivation is a traditional activity, typically undertaken by women. The project has also allowed a 730 meter protection dyke to be built which will protect houses that are being threatened by coastal erosion, a problem which affects the town's historical heritage as well as schools and the local cemetery.

[213] http://projects.dfid.gov.uk/IATI/document/3717592.

Special Climate Change Fund (SCCF)

The UK contributed £6 million to the adaptation window of SCCF between 2006 and 2009. The funding has been used to help adaptation in a number of ways. For example, in Northern Namibia 2000 households, including 35% orphan headed households, have adopted soil improvement and micro drip irrigation practices to improve fresh vegetable production.

5.7.3 Scotland

The Scottish government has been championing climate justice since 2009 when it hosted a national conference on climate change and human rights with the Scottish Human Rights Council and BTCV Conservation Volunteering.

On 9 October 2013, The Scottish government hosted an international conference on climate justice in Edinburgh to develop key messages on climate justice ahead of the UNFCCC summit in Warsaw in November.

5.7.4 Wales

Size of Wales Million Trees Project

The Welsh government has been working in partnership with the Size of Wales for the past three years – towards a shared goal of planting one million trees in the Mbale region of Uganda. The programme is being delivered by three local NGOs and a social enterprise. Each has some experience of tree planting but importantly their partnership is, for the first time, sharing that expertise, and that of the District Authorities, so that many more people in the region gain the necessary skills to engage in tree planting and understand the long term positive effects for their communities. To date an estimated 1.2 million trees have survived of the 1.5 million planted.

Welsh Government and Lesotho Meteorological Services

Wales and Lesotho agreed a joint programme of work on climate change at the UN Climate Change Summit in Doha (December 2012). The aim of the partnership is to exchange knowledge, skills and resources in jointly producing a Climate Change Strategy and delivery plan for Lesotho. To date, two Welsh placements have taken place with Lesotho Meteorological Services. Both placements were successful with initial work on building the partnership and ground work for the strategy being completed.

5.8 UK contribution to European Union work on adaptation

The European Commission has an important leadership role to play to ensure that all EU programmes and policies take full account of the changing climate. Over the past few years, the EU Commission and Member States have been discussing how best to meet this challenge. The UK has played an active role in developing these discussions.

Building on commitments in the EU Adaptation White Paper (2009), adaptation to climate change is currently focused on the implementation of the EU Adaptation Strategy which was published by the Climate Commissioner in April 2013.

The Strategy aims at promoting flexible and proportionate action across the EU by voluntary means. It sets out a framework and mechanisms for meeting the main climate change challenges for Europe both at global and regional level. By creating a strong common understanding of the opportunities and risks at the European level, the EU will complement action already taken by Member States at the national level.

The Strategy encourages all Member States to have a national adaptation plan in place by 2017. It also promotes knowledge sharing, closing knowledge gaps and mainstreaming adaptation into existing EU policies.

Chapter 6:
Financial assistance and support for technologies

6.1 Key developments

- In 2010, the UK government announced the £2.9 billion International Climate Fund (ICF). The purpose of the fund is to support international poverty reduction by helping developing countries grow in a low carbon way, address deforestation and adapt to climate change. In 2013, a further £969 million was announced, increasing the fund to £3.87 billion from 2011/12 to 2015/16.
- The UK delivered in full its Fast Start Finance pledge, which it committed to at the UN Conference on Climate Change (COP 15) in Copenhagen in 2009. This was achieved by providing over £1.5 billion over between 2010 and 2012.
- In 2011, the UK government launched the Prosperity Fund to help tackle climate change, strengthen energy security and promote an open global economy with a particular focus on emerging economies. Funding for 2013/14 is £19.6 million, over half of which is spent on climate projects.

6.2 Introduction

If the global average temperature rises more than 2°C above pre-industrial levels, significant negative impacts of climate change will be more likely and the cost of managing them will rise sharply.

To have a 50% chance of keeping climate change to within 2°C of pre-industrial levels, global greenhouse gas (GHG) emissions need to peak before 2020 and then decline steeply. To achieve this target, the UK government must work collaboratively at an international level to ensure all countries implement what is required to reduce GHG emissions. In this chapter we discuss the support and financial assistance that the UK provides to help reduce the impact, and mitigate, against the effects of climate change in developing countries and the UK overseas territories.

6.3 Financial resources

At the UN Conference on Climate Change (COP 15) in Copenhagen in 2009, developed countries committed to providing new and additional resources approaching $30 billion to help meet the adaptation and mitigation needs of developing countries (known as Fast Start finance). A long-term finance goal of mobilising $100 billion a year of public and private finance by 2020 was agreed, in the context of meaningful mitigation action and transparency of implementation.

As our contribution to Fast Start finance, the UK government pledged to provide £1.5 billion (approx. $2.4 billion) from 2010 to 2012 which was divided between adaptation and mitigation. Contributions were voluntary and were not subject to a burden sharing arrangement between developed country contributors.

Reports suggest that developed countries have delivered over of $35 billion of Fast Start finance, exceeding the commitment made in Copenhagen.

6.3.1 International Climate Fund (ICF)

Recognising the growing importance and urgency of tackling climate change and its impact on growth and poverty reduction, in 2010 the UK government announced the International Climate Fund (ICF). This was a new and additional 4 year (financial years 2011/12 to 2014/15) budget allocation for international climate finance of £2.9 billion. The ICF was increased by a further £969 million in 2013 for the financial year 2015/16, increasing the fund to a total of £3.87 billion. The UK climate finance reported for the Fast Start years of 2011 and 2012, as shown in Tables 7a and 7b, was funded from this budget.

The ICF provides this increasing level of climate finance from a rising UK Official Development Assistance (ODA) budget. The UK ODA spend increased from £7.2 billion in 2009 to £8.8 billion in 2012. The increase in the UK's climate finance over this period was from £300 million in 2009 to £712 million in 2012. The significant increase in overall UK ODA means that additional finance was available for both climate and wider aid programmes.

Through the ICF, we aim to:

- Demonstrate that low carbon, climate-resilient growth at scale is feasible and desirable. This will build confidence that climate resilient growth and adaptation to climate change are achievable, and it will help lay a key part of the foundations of a global climate change agreement;
- Support international climate negotiations, particularly through providing support for adaptation in poor countries and building an effective international architecture for delivery of climate finance;
- Drive innovation and new ideas for action, and create new partnerships with the private sector to support low carbon climate-resilient growth.

We will aim to do this by:

- Building global knowledge and evidence on how low carbon, climate-resilient development, including Reducing Emissions from Deforestation and Forest Degradation (REDD), supports growth and reduces poverty;
- Developing, piloting and scaling up innovative low carbon, climate-resilient programmes and approaches to reduce emissions, support adaptation and protect forests, including biodiversity;
- Supporting country level action on low carbon, climate-resilient development, including REDD;
- Building an enabling environment for private sector investment and by engaging the private sector to leverage finance and deliver action on the ground;
- Mainstreaming climate change into UK ODA, EU development assistance and Multilateral Development Bank (MDB) lending.

The ICF is seeking to deliver value-for-money and ensure that funding delivers transformational results. This will be pursued through catalysing and piloting changes in policy and actions by others, enabling a shift from one pattern of development to another, removing barriers to private financial action and accelerating change at a country level. To foster wider transformative change and deal with the scale of the challenge presented, the ICF needs to have an impact much larger than the sum of its individual projects.

The ICF is supporting developing countries, both through our bilateral programmes and through contributions to major international climate funds. Below are some attributable results we expect to achieve from a sample of programmes we are supporting from within the current ICF portfolio.

- Help 20 million people cope with the effects of climate change;
- Provide access to clean energy to 4.5 million people;
- Prevent the emission of 55 million tonnes of CO_2 equivalent;
- Leverage an additional £1.25 billion in public finance; and
- Leverage an additional £955 million in private finance.

6.3.2 Prosperity Fund

The UK Foreign & Commonwealth Office (FCO) launched the Prosperity Fund in April 2011 to tackle climate change, strengthen energy security and promote an open global economy with a particular focus on key emerging economies. Since its launch, the fund has supported almost 500 projects. In 2013/14 Brazil, China, India, Japan, Mexico, Russia, South Africa, South Korea and Turkey all have dedicated programmes and there are regional funds in the Gulf, Latin America and South East Asia to widen the global reach. Work is also carried out through the Organisation for Economic Co-operation and Development (OECD) and the International Energy Agency (IEA). Funding for 2013/14 is £19.7 million of which £14.9 million must be ODA eligible. Over half of the Fund is spent on climate projects that help create the conditions necessary to raise ambition on emissions mitigation and a shift in investment to low carbon.

6.3.3 UK and the United Nations Framework Convention on Climate Change (UNFCCC) – mandatory and voluntary contributions

As a signatory to the UNFCCC, the UK pays mandatory subscriptions to contribute to ensuring an effective Secretariat to the UNFCCC and meetings of its Parties.

The UK also makes voluntary contributions each year to fund priority activities within the UNFCCC such as:

- The UNFCCC Trust Fund for Supplementary Activities;
- The UNFCCC Trust Fund for Developing County Participation; and
- The UNFCCC additional intersessional meetings.

In addition, the UK provides small scale funding to help contribute to the costs of the OECD Climate Change Experts Group programme and to provide some small–scale targeted support to the most progressive and vulnerable countries in the negotiations, including through the Cartagena Dialogue.

6.4 Mitigation: activities undertaken by the public and private sectors to finance and facilitate emissions reduction

The UK's vision is for all countries to adopt low carbon pathways, in line with a 2°C goal, which improve economic development and reduce poverty by avoiding or reducing emissions. All countries will ultimately need to move to lower carbon pathways to meet a 2°C goal. Public finance, and its ability to leverage private finance, is a means to help close the gap between current emissions pathways and a pathway that is compatible with the 2°C target.

The ICF is supporting developing countries to achieve economic growth in a sustainable way, and access to affordable, reliable and sustainable energy is central to this. Interventions are being supported at the regional, national, sub-national or sectoral level through ICF bilateral and multilateral support (see Tables 3 and 4 in Annex 1 for details of UK's financial contribution). Many of these interventions aim to lay the conditions for increasing investment at scale.

6.4.1 Low carbon development and sustainable energy

The ICF focuses on 3 main areas in supporting low carbon development and sustainable energy, they are

- Achieving greater private sector investment in low carbon infrastructure and service delivery, to increase rates of deployment of technologies that are further along the innovation chain, or where abatement costs are relatively low;
- Supporting technologies critical to assist progress towards the 2°C goal , particularly where we are not on track globally, and in countries where there is the greatest potential for deployment; as well as supporting the development and deployment of locally relevant technologies, which will also support local economic and social development; and
- Enhancing the capacity of developing countries though provision of knowledge and monitoring tools.

The UK works both bilaterally and through multilateral organisations. The focus for our bilateral projects in the energy sector is:

- Decarbonising energy supply and increasing energy access through on and off grid measures;
- Decreasing energy demand e.g. through energy efficiency measures.

Where the UK works with other partners, including multilaterally (e.g. the Climate Investment Funds), our portfolio can be more diverse (e.g. including transport or emissions from agriculture). A key focus of our portfolio has been to increase private sector investment in renewable energy and energy efficiency, and to demonstrate the commercial viability of these investments. Many projects deliver both low carbon development objectives, as well as wider ICF objectives, such as forestry or adaptation outcomes.

GET FiT

Working alongside Norway, Germany and the EU, the UK is providing approximately £35 million to support the development and completion of small-scale on-grid renewable energy projects in Uganda. This will help meet the anticipated increased energy demand in Uganda and avoid either an energy shortfall or the use of 'quick to build' temporary fossil fuel installations.

This programme is topping up the existing Feed-in-Tariff for renewables and provides capacity building support to the Ugandan Energy Regulatory Authority. The project will also facilitate World Bank guarantees to project developers.

Get FiT aims to demonstrate to private sector developers that investment in renewable energy in Uganda is financially attractive, despite currently being regarded as high risk. The project also aims to demonstrate to developing countries that an effective regulatory regime and cost-reflective tariffs will bring in investment in renewables.

The project as a whole will result in 125MW of installed energy, increasing Uganda's overall energy production by approximately 20% and diversify both the ownership and the technology mix of Uganda's energy. It will also improve the availability of energy for approximately 1.2 million people, particularly in rural areas.

The project is progressing well with 15 companies applying for the first tender in April 2013.

6.4.2 Contributing to international climate change mitigation funds

The UK has contributed £810 million to the **Clean Technology Fund (CTF)** – one of the Climate Investment Funds (CIFs)[214]. The CTF is supporting large scale low carbon investment plans in 17 developing countries. 28 CTF projects[215] approved to date are expected to support emission reductions of 582 million tonnes of CO_2e; lead to over $16.5 billion of co-financing; contribute to 6.35 GW of installed renewable energy capacity; deliver energy savings of over 100,000GWh; and support 60.5 million people to access low carbon public transport. The CTF will also deliver significant developmental benefits, such as increased energy security, reduced local air pollution, and job opportunities.

The UK has contributed £100 million to supporting the **Scaling Up Renewable Energy Programme (SREP)** – another of the Climate Investment Funds (CIFs) – that aims to increase energy access through renewable energy use and demonstrates the economic, social and environmental viability of low carbon development pathways in the energy sector. SREP is supporting investment plans in 8 developing countries. 7 endorsed Investment Plans[216] expect to leverage an additional $2.7 billion of investment in renewable energy projects and contribute towards over 930 MW of installed renewable energy capacity. This is demonstrated in Kenya where the construction of a geothermal plant will increase the country's renewable energy supply by 32%, and is expected to provide energy to 500,000 households and 300,000 businesses. In Nepal, SREP financing will supply more than 900,000 households with electricity or cleaner fuel through increased energy capacity from both on-grid and off-grid sources.

[214] The CIFs help developing countries pilot low-emissions and climate resilient development through funds implemented by multilateral development banks. With CIF support 48 countries are piloting transformations in clean technology, sustainable management of forests, renewable energy access, and climate resilient development (https://www.climateinvestmentfunds.org/cif/).

[215] Clean Technology Fund: First Round of Monitoring and Reporting on Results – October 2013: https://www.climateinvestmentfunds.org/cif/sites/climateinvestmentfunds.org/files/CTF_TFC.12.Inf_.2_First_round_of_monitoring_and_reporting_on_results.pdf

[216] SREP: Semi Annual Operational Report - October 2013: https://www.climateinvestmentfunds.org/cif/sites/climateinvestmentfunds.org/files/SREP_SC.10_3_Semi_annual_report.pdf

6.5 Forestry

Through the ICF, the UK is supporting global efforts to slow, halt and reverse deforestation. As well as the climate change mitigation benefits, tackling deforestation also offers big opportunities to reduce poverty and protect biodiversity, with corresponding benefits for resilience and adaptation.

The UK ICF forests strategy has four areas of focus:

- Supporting progress towards an international REDD+ mechanism;
- Incentivising governance and market reforms to curb illegal and unsustainable use of forest resources;
- Facilitating increased public and private investment in sustainable forestry and agriculture, to reduce pressure on forests;
- Encouraging greater sharing of knowledge, tools, evidence and learning to enhance the effectiveness of deforestation interventions internationally.

Through the ICF, we are supporting a number of bilateral and multilateral programmes, including the following four examples, discussed in detail below:

- Forest Governance, Markets and Climate (FGMC);
- The growth of silvopastoral systems in Colombia;
- Reducing Deforestation in the Brazilian Cerrado Programme; and
- The Forest Investment Programme.

The **FGMC** programme aims to reduce the illegal trade in forest resources by addressing forest sector governance and market failures that permit illegal forest practices. The FGMC programme makes use of trade and market incentives. These incentives are used to influence reforms in timber-producing countries where governance failures often result in illegal logging and the neglect of the rights of those living in poverty to forest land and resources. By reducing illegal logging those living in poverty will have a greater voice in what happens to their forest. This will not only reduce the likelihood of conflict over forest tenure, it could also help avoid up to £13 billion in revenue and tax loss to developing countries by clarifying forest-dependent peoples' tenure rights and supporting improved governance and stronger enforcement of forest laws.

Over the next 25 years, the FGMC programme will help protect up to 39 million hectares of forest (13 million hectares more than the size of the UK). It will help avoid billions of tonnes of carbon equivalent (CO_2e) emissions, protect the livelihoods of tens of millions of forest-dependent communities and increase the incomes of 50 million men, women and children reliant on farming. The UK has committed £79 million to the FGMC programme between 2012 and 2016.

The UK has invested £15 million over four years to support the growth of **silvopastoral systems**[217] in Colombia. The project will contribute to reducing GHG emissions from cattle ranching, improve the livelihood of farmers, protect local forests and increase biodiversity. The project aims to convert 28,000 hectares of grazing land to silvopastoral systems, saving around 2 $MtCO_2e$ over eight years, and create a strategy for increasing the use of silvopastoral systems in Colombia and beyond. The project will work in seven regions of Colombia, including two deforestation hotspots, testing the effectiveness of silvopastoral systems to curb the expansion of the cattle frontier, the biggest driver of deforestation in Colombia.

[217] Silvopasture is the practice of combining forestry and grazing of domesticated animals in a mutually beneficial way.

The UK has provided £10 million to the **Reducing Deforestation in the Brazilian Cerrado Programme**, which aims to reduce deforestation by improving compliance with the forest code, registration of land ownership and by supporting measures to prevent and deal with forest fires. This project will contribute to reduced rates of deforestation, a reduced rate of biodiversity loss, poverty reduction and reduced GHG emissions in the Cerrado Biome.

The **Forest Investment Programme (FIP)** – one of the CIFs – is supporting eight pilot countries to implement programmes to reduce deforestation, including innovative programmes to support community-based forest management in Burkina Faso. FIP investments will enhance the wellbeing of forest dependent communities, increasing their resilience to climate change and providing new sources of income, whilst reducing GHG emissions associated with deforestation. Funding will be used to tackle forest fires, establish tree nurseries, plant trees in degraded pastures and help farmers manage their woodlands more sustainably. The FIP programme is expected to save millions of hectares of forests and increase the incomes of many forest dependant people. The UK has contributed £100 million to FIP. Although impacts will vary project to project, examples of expected impact include a reduction in GHG emissions by 14.9 $MtCO_2e$ in Democratic Republic of the Congo and 5.3 $MtCO_2e$ in Laos through work with charcoal industries, with additional local benefits expected.

6.6 Private finance

Mobilising private investment in climate action is crucial to meeting the global goal of limiting temperature increase to 2°C. A key aim of the ICF is therefore to mobilise private finance.

The ICF provides an opportunity to use public finance to mobilise increased flows of private finance and test new and innovative approaches that can be replicated and scaled-up. In seeking to mobilise private finance, we are using the ICF to:

- Test innovative approaches to mobilising private climate finance to better inform future UK or other international initiatives;
- Mobilise private climate finance in ICF priority countries that would not otherwise flow to those countries, and seek to create a sustainable climate investment market;
- Mobilise private sector engagement and finance in specific sectors and/or technologies that experience difficulties in accessing private finance or which pose long term financial risks;
- Create a better understanding of private finance within ICF priority country governments, HMG and internationally to inform future climate finance policy and climate projects, including the Green Climate Fund.

One example of mobilisation of private finance is the **Climate Public Private Partnership (CP3) programme**. The UK is working alongside the Asian Development Bank and International Finance Corporation Asset Management Company in a joint effort to encourage new forms of private sector finance, such as sovereign wealth funds and pension funds, into climate investments and boost economic growth in developing economies. The CP3 programme aims to demonstrate to major private sector investors that climate friendly investments are financially viable. The UK will provide £110 million as an anchor investor into two private equity funds, managed by professional fund managers that will pick the best investments in sectors, such as water, renewable energy, energy-efficiency, low carbon transport and clean technology, to support developing country economies grow and prosper. An additional contribution (up to £19 million) for technical assistance will provide support for first time fund managers and the development of the project pipelines, especially in poorer countries.

6.6.1 Global carbon market

The UK government considers that the development of a global carbon market is critical to securing a cost effective shift to low carbon development globally. The establishment of a global carbon market (or a number of internationally linked carbon markets) should lower the global cost of mitigation and increase the incentive to invest in abatement and low carbon technologies. Putting a global cap on carbon emissions not only guarantees the level of reductions achieved but also enables countries and businesses to deliver those reductions in the most economically efficient way.

In this context, the UK has promoted the use of market-based instruments both domestically and internationally. We now have a decade of experience developing policies using market approaches through initiatives such as our Climate Change Agreements, the Carbon Reduction Commitment Energy Efficiency Scheme and, of course, the UK Emission Trading Scheme of 2002, which helped shape the EU Emissions Trading System (EU ETS) that we have in operation today.

In only a few years we have built the foundations of a global carbon market, which encompasses many developed countries and a growing number of developing countries.

The UK believes that the more global the carbon market becomes, the lower the cost of mitigation, allowing greater ambition in global emissions reductions. With this in mind, we believe that linking the EU ETS with other comparable systems will be an important future development.

The UK has promoted the development of market-based instruments globally. We have invested £7 million in the **World Bank Partnership for Market Readiness (PMR) Programme**, a country-led initiative that builds on countries' own climate mitigation priorities, and aims to build their capacity to design and implement market-based policies. Through the PMR programme, countries receive both financial and technical support to design and implement market-based policies. Currently 16 countries are participating in the PMR programme and, as of October 2013, six of these countries (China, Mexico, Chile, Costa Rica, Turkey and Indonesia) have received approval and been allocated funding.

In addition, the UK is aiming to improve access to carbon finance in least developed countries by investing £49 million in the **World Bank's Carbon Initiative for Development (Ci-Dev)**. Through Ci-Dev the UK aims to help some of the poorest countries participate in the international carbon market, through the Clean Development Mechanism (CDM) and in doing so, provide clean energy for households and communities, particularly in Africa. Ci-Dev will also work to drive CDM reforms that will lower the administrative costs of implementing projects and improve the ability of the CDM to deliver projects that cut GHG emissions while delivering high development benefits.

Going forward, we believe that although the CDM will continue playing a key role in least developed countries, scaled-up market mechanisms should enable greater global emissions reductions and improve the quality of carbon credits that are traded internationally, to ensure that market mechanisms drive genuine emissions reductions.

6.7 Adaptation: Assistance provided to developing countries particularly vulnerable to the adverse effects of climate change in meeting the costs of adaptation

The world's climate and weather patterns are changing. Global temperatures are rising, contributing to more extreme weather events, such as flooding and heat-waves.

As of September 2013, the UK is funding ICF adaptation programmes worth over £800 million, working with the poorest countries in the sectors that are most important to the livelihoods of people living in poverty and are vulnerable to climate change.

These areas are:

- Agriculture (food and farming systems);
- Better preparation for disasters;
- Water resources management;
- Infrastructure and urban development;
- Coastal areas;
- Ecosystems;
- Social protection; and
- Health.

UK support provided through the ICF seeks to help build adaptation knowledge, capacity, institutions and evidence as well as support direct adaptation actions. It will also help with the development of effective national and international climate finance architecture, which is needed for delivering adaptation finance.

Some examples of ICF support are:

Adaptation for Smallholder Agriculture Programme (ASAP) – The UK is providing up to £150 million (approximately $235 million) for the ASAP. This five year initiative, launched in 2012, is implemented by the International Fund for Agriculture Development (IFAD), a specialised UN agency working on financing agriculture and rural development. ASAP will work in approximately 40 developing countries, investing in practices and knowledge sharing to help smallholder farmers adapt, for example, through small scale water-harvesting and storage, flood protection, irrigation systems, agroforestry, and conservation agriculture. ASAP will invest in strengthening farmers' access to better seeds, markets and information, and support their access to weather forecasts, through use of text messages to know when best to plant and harvest crops. ASAP will work with governments on improved policies to support economic growth and agriculture systems that help farmers adapt to climate change. An ASAP Knowledge Management, Learning and Advocacy Plan for Climate Change Adaptation and Smallholder Resilience has been developed. This will identify from ASAP projects "what works" to help farmers cope with climate change, and to share these lessons with national governments, development agencies and civil society to help them develop new programmes. We expect the UK's support will directly benefit 6 million small-holder farmers.

The UK is providing £21 million over four years (2012-2015) to increase secure and sustainable access to water resources for people living in poverty. The Water Security Programme will benefit over 18 million people through improved access to water services, including, water for drinking, sanitation and irrigation, and over one hundred million people indirectly, through

improved water planning, development and management in strategic river basins. It will do so by promoting investment in the information, institutions and infrastructure needed to deliver water security in developing countries.

Working through the **Global Water Partnership** and the **World Bank's Water Partnership Programme** (WPP), the UK is supporting **Global Water Partnership**'s and WPP's global programmes, which between them operate in over 50 countries. Many of their programmes are trans-boundary – improving the management water resources shared between two or more nations states. A strong focus for both programmes will be Sub-Saharan Africa.

The UK is also providing £23.5 million from 2012 to 2017 to the **South Asia Water Governance Programme**. The programme is jointly funded by the UK, Australia, Norway, the World Bank, and the International Centre for Integrated Mountain Development and is helping countries work together to manage the Himalayan rivers for the benefit of 500 million people who live in the river basins.

6.7.1 Contributing to international climate change adaptation funds

The UK contributes to international adaptation funds that work to help developing countries adapt to climate change. The UK has provided £325 million to the **Pilot Programme for Climate Resilience (PPCR)**, one of the Climate Investment Funds (CIFs). The PPCR focuses on a targeted number of countries for maximum impact. It is supporting countries and regions in developing holistic adaptation programmes, such as drought resistant crops, improved irrigation systems and the redesign of water storage infrastructure, flood protection or hydropower. The PPCR pilots new approaches to adaptation in some of the most vulnerable countries in the world. For example, in Nepal, the PPCR will help with development of weather forecasting, early warning systems and improved access to credit and insurance in vulnerable communities that can lessen the impact of climate-related disasters.

The UK has provided £80 million to the **Least Developed Countries Fund (LDCF)** which helps vulnerable countries undertake their long term National Adaptation Planning process as well as prepare and implement National Adaptation Programmes of Action. These focus on helping the poorest and most vulnerable adapt to their immediate climate change needs.

The UK has contributed £10 million to the **Adaptation Fund (AF)**, which has recently financed a $4 million project in Pakistan to reduce the risks of glacial lake outburst floods. The project will identify all risk sites in Pakistan and reduce risk in two flood prone valleys, enabling 90% of households to respond to early warning signals.

6.8 Steps taken by government to promote, facilitate and finance transfer of technology to developing countries

The world needs increasing energy supplies to sustain economic growth and development. However, our energy resources are under pressure and CO_2 emissions from today's energy use are already changing our climate. We therefore need to accelerate the deployment of low carbon energy technologies and increase energy efficiency in order to address the global challenges of energy security, climate change and economic development.

ICF technology development and transfer programmes

Many ICF programmes actively support some form of technology development or transfer (see Table 5 in Annex 1). These include:

(i) Renewable Energy and Adapting to Climate Technologies (REACT): This is a window of the Africa Enterprise Challenge Fund which aims to stimulate private sector investment in developing and delivering low cost, clean energy and climate adaptation technologies, such

as solar power, biogas, irrigation and water efficiency measures. Provisional estimates are that with the help of this funding, by 2015, REACT will have helped deliver access to cheaper, cleaner energy technologies to 200,000 people. The UK is contributing £11 million to the REACT programme.

(ii) Carbon Capture and Storage (CCS) technologies: The UK is providing £60 million to support developing countries to advance both the technical and institutional knowledge necessary to enable the deployment of CCS technologies. Successful demonstration of CCS will help to deliver ambitious international climate action. This pledge will be channelled to trust funds operated by the World Bank and Asian Development Bank. These two trust funds will support a range of capacity building projects in China, South Africa and Indonesia, through pilot and demonstration activities. In particular, our funding will support:

- Preparation and implementation of early-stage full scale integrated CCS pilot demonstration projects by financing CCS planning & pre-investment, capital costs for CCS units and components, and CCS related post-completion & operation activities;
- Development of geological site characterisation intended for integrated full scale CCS projects, both at the pilot and commercial demonstration scales to maximise knowledge on both near-term and future storage capacities;
- Pilot and demonstration activities aimed at reducing the cost of the technology application across the CCS chain. It is expected that the UK's funding will lead to full scale demonstration projects in developing countries, and ultimately accelerate the deployment of CCS.

(iii) Climate Innovation Centre (CIC), Kenya: The first Climate Innovation Centre (CIC) was launched in Kenya in September 2012 with a total of £9.5 million support from the UK, Danida and the World Bank, and provides a domestic hub for climate technology innovators. As of August 2013, the Kenyan CIC is supporting 53 clean technology ventures with mentoring, training and proof-of-concept funding, from over 200 applications in the following sectors: renewable energy, agribusiness and water and sanitation. The aim is to support over 70 local, climate technology enterprises and provide over 104,000 households with low carbon energy by 2015. It will help support up to 4,650 'green' jobs and nurture the development of local partnerships, supply chains and collaborations.

(iv) Policy Innovation Services for Clean Energy Security (PISCES): With a £4.5 million UK contribution to the PISCES programme, we are supporting the research programme that aims to develop innovative knowledge on energy from biomass, to supporting improved access to energy and better livelihoods for those living in poverty in sub-Saharan African and South Asia. For example, in Tanzania the private sector is partnering with PISCES on field trails of the most promising local modified plant oils to replace diesel in small generators, power tillers and irrigation pumps.

(v) The Climate and Development Knowledge Network (CDKN): The CDKN is a 5 year initiative that has received a £57 million contribution from the UK. Launched in 2010, this network will provide on-going support to 40 developing countries to build their knowledge, capacity and action plans on climate change. CDKN is an alliance of 6 private and non-governmental organisations that help 'decision makers' to design and deliver climate and environmental policy and programme, introduce new technologies and mobilise new funding sources.

6.9 Securing policy commitments to accelerate low carbon technology deployment through multilateral initiatives

A key barrier to wider deployment of low carbon technology globally is a lack of wider international commitment to low carbon. The UK government works broadly at a series of international forums to create the right regulatory environment and conditions for investment, in particular making the economic case.

We also support the UNFCCC regime's work to support low carbon technology deployment. This is done, through the UNFCCC's Technology Mechanism (its Climate Technology Centre (CTC) and CTC-Network (CTC-N) and Technology Executive Committee), which aims to support and facilitate the development and deployment of low carbon technology, primarily for developing countries. We are also trying to secure broader support for a focus on phasing down fossil fuel subsidies. This falls under the UNFCCC work to raise mitigation effort in the years leading to 2020, building on commitments agreed by the G20; given resistance on this issue elsewhere it will likely be very challenging to make substantial progress.

We have continued to leverage the collective commitment of the international community in other key fora and institutions to deliver policy interventions and high level actions that encourage the promotion of low carbon technologies, including:

- International Energy Agency (IEA) – The UK has played a key role in supporting the IEA's increasing focus on low carbon energy technology, including through support of their flagship Energy Technology Perspectives, which is the most comprehensive analysis of global low carbon technology deployment, both in OECD and major non-OECD countries;
- The UK funds various IEA Implementing Agreements relating to low carbon energy including Renewable Energy Technology Deployment IA and active engagement in the Renewable Energy Working party;
- Active memberships and provision of funding to the International Renewable Energy Association (IRENA);
- Active membership of the Clean Energy Ministerial (CEM), a multi-lateral ministerial-level forum, whose members include most of the G20. This forum aims to promote policies and programs that advance clean energy technology, to share lessons learned and best practices, and to encourage the transition to a global clean energy economy. The UK supports the process by providing policy input across a range of clean and low-carbon technology interests including the Carbon Capture Use and Storage (CCUS) Action Group which we co-chair with the government of Australia. The UK hosted the third Ministerial in London in 2012.
- Active membership of the Carbon Sequestration Leadership Forum and its Capacity Development Steering Committee.
- Active membership of the 4 Kingdoms CCS Initiative including hosting the third workshop in 2013;
- The UK supports the UN Secretary General and World Bank President's jointly initiated Sustainable Energy for All initiative, which seeks to achieve three goals by 2030:
  - Ensuring universal access to modern energy services
  - Doubling the share of renewable energy in the global energy mix
  - Doubling the global rate of improvement in energy efficiency.

- The Department for International Development (DFID) Secretary of State is a member of the Sustainable Energy for All initiative advisory board, and DFID has provided funding to improve the tracking of commitments and the development of an accountability framework. Through the ICF, the UK provides funding for projects which contribute to the aims of Sustainable Energy for All.

6.10 Bilateral relationships

The UK participates in a wide range of bilateral initiatives through which it supports low carbon development in addition to working multilaterally. Many of these bilateral initiatives serve to also strengthen collaboration with the participating governments. To take two examples:

6.10.1 China

The UK uses its extensive network of climate change and energy attachés, which operates throughout China in Beijing, Chongqing, Shanghai, Guangzhou and Hong Kong, to support China's low carbon development. FCO through its Prosperity Fund and DECC through its Memorandum of Understanding with China's National Development and Reform Commission (NDRC), have helped support projects, including, emissions trading and climate legislation.

6.10.2 India

The UK is sharing with India its experience in meeting the parallel challenges of energy security, low carbon growth and climate change and is supporting India in its transition towards becoming a low-carbon economy. The UK-India collaboration is helping develop India's energy efficiency and renewable energy capabilities to ensure better energy access and security. It is also helping those – particularly those living in poverty who are most vulnerable – to adapt to the changing climate. The UK supports a number of projects, including through the International Climate Fund and the FCO's Prosperity Fund, which aim to accelerate sustainable economic development and low carbon transition in India.

Chapter 7:
Research and systematic observation

7.1 Key developments – research

- Publication of the UK Climate Change Risk Assessment and the National Adaptation Programme has informed UK adaptation policy. The Committee on Climate Change's Adaptation Sub-Committee (ASC) reported on managing land in a changing climate, and the preparedness for flood risk to people and property and availability of water for households and businesses.
- The new Met Office Hadley Centre (MOHC) climate programme, jointly funded by DECC and Defra, will strengthen national climate capability. It will develop improved understanding of the climate system and the next generation of state-of-the-art climate and Earth system models, in partnership with the UK academic community.
- DECC developed the 2050 Calculator, a user-friendly model that brings energy and emissions data alive, showing the benefits, costs and trade-offs of different energy futures.
- Improvement of climate information for a range of audiences. For example, Climate Service UK is a new initiative led by the Met Office, which will provide business and society with information to help make them more resilient to climate variability and change.
- The Living with Environmental Change (LWEC) partnership has set up a Task Force on Climate Mitigation. It is exploring the global and regional impacts of a range of emissions scenarios, the technical and economic feasibility of achieving such pathways, and how results can be used to stimulate action. LWEC has developed Climate Change Impact Report Cards to build up a picture of historical and future impacts resulting from climate change.
- Defra has developed the Sustainable Pathways for Low Carbon Energy Research Programme to address evidence for mitigation policy needs.
- The Health Protection Agency (Public Health England from 1st April 2013) set up a new programme on Climate Change and Extreme Events and published an authoritative report on the Health Effects of Climate Change in the UK 2012 – Current evidence, recommendations and research gaps.

7.2 Key developments – systematic observations

- A group of experts has been set up to oversee co-ordination of UK Global Climate Observing System (GCOS) activities, the "Coordinating Climate Observations Group" (CCOG).
- In 2012 the British Standards Institution (BSI) published a new national standard for the acquisition and management of meteorological precipitation data from a rain-gauge network.

7.3 Introduction

The UK continues to be a world-leader in many aspects of climate research and observations of the climate system. It continues to be very active in both fields, both independently and with international partners. This chapter covers firstly research (sections 7.4 to 7.9) and then systematic observations (section 7.10).

7.4 Introduction to research

The scientific evidence that the world's climate is changing is clear and extensive. The Fifth Assessment Report[218] by the Intergovernmental Panel on Climate Change (IPCC) stated that "It is *extremely likely* that human influence has been the dominant cause of the observed warming since the mid-20th century". Nevertheless, further research is needed to refine understanding of how the climate system works and to model future climate change.

The UK government is working internationally to agree actions to reduce global GHG emissions and at home to reduce emissions, for example by investing in low carbon energy sources, improving fuel standards in cars and increasing energy efficiency. The UK government is also working at home and internationally to develop strategies and actions to adapt to the effects of climate change.

The research section of this chapter emphasises the UK government's general policy and funding of climate change research. Government departments develop and commission research evidence according to their policy needs. Increasingly, greater coordination of research is taking place to ensure users are benefitting more from the results and gaining better value from research investments. For several years, there has been more emphasis on climate information and services and making the information available to all audiences to ensure that everyone has the information to make lifestyle choices. Public sector funding organisations and capability in the UK research landscape are highlighted, followed by a description of some of the strategic research programmes funded by the public sector. The research programmes are attributed to the following headings provided by the UNFCCC: climate process and climate system studies; modelling and prediction; research on the impacts of climate change; socio-economic analysis; and research and development on mitigation and adaptation technologies. The UK collaborates internationally in many global programmes and initiatives, and provides significant funding for capacity building for developing countries.

7.5 UK strategy and policies for climate change science

The UK government believes strongly in supporting climate research and the procurement of climate-related observations. Research is sponsored by various government departments to support a range of responsibilities and policy requirements. In addition, some research is increasingly being funded from a wider stakeholder base in both public and private sectors, particularly in the area of climate impacts and adaptation.

[218] http://www.climatechange2013.org/images/uploads/WGIAR5-SPM_Approved27Sep2013.pdf

In the UK, climate change policy is delivered by several government departments. The DECC brings together energy policy with climate change mitigation policy. DECC leads on international negotiations on climate change mitigation and adaptation policies and provides funds for climate research to improve scientific understanding and to advise the UK's policies. Defra leads on policy on climate change adaptation in the UK. Defra leads on many policies which encourage sustainable behaviours and support the transition to a green economy. It also leads on marine science across government. Defra funds research into climate change impacts and adaptation including the UK Climate Projections, and the statutory Climate Change Risk Assessment (Climate Change Act, 2008).

DECC and Defra jointly fund the Climate Programme of the Met Office Hadley Centre. The Met Office Hadley Centre is a world-leader in climate research, modelling and prediction. The current Met Office Hadley Centre Climate Programme runs until 2015 and is delivered by a multi-departmental Memorandum of Understanding. It is strongly focussed on collaborative research within the UK, particularly with the Natural Environment Research Council and with European and other international partners. The Met Office Hadley Centre is at the core of the UK's national climate capability.

Defra supports a number of agencies and public bodies to advise and implement the UK government's environmental strategy. The Environment Agency (EA) protects and improves the environment and promotes sustainable development in England. It plays a lead role in managing flood risk and minimising the impact of flooding. Natural England (NE) is the government's advisor on the natural environment. NE aims to increase the capacity of the natural environment to cope with climate change, and support opportunities to mitigate against the causes of climate change. NE has developed the evidence base on carbon sequestration and storage by semi-natural habitats, including peatlands. The Forestry Commission is responsible for protecting and expanding England and Scotland's woods and forests. Through its research agency, Forest Research, it supports research on the role of woodlands in climate change mitigation and adaptation, both in rural and urban areas. In 2009, it commissioned a major assessment of the science behind the role of UK forests in tackling climate change – the Read Report.[219]

Both climate change mitigation and adaptation are devolved issues. Defra and the devolved administrations collaborate on initiatives where relevant. The Scottish government funds significant research programmes regarding environment, fisheries, rural affairs and health. One of the major drivers for this policy-related research is adaptation to, and mitigation of, climate change impacts on Scotland's people, environment and economy. The potential positive and negative effects of climate change on Scotland's important primary production industries (farming, fishing, forestry and energy), tourism, biodiversity and health are important topics for research programmes.

The Welsh government is engaged as an active partner in many of the climate science programmes identified in this chapter. These programmes feed in to the Welsh government's climate change policy and provide a robust evidence base to support action in this area. In addition to the UK research programmes, the Welsh government supports a wide range of additional climate change research. Two key bodies provide advice to the Welsh government. Natural Resources Wales acts as a principal adviser on the environment, enabling the sustainable development of Wales' natural resources. The Climate Change Commission for Wales is an independent body, comprising a wide range of political, business, local authority, third sector and other organisations. The Commission provides leadership and advice to the Welsh government and is an open and trusted source of information on climate change.

[219] http://www.forestry.gov.uk/forestry/infd-7y4gn9

Science and research are at the heart of the UK's growth, prosperity and wider wellbeing.[220] Public investment in science and research is an investment in the nation's future, ensuring that the UK has a productive economy, healthy society and contributes to a sustainable world. Global challenges in areas like climate change, security and the demographic shift are on an unprecedented scale and will require greater levels of ingenuity and innovation.

BIS provides public sector funding for science and research through the Research Councils and the higher education funding bodies, which provide block grant funding to universities. BIS funds seven research councils, which are the main public investors in fundamental research in the UK covering a wide range of disciplines:

- Arts and Humanities Research Council (AHRC)
- Biotechnology and Biological Sciences Research Council (BBSRC)
- Engineering and Physical Sciences Research Council (EPSRC)
- Economic and Social Research Council (ESRC)
- Medical Research Council (MRC)
- Natural Environment Research Council (NERC)
- Science and Technology Facilities Council (STFC).

Despite enormous pressure on public spending, funding for science and research programmes has been protected in cash terms, demonstrating the government's commitment to rebalancing the economy and promoting economic growth. For the first time, Higher Education research funding in England has been included within this ring-fence, providing stability and certainty to both parts of the dual support system of research funding. BIS will protect the vital components of research infrastructure and maintain membership of international facilities, providing researchers with access to key large scale research infrastructure, both here and abroad.

BIS will achieve efficiencies of £324 million by 2014-15. All these savings will be reinvested in science and research, within the ring-fence.

A theme of collaboration runs throughout these allocations of science and research funding. In a period of constrained public finances, we are putting increased emphasis on bringing people together to develop creative solutions. Researchers will have access to a wider range of facilities and equipment through a pooling of resources and expertise. This larger pool of capability will be crucial in building the reputation of UK science and research and attracting international investment and talent.

These allocations and reforms will provide strong incentives and rewards for universities to improve further their relationships with business, charities and government, and to deliver even more impact on the economy and society.

The government provides support for research, development and demonstration (RD&D) of low carbon technologies, with the aim of bringing forward the point at which cheap, green, effective technologies are sufficiently proven that the market can deploy them widely. Over £1 billion is committed to low carbon RD&D over the current spending review period. This investment is distributed through members of the Low Carbon Innovation Coordination Group (LCICG),[221] which brings together the UK's major public-sector funding and delivery bodies that support low carbon innovation in the UK. The LCICG has developed a common evidence base, the Technology Innovation Needs Assessments (TINAs), and is now building on this with a joint Low

[220] Innovation and Research Strategy for Growth

[221] http://www.lowcarboninnovation.co.uk

Carbon Innovation Technology Strategy, to ensure the focus is on those areas of most impact, and to ensure strong coordination of members' work.

Innovation and technologies are supported through the Technology Strategy Board (TSB). TSB is an executive non-departmental public body of BIS with an annual budget of £440 million. The TSB takes a strategic view of where UK capability exists in technologies and where future opportunities may emerge. Based on this knowledge the TSB develops technology strategies and funds particular sectors, markets and challenges, as well as emerging technologies. Funding of innovation projects is usually matched by business.

To encourage the continued growth of the UK space sector, the UK Space Agency was established as an executive agency of BIS in 2011. It consolidated funding for space programmes from across government, the Research Councils and other public bodies. The UK Space Agency is responsible for space policy; working with the scientific community, policy makers and business; and strengthening the UK's relationship with the European Space Agency (ESA), the EU and other international agencies. The demand for space technology for climate and environmental services is growing within the portfolio. The Agency's *Strategy for Earth Observation from Space*[222] articulates a strategic priority to build on UK leadership in processing, analysis, quality assurance and control, modelling and visualisation of space data for environmental research and climate applications.

BIS also hosts the Government Office for Science[223] which ensures that all levels of government receive the best scientific advice possible and create policies that are supported by strong evidence. The The Government Office for Science runs the Foresight Programme,[224],which helps the UK government to think systematically about the future, based on the latest science and evidence with futures analysis.

Two recent Foresight reports addressed climate change issues. The International Dimensions of Climate Change[225] (2011) report gave an overview of the evidence of threats and opportunities to the UK from international climate change, and considers how these may be considered by policymakers to ensure the UK is able to remain competitive, secure and able to protect the wellbeing of the nation. The Migration and Global Environmental Change[226] (2011) report examined how profound changes in environmental conditions such as flooding, drought and rising sea levels will influence and interact with patterns of global human migration over the next 50 years.

Public Health England (PHE) is an agency of the Department of Health. Its mission is to protect and improve the nation's health and to address inequalities. The UK has been giving serious consideration to the risks climate change could pose to human health. In 2012, the *Health Effects of Climate Change in the UK* report[227] was updated by the Health Protection Agency (HPA), now part of PHE, on the recommendation of the Department of Health, and provides further evidence and analysis from earlier reports, based on the most recent climate change projections for the UK. Public health recommendations and research needs have been identified for each of the specific health effects of climate change in the UK covered in the report. The report follows on from the first UK Climate Change Risk Assessment and informs the National Adaptation Programme.

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[222] http://www.bis.gov.uk/assets/ukspaceagency/docs-2013/eo-strategy.pdf

[223] http://bis.gov.uk/go-science

[224] http://www.bis.gov.uk/foresight

[225] http://www.bis.gov.uk/foresight/our-work/projects/published-projects/international-dimensions-of-climate-change/reports-and-publications#sthash.TLZtC02V.dpuf

[226] http://www.bis.gov.uk/foresight/our-work/projects/published-projects/global-migration#sthash.N7XC47R6.dpuf

[227] http://www.hpa.org.uk/hecc2012

Domestic transport emissions make up nearly a quarter of UK emissions. By 2050, domestic transport will need to substantially reduce its emissions. To support this aim the Department for Transport (DfT) conducts research to mitigate the negative environmental impacts of transport. This includes developing more environmentally friendly fuels to help reduce emissions; promoting the take up of Ultra Low Emission Vehicles (ULEV); and encouraging people to travel by foot or bicycle. DfT also undertakes research to ensure that the transport network is able to adapt to the changing climate and predicted increase in extreme weather events. Resilience to flooding and extremes of temperature and precipitation will be a priority in the future.

The DfT has an evolving evidence base on public attitudes and behaviours in relation to climate change, and the motivators for, and barriers to, more sustainable travel choices. In 2011 a segmentation model[228] was published identifying distinct groups according to their transport behaviour, attitudes to transport, attitudes to climate change and the environment, and characteristics and circumstances.

There are still key gaps in understanding the regional impacts of climate change. Over the next 20 years, world demand for energy will grow by up to 50%, and it will increase levels of GHGs. Research needs to show how to improve access to energy and how to grow economies while keeping carbon emissions low in the long term.

The government set up the International Climate Fund (ICF) to provide £2.9 billion over 4 years to help the world's poorest people adapt to climate change and promote cleaner, greener growth. As part of this initiative, the Department for International Development (DFID) is funding: climate science, especially in Africa; climate change in national and international policy; adaptation strategies; actions to reduce the impact of climate change and promote low carbon growth; and ecosystem services for poverty alleviation. Further information on the ICF can be found in Chapter 6.

7.6 Co-ordination mechanisms for climate research

The UK Collaborative on Development Sciences (UKCDS), whose members comprise UK government departments and research funders, work together to add value to research interests focused on development in low and middle income countries. UKCDS acts as a coordinator and facilitator connecting experts in academia and NGOs on climate change relevant topics.

Improved coordination and alignment of research activities in environmental change is being provided by the LWEC partnership. LWEC brings together 22 public sector organisations that fund, carry out and use environmental research and observations. Partners include the UK Research Councils, government departments with environmental responsibilities, devolved administrations and government agencies. The overall vision of LWEC is to ensure that decision makers in government, business and society have the knowledge, foresight and tools to mitigate, adapt to and benefit from environmental change.

Marine science provides vital knowledge and information to enable key decisions on the management of the seas and oceans. The Marine Science Co-ordination Committee (MSCC) provides the forum to deliver the UK Marine Science Strategy (2010 to 2025);[229] and to improve UK marine science co-ordination. The committee involves the major marine science funding Departments, the Devolved Administrations, the key marine science providers and independent members. One of the priority areas is responding to climate change and its interaction with the marine environment.

[228] https://www.gov.uk/government/publications/climate-change-and-transport-choices-segmentation-study-final-report

[229] http://www.defra.gov.uk/mscc/files/uk-marine-science-strategy-.pdf

7.7 Climate information services

The need for information and tools to enable both the UK and wider world to cope with the impacts of climate change is real and urgent. To ensure that society is sufficiently resilient and prepared requires the development and delivery of operational climate services – climate information prepared, interpreted and delivered to meet society's needs.

Climate Service UK, is a new initiative led by the Met Office, which will provide business and society with information to help make them more resilient to climate variability and change. Climate Service UK offers expert advice, bespoke climate information, value-added services and solutions to help build capacity in developing countries. Examples of climate services delivered by the Met Office include:

- The Met Office's National Climate Information Centre (NCIC) – an accessible catalogue of UK weather and climate information going back hundreds of years.
- The Hunger and Climate Vulnerability Index produced by climate scientists from the Met Office Hadley Centre working with World Food Programme experts.
- Expert advice delivered for Britain's National Rail Network to guide decision-making for strategic investment, maintenance, and day-to-day operations in future decades.

To help everyone engage in the debate on how the UK can best meet its energy needs and reduce emissions, DECC developed the 2050 Calculator.[230] It is a user-friendly model that brings energy and emissions data alive, showing the benefits, costs and trade-offs of different versions of the future.

Online advice, guidance and tailored support to help organisations adapt to the changing climate is available from Climate Ready.[231] The service is delivered by the Environment Agency. Its priorities are informed by the Government's National Adaptation Programme. The service provides information about how the climate of the UK may change and guidance and advice on carrying out climate change impacts assessments. Help is also available to develop climate change adaptation strategies.

To build up a picture of historical and future impacts resulting from climate change, a series of Climate Change Impact Report Cards are being developed by the LWEC partnership. Two report cards have been published. The Water Climate Change Impacts Report Card 2012-13 looks at the effect of climate change on fresh water – including rainfall, floods and droughts. The report card is intended to help people understand the scale of possible change and to inform decisions about the way that water is managed. The Terrestrial Biodiversity Climate Change Impacts Report Card shows where observed changes in UK biodiversity are likely to have been caused by changes in the UK climate over recent decades. It also assesses potential future impacts of climate change on biodiversity. Two new report cards on Critical Infrastructure and Health are in preparation.

7.8 Key research initiatives

7.8.1 Policy-led research

The UK government is working at home and abroad to adapt to the effects of climate change and reduce greenhouse gas (GHG) emissions by investing in low carbon energy sources, improving fuel standards in cars and increasing energy efficiency wherever possible. The government funds a wide range of climate change research directly to inform UK policy

[230] https://www.gov.uk/2050-pathways-analysis

[231] http://www.environment-agency.gov.uk/research/137557.aspx

development, contribute towards the science base for the IPCC and to support negotiations on international action on climate change through the UNFCCC. Policy-led research is managed along the lines of mitigation and adaptation.

7.8.1.1 Mitigation

To address the threat of climate change, the UK has a legally binding target to cut GHG emissions by 80% by 2050. Achieving this will require a massive change in how energy is used and generated. This poses substantial challenges such as affordability of new infrastructure, its impact on the environment and competing pressures on land and resources.

DECC works to make sure the UK has secure, clean, affordable energy supplies that fully support the UK economy, and promote international action to mitigate climate change. To achieve these objectives requires rapid and large-scale changes in energy efficiency, electricity generation, heating, transport and industrial processing. There are currently technology gaps and many low carbon technologies are not currently cost-effective. To address these issues DECC utilises analysis and advice from the independent Committee on Climate Change (CCC) and conducts a range of research and development to underpin policy decisions.

DECC invests in research to address the following policy issues related to mitigation of climate change:

- To save energy, better understanding of what the climate will be like over the lifetime of policies is needed, so that the measures which are set are as effective as possible.
- To maintain energy security and increase the use of low carbon technologies requires prediction of the availability of renewable energy resources in the future.
- To reduce the UK's GHG emissions and mitigate international climate change requires evidence of why action against climate change is important and what the risks are if no action is taken.
- To manage our energy legacy responsibly and cost-effectively requires knowledge of potential risks posed by the climate in the future and adaptation of energy systems.

Defra is responsible for several policy areas that are associated with GHG emissions. These include agriculture, forestry, land management, waste, fluorinated gases and non-CO_2 emissions from industrial processes, and treatment and use of water. Hence, one of Defra's policy objectives is to support decision making by society on how best to mitigate against the effects of climate change in a sustainable manner. To deliver on its mitigation objectives, Defra focuses on the removal of key uncertainties over the sustainability of low carbon power technologies and ensures specific government policies on low carbon energy are in tune with objectives on the environment and rural economy.

The 2011 Natural Environment White Paper (NEWP) highlighted significant gaps in the evidence about the impact of low carbon energy on the natural environment. NEWP commits the government to establish a research programme to fill evidence gaps on the natural environment impacts from the energy infrastructure needed to meet 2050 objectives. The research will be used in a strategic way to inform pathways to 2050 and inform judgements on the best ways to achieve GHG benefits, energy security, affordability and protection of the natural environment. This led to Defra developing the Sustainable Pathways for Low Carbon Energy Research Programme (SPLiCE).

7.8.1.2 Adaptation

Building the UK's resilience to climate change is an economic, social and environmental challenge that cuts right across the work of government and every sector of society. The Climate

Change Act requires the government to publish a report to Parliament on a National Adaptation Programme (NAP), following the publication of the Climate Change Risk Assessment in January 2012. The Defra 'Climate Ready' service leads the work on behalf of government, working alongside other government departments, businesses, local authorities and civil society. The objectives of the NAP are: improving the climate evidence base; developing adaptive capacity in key sectors; providing the conditions for adaptation by removing barriers and supporting others; and taking action to adapt.

Defra commissions research directly to analyse the costs, benefits and wider impacts of adaptation policy options and to improve understanding of the threats and opportunities implied by a changing climate. Current projects are analysing the rationale for adaptation action for government alongside other organisations and private individuals in a number of sectors identified as priority by the Climate Change Risk Assessment. This includes looking at climate change adaptation in agriculture, forestry, power, transport, business, health, fisheries and the natural environment.

Better understanding in key areas that were not covered in depth by the UK's 2012 Climate Change Risk Assessment is required too. This evidence will help to gain an understanding of the threats and opportunities of climate change to the UK and inform the options to approach climate change risks effectively in the future. High priority evidence gaps include, for example: improved projections of potential changes in extremes such as heat waves and intense rainfall; development of socio-economic scenarios to consider how changing conditions in the UK's social and economic context might affect adaptation responses; and the threats and opportunities of climate change driven by the international context.

DECC and Defra jointly fund the Met Office Hadley Centre Climate Programme to provide knowledge and scientific evidence for the UK's mitigation and adaptation policies. For example, adaptation-relevant outputs from the programme include information on the regional consequences of climate variability and change, which will inform future climate risk assessments and national adaptation planning. Similarly, the DECC-Defra funded AVOID research programme has helped put the latest scientific knowledge into the hands on policymakers.

7.8.2 Research councils

The primary role of the Research Councils is to fund research, training and knowledge exchange. Each year a total of around £3 billion is invested in research conducted at UK universities, Research Council institutes, and in securing access to international facilities for UK researchers. Together the Research Councils cover the full spectrum of academic disciplines from the medical and biological sciences to astronomy, physics, chemistry and engineering, social sciences, economics, and the arts and humanities. The Research Councils work in partnership with each other and with policy and business partners to tackle global challenges, such as environmental change, energy, and food security.

The Natural Environment Research Council (NERC) is the UK's leading public funder of environmental science. NERC invests around £330 million each year in cutting-edge research, postgraduate training and innovation in universities and research centres. Climate change is a fundamental issue for NERC supported research that addresses the great challenges facing society: benefiting from natural resources; resilience to environmental hazards and managing environmental change. In addition, NERC-funded discovery science drives fundamental advances in knowledge across the breadth of the NERC science remit. Long-term science funding sustains UK national capability that delivers scientific understanding of environmental processes over large time and space scales, supports world-leading environmental science and innovation, and meets national needs. NERC plays a leading role in the development of risk-based predictions of the future state of the climate – on regional and local scales, spanning

days to decades. NERC also develops improved predictive capability working with national and international partners, notably with the Met Office Hadley Centre.

NERC research centres all have programmes delivering climate change science, some of which are highlighted in this chapter. The centres are the: Centre for Ecology and Hydrology, British Geological Survey, British Antarctic Survey, National Oceanographic Centre, National Centre for Atmospheric Science and the National Centre for Earth Observation.

Research is revealing and enabling prediction of how plants and animals, and their pests and pathogens, respond to environmental change, and what this means for agricultural systems and the wider environment. It will help farmers to choose systems that meet their particular environmental and market needs. The Biotechnology and Biological Sciences Research Council (BBSRC) supports research relevant to environmental change, including the responses of biological systems to climate and other environmental factors and their possible adaptations to them. Bioscience is identifying options for reducing energy consumption and GHG emissions, and developing renewable biological sources of energy, materials and chemicals that will reduce dependency on petrochemicals and help the UK become a low carbon economy.

BBSRC contributes to research relevant to climate change through the multi-agency LWEC partnership and Global Food Security programme, and the EU's Joint Programming Initiative in Agriculture, Food Security and Climate Change, and in its own focus on bioenergy and industrial biotechnology. As well as funding strategic science, BBSRC continues to support environmental change research across its remit in the biosciences. This enables the best ideas from the best people to be funded and provides agility to respond to emerging needs and opportunities. BBSRC also funds eight mission-driven bioscience institutes with critical expertise in research into the impacts of climate change on the function and behaviour of plants, animals and soils. In bioenergy, BBSRC's "virtual" Sustainable Bioenergy Centre is examining all the relevant areas of science needed for sustainable bioenergy, and studying the economic and social impacts of the bioenergy process.

The Engineering and Physical Sciences Research Council (EPSRC) funds a broad range of research and training aimed at tackling climate change. EPSRC leads the Research Councils Energy Programme, whose key drivers are to ensure secure and affordable energy supplies, whilst reducing CO_2 emissions and therefore mitigating against climate change. EPSRC's specific focus is on engineering and scientific research into new low carbon energy technologies, both for energy generation and supply and for managing and reducing demand for energy in buildings, industries and transport. A key element is the provision of training to ensure sufficient researcher capacity to underpin future energy options. Research areas specific to the engineering and physical sciences include aspects of sustainable power generation and supply, conventional generation including carbon abatement technologies, nuclear fission and nuclear fusion.

EPSRC supports research in engineering and physical science that advances the utility of models (i.e. developing better mathematical sciences for modelling and reducing uncertainties eg. CliMathNet) and improvements to the input into models (i.e. better sensors/data acquisition). Research on mitigation and adaptation strategies for energy and infrastructure are also funded. For example, research to increase the contribution of bioenergy to the UK and how to build resilience into national infrastructure and transform cities to minimise the impacts of climate change.

Environment and climate change is central to the Economic and Social Research Council's (ESRC) research priorities. ESRC's work in this field involves funding interdisciplinary research and postgraduate training alongside stakeholder engagement to maximise the impact of the research it funds. ESRC funds research into climate change through its Centre for Climate

Change Economics and Policy (CCCEP), contributions to the cross-Council Energy and LWEC programmes and the responsive Research Grants scheme.

Key themes emerging recently for ESRC include: climate change and the city; interactions between climate change, development and social justice; climate change politics and policy making; and public engagement. In 2013, ESRC undertook a consultation to identify the social science research priorities that emerged out of an assessment of the interrelated challenges of Energy, Environment and Food Security. The result is an interconnected set of social science challenges – the Social Science of the Nexus. ESRC is working with a range of partners to take forward a programme of research and capacity-building. The programme ties in with on-going ESRC research programmes through the Living with Environmental Change Partnership, the Research Councils UK Energy Programme and the Global Food Security Programme.

The Science and Technology Facilities Council (STFC) works with partners (NERC, Met Office, DEFRA, DECC and industry) to enable climate change research. STFC's main research areas are astronomy, particle physics and nuclear physics, but STFC hosts and provides access to world leading facilities, technologies and expertise serving the whole of the UK research base. For example, STFC:

- Operates the British Atmospheric Data Centre (BADC).[232] The BADC assists UK researchers to locate, access and interpret atmospheric data and to ensure the long-term integrity of atmospheric data. 15% of the 20,000 registered users are working specifically on climate change research;
- Is a key partner in the development and data services of the Along Track Scanning Radiometer (ATSR)[233] series of instruments. These satellite-based instruments have provided a long-term data record of global sea surface temperatures;
- Works with the Space Applications Catapult to provide the Climate and Environmental Monitoring from Space (CEMS)[234] facility. CEMS provides a virtualised environment to give users access to extensive climate and Earth observation data holdings together with a range of applications and tools to help them analyse data more effectively.

STFC has formed new cross-disciplinary communities and projects to develop novel approaches in areas such as Carbon Capture and Storage (CCS) and the monitoring of tropical forests, by applying STFC capabilities to mitigation and adaptation research. Examples include:

- The Boulby Underground Laboratory, located one mile beneath the surface, was originally created to search for dark matter. Following investments from STFC, DECC and industry, Boulby is now hosting studies to develop new technology for long-term monitoring of the geological integrity of CCS sites.
- Software developed to study complex data from astronomy research is being applied to create a 'virtual observatory' and improve the monitoring of tropical forests, a critical component of the Earth's climate system.
- STFC and NERC are working to link bioinformatics and environmental 'omics with other large scale data structures and models involving climate change. The STFC community is providing expertise in handling, visualising and curating large complex data sets.

[232] http://badc.nerc.ac.uk/home/about.html

[233] http://www.stfc.ac.uk/2791.aspx

[234] https://sa.catapult.org.uk/climate-and-environmental-monitoring-from-space

The Medical Research Council (MRC) supports research into climate change through its response mode schemes and through targeted strategic investments. The MRC is a partner in the LWEC Health and Wellbeing Task Force which aims to improve understanding of how environmental changes, including increased exposure to extreme events, will affect current and future health and wellbeing in the UK and beyond.

Novel, multidisciplinary approaches are needed to solve many, if not all, of the big research challenges over the next 10 to 20 years. This requires the UK's research councils to work together with additional partners that bring new expertise. Two major investments relevant to climate change are The LWEC partnership and the Research Councils Energy Programme.

The LWEC partnership focuses its research activities along two objectives: knowledge synthesis and translation, and alignment of research agendas. Partners identified priority areas to collaborate on and set them up as time-limited task forces. They include; Climate Mitigation, Ecosystems, Health and Wellbeing, and Policy Evaluation. Key LWEC activities also include: the Flood and Coastal Erosion Risk Management Research Strategy, the UK Water Research and Innovation Partnership and the UK Environmental Observation Framework. The Climate Mitigation Task Force is exploring the global and regional impacts of a range of emissions scenarios, the technical and economic feasibility of achieving such pathways, and how results can be used to stimulate action. The work assesses if the evidence base is sufficient for UK needs and addresses priority knowledge gaps.

The Research Councils Energy Programme (RCEP) brings together, in one framework, all the Research Council activities on energy research and training. Over the period 2011-15 expenditure under the Programme will exceed £540 million. The Energy Programme's vision is to bring together engineers with physical, natural environment, biological, social and economic scientists to tackle the research challenges involved in creating new energy technologies and understanding of the environmental, social and economic implications. The aim is to position the UK to develop, and exploit sustainably, low carbon and/or energy efficient technologies and systems to enable it to meet national energy and environmental targets for 2020 and beyond. Priorities for the Energy Programme include continuing support for a broad research portfolio in power generation and supply (including renewables, fusion, distribution networks and energy storage), and to grow the portfolio in demand reduction, transport, security of supply, research capacity building and international engagement. It includes investments in large research consortia, "whole-system" research, strategic partnerships with leading companies and support for the UK Energy Research Centre (UKERC), as well as support for fundamental science based energy research through investigator-led projects.

7.8.3 Research programmes

The following section provides some research highlights from research programmes funded wholly or partly by the UK. Major research programmes funded by the UK are broadly identified as contributing to the following headings: climate process and system studies, modelling and prediction, impacts of climate change, socioe-conomic analysis, mitigation and adaptation technologies. A significant volume of research is also being carried out through Research Council grants schemes and through other funders of research. The LWEC Envirobase provides information on over 20,000 research projects.

Research Highlights

Weather extremes and climate change – Recent world-leading climate attribution research shows that human activities have already altered the risks of certain extremes of weather and climate events and will cause further changes in the future. A report edited by the Met Office Hadley Centre and the US National Oceanic and Atmospheric Administration (NOAA) looked at 12 extreme weather and climate events from 2012, finding that half of them had had a human influence.

Climate stabilisation – Research led by Oxford University has shown a new insight into the relationship between CO_2 emissions and global warming. It shows that the amount of warming is closely related to the total cumulative emissions of CO_2 over time. It has been estimated that avoiding 2°C of global warming implies keeping cumulative emissions of CO_2 from the industrial revolution onwards below 1 trillion tonnes of carbon. More than half of this carbon budget has already been emitted to date.

The Avoiding Dangerous Climate Change (AVOID) programme led by the Met Office provided key advice to the UK government on avoiding dangerous climate change brought on by GHG emissions. Whilst a rise in global temperature is inevitable, society can still have an influence on how much the temperature rises in the foreseeable future but only if emissions are reduced immediately. Key results from the programme include:

- The later the emissions peak, the more likely that techniques to remove CO_2 from the atmosphere will need to be developed and employed to limit warming to 2 °C.
- The transition to a low carbon economy, which is necessary to limit warming, appears challenging but is still technologically and economically feasible.

Future-proof building design contributes to UK climate change targets – Research on adaptation and resilience to a changing climate is informing building design and refurbishment practice, resulting in 'future-proof' buildings. These buildings will help reduce carbon emissions, avoid people falling seriously ill from future heat waves, and limit inefficiencies arising from offices that overheat. Over £2 billion of construction work stands to benefit from research in this area. Climate change projections were used to inform a large scale refurbishment of council offices in Cornwall. The design will reduce solar gain, promote cooling and increase ventilation. Existing research draws on the expertise across a range of stakeholders including climate scientists, engineers, technologists and builders, policymakers, regulators and the private sector. Likewise, the NHS is issuing guidance on how to improve hospital buildings, and the National House Building Council (NHBC) is drawing the attention of house builders to new ways of building homes that use little energy and do not overheat.

Floods in the WHO European Region: health effects and their prevention – The WHO Regional Office for Europe and the United Kingdom HPA collaborated to assess the health effects of floods as well as to identify measures to prevent or minimize their health effects. The resulting report Floods in the WHO European Region: health effects and their prevention is intended to provide decision-makers with evidence for action before, during and after flooding events.

7.8.4 Climate process and climate system studies

Predictions of regional climate are reliant on global climate models, and observations. Global climate models have developed rapidly over the last few decades but require further improvements particularly in the representation of key earth system processes. The UK is

funding several major research initiatives to improve the understanding of key processes and refine their representation in climate models.

7.8.4.1 Cryosphere

The Arctic is a region of higher than average climate change and is predicted to remain so. The most iconic evidence of this rapid climate change is the loss of summer sea ice, with recent loss rates exceeding most model projections. Other changes include the thawing of permafrost (perennially frozen earth), melting of land ice, including ice sheets and glaciers, and the changing physical environment of Arctic ecosystems. These can lead to major feedbacks to the climate system, and the loss of sea ice and degradation of permafrost represent potential "tipping points" in the Earth system. Additionally, the widespread destabilisation of gas hydrates through melting can potentially cause marine landslides and tsunamis which could impact the Arctic, North East Atlantic and the UK.

The Arctic Research Programme (£15 million from 2010 to 2015, funded by NERC and DECC) will focus on four linked objectives: understanding and attributing the current rapid changes in the Arctic; quantifying processes leading to Arctic CH_4 and CO_2 release; reducing uncertainty in Arctic climate and associated regional biogeochemistry predictions; and assessing the likely risks of submarine hazards associated with rapid Arctic climate change. The programme is being developed in collaboration with other nations (e.g. Canada and Russia), a number of UK universities and research centres, and government departments (e.g. DECC and FCO).

The great ice sheets of Antarctica contain the world's largest reservoirs of freshwater. Changes in these ice sheets can induce large changes in sea level and in the freshwater flux to the oceans, which in turn can affect the ocean circulation and climate. The Intergovernmental Panel on Climate Change Fourth Assessment Report (IPCC AR4) identified the cryosphere as the largest source of uncertainty in predictions of future sea level rise over the 50-200 year time horizon. The NERC Ice Sheet Stability research programme is a five year programme with a budget of £7.4 million. The goal is to improve fundamental understanding of the interaction of ice with the oceans and the resulting ice sheet response, and to incorporate this new understanding into predictive models. There are two closely linked components: ocean forcing of the ice sheet and ice sheet response to ocean forcing. Results should deliver an improved prediction of ice sheet melt rates over time scales of up to 200 years. These improvements will then be available to modellers for use in ocean circulation and sea-level-rise models.

7.8.4.2 Water cycle

Changes in the hydrological cycle as a consequence of climate and land use drivers are expected to play a central role in governing a vast range of environmental impacts. At the same time, predictions of water-related variables show very high uncertainty, for example, as shown in the IPCC AR4. The Changing Water Cycle (£10.1 million) programme is working to understand how local to regional scale hydrological and biogeochemical processes are responding and will respond to changing climate and land use, together with their consequent impacts on the sustainable use of soil and water. It will investigate the consequences of the changing water cycle for water-related natural hazards, including floods and droughts, improving prediction and mitigation of these hazards.

7.8.4.3 Greenhouse Gases

To quantify the influence of man-made GHGs on recent and future climate, it is essential to quantify their sources and sinks. This includes both anthropogenic emissions and the response of natural sources and sinks to changing environmental conditions. However, inconsistencies currently exist between the budget estimates for some gases, and there is a poor understanding of the impacts of land use on GHG emissions and the effects of climate change on terrestrial

and marine carbon sinks. These factors are major sources of uncertainty in predicting climate change. To address these scientific uncertainties, NERC is investing £8.1 million into a five-year GHG Emissions & Feedbacks research programme. The aim is to develop the capability to measure and predict sources and sinks of the major anthropogenic GHGs. It focuses on the three major anthropogenic GHGs not regulated by the Montreal Protocol: CO_2, CH_4 and N_2O.

The UK GHG Inventory contains estimates of all GHG emissions by sources and removals by sinks from 1990 to the latest available year of reporting. DECC commissions research on an annual basis to improve the methods and data it uses. Improvements are driven by recommendations received from the UNFCCC and policy needs, and is overseen by the cross-governmental National Inventory Steering Committee, who approve all planned improvements. A recent example is the update of the refrigeration and air conditioning model, which estimates emissions of fluorinated gases.

The UK has undertaken research to develop its agricultural inventory of GHG emissions through the Agricultural GHG Research and Development Platform.[235] The research brings together existing knowledge from UK and international research to develop an improved characterisation of emissions from the UK agricultural sector, whilst identifying opportunities to mitigate those emissions. Targeted measurements of N_2O and CH_4 emissions from UK agricultural systems are also being undertaken to fill gaps in existing knowledge.

DECC also funds the Atmospheric Observations Programme, which takes high-frequency, high-precision measurements of atmospheric gas concentrations. These are used to estimate GHG emissions using a technique designed specifically for the DECC research programme – InTEM (Inversion Technique for Emission Modelling). The results of the work provide emission estimates as yearly averages and are used as an important cross-check for the GHG Inventory. The UK is one of very few countries verifying its Inventory in this manner.

The potential destabilisation of the vast methane hydrates reservoirs as a tipping point for global climate change is a specific challenge. Methane hydrates are also of interest to the energy industry as a potential energy reservoir and as a hazard during drilling. These hydrate reservoirs (methane/water ice-like structures) are only stable within a specific temperature and pressure range, and hence increases in temperature or decreases in pressure (eg submarine landslides) clearly have the potential to destabilise these reservoirs, leading to large scale methane release.

Predictions of the future risk of methane hydrate destabilisation are uncertain because of a lack of fundamental understanding of their distribution, magnitude and stability. NERC has funded a three year Methane Network to increase collaboration between research groups and also with relevant LWEC and industry partners. The outputs of this network should assist with policy options for the management of GHGs.

7.8.5 Modelling and prediction, including general circulation models

Earth System Modelling (ESM) is central to predicting climate and environmental change. It is also critically important for extrapolating observational data to broader space and time scales and for exploring linkages and feedbacks within the Earth System.

The climate modelling effort in the UK is led by the DECC-Defra funded Met Office Hadley Centre Climate Programme. This programme strengthens the national climate capability by developing the next generation of state-of-the-art climate and Earth system models, in partnership with the UK academic community. Combined with some of the most comprehensive climate datasets in the world, research on the physics and chemistry of the climate system and powerful supercomputing facilities, these models form a toolkit to ensure

[235] www.ghgplatform.org.uk

that policy is built on the best climate science evidence base. The aim is to deliver better predictions of global and regional climates over a timescale of 10–20 years, and more confident assessments of global long-term climate change. It also underpins the development of a near real-time system to determine the extent to which manmade emissions have influenced the risk of extreme events, such as heatwaves, floods and drought.

The Joint Weather and Climate Research Programme (JWCRP) of the Met Office and NERC, builds on the UK's leading role in weather and climate research. The JWCRP has established a jointly-owned supercomputer, MONSooN (Met Office and NERC Supercomputing Node), to enable scientists to share data and develop models on the same platform. Following on from the successful first phase of JWCRP, the Met Office and NERC have developed a strategy for Earth System Modelling to improve the usability of the Unified Model system for research in weather and climate, and to develop the next generation UK Global Environmental Model ("UK-GEM").

Technical developments in computing and in global scale observations create an enormous opportunity for improving capabilities for weather and climate prediction, but there are major scientific and technical barriers to realizing this potential. The Next Generation Weather & Climate Prediction programme aims to address the resolution of small scale weather systems in the atmosphere and ocean and the use of observations to initialise climate predictions. To achieve the first objective, NERC, STFC and the Met Office will design and develop a new atmospheric dynamical core for a next-generation weather and climate prediction system. This will eventually replace the dynamical core of the Unified Model (UM), the principal UK tool for weather and climate prediction. The second part of this programme supports research on the initialization of climate predictions. This is central to exploiting the opportunities to improve climate models and predictions that arise from the wealth of new observations from Earth-based and space-based platforms.

The development of capabilities for predictions of climate that are initialised with observations is a major opportunity to advance climate science, offering a new approach for testing models against observations at a process level. The NERC National Centre for Atmospheric Science (NCAS) in collaboration with others (notably the Met Office and the European Centre for Medium-Range Weather Forecasts) is developing and exploiting capabilities for initialised monthly-to-decadal climate predictions. These capabilities include the new Met Office climate prediction system that – built on research by NCAS and others – includes, for the first time, a proper representation of the stratosphere.

7.8.6 Research on the impacts of climate change

Global climate models predict large-scale changes in climate but are not yet capable of providing fine-scale information about areas such as mountains and inland water basins, or representing high-resolution weather phenomena such as fronts and cyclones, all of which are needed to gauge the impacts of climate change and plan for adaptation. The Providing Regional Climates for Impacts Studies (PRECIS) system has been developed at the Met Office to provide a tool for predictions on a regional scale and can be applied in any region of the world.

7.8.6.1 Ocean acidification

The Ocean Acidification Research Programme is a 5-year collaborative programme with a budget of £12 million funded by NERC, Defra and DECC. In response to rising CO_2, the oceans are taking up more CO_2 and becoming more acidic. The associated increases in ocean acidity over coming decades are likely to be at a rate and on a scale that is unprecedented in at least the last 20 million years. This acidification will clearly have major impacts on ocean biogeochemistry and biodiversity, but impacts will extend beyond this to the whole Earth system via impacts on air-sea gas exchange and sedimentation of material through the oceans. The scale and nature of the effects of acidification on marine systems more widely are poorly known.

Research is focusing on the North-East Atlantic (including European shelf and slope), Antarctic and Arctic Oceans, and includes the effects of acidification on biochemistry and biodiversity, past responses to acidification, ecosystem structure and function, habitats and species, and socio-economic implications.

7.8.6.2 Biodiversity

The analysis of data associated with large-scale monitoring and experimental-activities is crucial to unravelling how the UK flora, fauna, habitats and ecosystems are changing with the climate. The NERC Centre for Ecology and Hydrology (CEH) is carrying out such assessments along with the identification of the main drivers of change – physical and chemical (nitrogen deposition, ozone, rainfall, temperature, etc.) or biological and social (changes in farming practices, invasive species, emerging disease, habitat fragmentation, etc). Natural England's research has focused on the impact of climate change on biodiversity, vulnerability studies and monitoring climate change impacts at a set of national nature reserve sites.

7.8.6.3 Water availability

Over-abstraction to meet the needs of growing populations, agricultural and industrial use, and the effects of climate change are causing multiple challenges in many water-stressed regions, and these are likely to increase. With shifting frequency and patterns of rainfall and increasing demand for water, the effects of water shortages are becoming increasingly critical for the environment, food production, industrial efficiency and households. The UK Droughts & Water Scarcity research programme is a five-year interdisciplinary, £12 million NERC programme in collaboration with ESRC, EPSRC, BBSRC and AHRC. It supports improved decision-making in relation to droughts and water scarcity by providing research that identifies, predicts and responds to the interrelationships between drivers and their impacts.

7.8.6.4 Quantifying uncertainty

Decision making in risk-averse areas such as water supply requires high levels of confidence in forecasts. Currently it is not possible to accurately predict the occurrence, duration and intensity of drought events. Quantitative estimates of uncertainty are therefore a key element of the user requirement for climate predictions, but the challenge of producing such estimates has received little attention. Many current predictions simply represent uncertainty in terms of an ensemble of different model predictions, with no indication as to whether some predictions may be more trustworthy than others, or what is the actual likely range within which we should expect future observable quantities to fall. The NERC Quantifying Uncertainty in Predictions of Climate Change & Climate Impacts programme is developing and testing methods to combine observations and models to quantify the uncertainty in predictions of regional and local climate change, including changes in extreme events and climate impacts, especially for the next few decades.

7.8.7 Socio-economic analysis

There is increasing interest in the socio-economic aspects of climate change and how policies affect, and are affected by, behaviour and social issues, including economics, regulation, and lifestyle choices. Public perceptions and attitudes are critically important to the climate change challenge. On the supply side, public acceptance of new and innovative energy facilities such as power stations and new grid infrastructure will play a key role. Community opposition can lead to delays or even cancellation of plans and construction. On the demand side, perceptions of the need to take mitigating action against climate change, and of the ability to act on this, will be key precursors to personal behaviour change and compliance with wider policies aimed to motivate such changes.

7.8.7.1 Economics

The Centre for Climate Change Economics and Policy (CCCEP) brings together some of the world's leading researchers on climate change economics and policy, from many different disciplines to advance public and private action on climate change through rigorous, innovative research. CCCEP is hosted jointly by the University of Leeds and the London School of Economics and Political Science (LSE). The relationship between sustainability and prosperity in the context of the green economy is being explored by the Prosperity and Sustainability in the Green Economy (PASSAGE) programme. It will build a macroeconomic model of the green economy. Defra recently developed an approach to quantify the economic benefits of climate change adaptation in the light of the impacts of extreme weather events on agriculture.[236] Two infrastructure business model centres to explore the future of infrastructure at the local, national and international levels have been jointly funded by EPSRC and ESRC; the "International Centre for Infrastructure Futures" and the "Infrastructure Business models, valuation and Innovation for Local Delivery".

The ASC, established under the Climate Change Act, has a statutory role to report to Parliament on progress made on the National Adaptation Programme. The ASC has commissioned a series of research analyses on adaptation. These focussed on developing indicators to help track progress on adaptation and using economic analysis to understand what additional adaptation actions could be taken to increase resilience to climate change.

7.8.7.2 Lifestyles

The Energy Saving Trust (EST) is the leading UK organisation in developing evidence-based insight, research and advice to engage households and communities on their energy and water use. The Trust's report, 'Powering the nation', uncovered the electricity consumption habits of the UK. The data and evidence on how people use energy in the home will help to develop programmes and strategies to help the nation to become energy-smart. The Sustainable Practices Research Group (SPRG) at Manchester and co-funded with Defra aims to gain a better understanding of the processes that lead to radical changes in behaviour by examining entrenched habits and social practices. The group will provide advice on realistic strategies to encourage more sustainable behaviours. The Sustainable Lifestyles Research Group (SLRG) at Surrey and funded by ESRC and Defra aims to gain a better understanding of the processes which lead to changes in people's lifestyles, behaviours and practices and to offer evidence-based advice to policy-makers about realistic strategies to encourage more sustainable lifestyles.

7.8.8 Research and development on mitigation and adaptation technologies

The ability to develop, commercialise and adopt new technologies across the economy will define successful countries. It is essential to prioritise investment in technologies that emerge from the research base, into those that offer the greatest potential returns. Innovation is increasingly driven by challenges such as climate change, so the UK government will back challenge-led innovation in these areas to develop new business models, products and processes.

DECC has a £178 million innovation portfolio in the current spending review period (2011-15), which includes programmes for offshore wind, CCS, Bioenergy, Nuclear Fission and Buildings. DECC is also investing £1billion into enabling the development of the UK's first commercial Carbon Capture and Storage demonstration plant.

[236] http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=18670

Technology Innovation Needs Assessments[237] (TINAs) inform investments by members of the Low Carbon Innovation Coordination Group. TINAs aim to identify and value the main innovation needs of specific low carbon technology families, to inform the prioritisation of public sector support. For example, the Offshore Wind TINA informed DECC's decision to make available up to £15 million to the Offshore Wind Component Technologies Development and Demonstration Scheme to help companies test and demonstrate technologies that can help cut deployment costs in the run up to 2020 and beyond.

The Carbon Trust is an independent company helping businesses and governments accelerate the move to a sustainable, low carbon economy through carbon footprinting and reduction expertise, and developing, commercialising and deploying innovative low carbon technologies and solutions, from energy efficiency to renewable power. DECC presently funds the Carbon Trust to deliver three schemes, including a large collaborative programme with the Offshore Wind industry.

The Technology Strategy Board (TSB) focuses on thematic areas which are most likely to generate UK economic growth and which address global challenges and opportunities – and on competencies and technologies which enable innovation in these areas. The TSB tackles the barriers to innovation by working across business, academia and government, striving to create a more effective innovation environment, reducing risk and promoting collaboration, knowledge exchange and open innovation. To facilitate working, the TSB builds strategic partnerships with key organisations such as the research councils.

7.8.8.1 Energy technologies

TSB's energy theme focuses on developing affordable and secure sources of energy supply, which also reduce GHG emissions, integrating future demand and energy supply into a flexible, secure and resilient energy system.

The Energy Technologies Institute (ETI) is a public-private partnership between global industries – BP, Caterpillar, EDF, E.ON, Rolls-Royce and Shell – and the UK government. The ETI brings together projects that accelerate the development of affordable, clean, secure technologies needed to help the UK meet its legally binding 2050 targets. Targeted investments are made in projects in offshore wind, marine, distributed energy, buildings, energy storage and distribution, CCS, transport and bioenergy. These projects bridge the gap between laboratory scale research and development and commercial deployment of large-scale engineering projects.

Defra's Sustainable Pathways for Low Carbon Energy Research Programme (SPLiCE) will fill gaps in knowledge about the sustainability of different mixes of low carbon energy (e.g. wind, wave, tidal, solar, geothermal, nuclear, bioenergy with CCS) and their effects on both the environment, and also societal impacts in the UK. SPLiCE will also have a strong focus on bringing together information produced by SPLiCE with existing research and presenting it in an accessible format where it is easy to delve into the interactions between different impacts. This will aid understanding of the issues by policy makers and those making decisions about infrastructure so they can deploy low carbon power systems in a sustainable way. It should help deployment of low carbon energy by reducing the need for future policy change due to unforeseen impacts, improve investor certainty and speed up planning decisions where lack of evidence has caused delays.

[237] [Add link]

7.8.8.2 Built environment and infrastructure

The Low Impact Buildings Innovation Platform aims to help the UK construction industry deliver buildings with a much lower environmental impact. The UK construction market is worth over £100 billion per year, and there is growing pressure from customers and regulators for more environmentally friendly buildings, creating new growth opportunities for innovative businesses. Defra has launched the Design for Future Climate: Climate Resilient Infrastructure competition to fund the development of innovative solutions to increase the resilience of UK infrastructure to a future changing climate.

7.8.8.3 Transport

The Low Carbon Vehicles Innovation Platform invests jointly with industry, the Department of Transport and other funders in interventions that promote UK-based R&D in low carbon vehicle technologies, and strengthen the relevant supply chains within the UK. DfT funds the Low Carbon Fuels (LCF) programme, supporting the government policy of promoting the use of more fuel-efficient, cleaner and quieter vehicles, and the introduction of cleaner fuels. The programme focuses on technological and fiscal means of reducing the impact of transport on the environment – including climate change emissions. One of the sub-programmes, the Foresight Vehicle Programme, was established to develop and promote technology for vehicles that will be available to the mass market by 2020.

7.8.8.4 Geoengineering

There is currently insufficient information to inform the emerging debate about geoengineering. To address the gaps in the knowledge about the effectiveness and side effects of geoengineering schemes, the Integrated Assessment of Geoengineering Proposals (IAGP) project has been funded by EPSRC and NERC. Integral to the assessment process is active and ongoing engagement with stakeholders, including science policy experts and the general public, to produce objective and informed policy-relevant science. The Stratospheric Particle Injection for Climate Engineering (SPICE) project is investigating the technical feasibility of geoengineering through stratospheric aerosol injection. Funded by EPSRC, NERC and STFC, it is considering the choice of aerosols species and their radiative properties, the unintended climatic consequences of geoengineering through climate modelling and the possible mechanisms of delivery of particles into the stratosphere. IAGP and SPICE surveyed public opinion with regard to this form of geoengineering.

The Living With Environmental Change Climate Mitigation Task Force is considering where there might be a need for research activity in geoengineering. A joint NERC and Met Office Hadley Centre report *The LWEC Geoengineering Report – A forward look for UK research on climate impacts of geoengineering*[238] has been published. The report provides an overview of climate-related geoengineering research activities in the UK and identifies ten research gaps that could be addressed by further research.

7.9 International cooperation

Innovation and research are now increasingly international endeavours. Most innovations originate from multiple countries, drawing in components or technologies developed in multiple locations with the high-growth economies playing an increasingly important part. The UK government supports new forms of international partnership and collaboration, with the government taking an active role in promoting UK expertise around the world. Many UK academics are involved in international research programmes in the area of climate change. This section highlights some of the key programmes that UK researchers are involved in.

[238] http://www.lwec.org.uk/challenges/climate-challenge/what-geoengineering

The BIS International Science and Innovation Unit (ISIU) works to promote the UK as the partner of choice for the UK's overseas counterparts. It helps UK researchers, business and government gain greater benefit from international partnerships, programmes and relationships in science, technology and innovation. It is responsible for developing the UK position on European research and innovation policy, including the new EU programme for research and innovation – Horizon 2020. Global challenges, such as climate change, require the ability to engage other governments with science and find more innovative solutions internationally. BIS and the FCO jointly fund the Science and Innovation Network, which is uniquely placed to identify and deliver on opportunities, influence key players in country and bring insight to UK decision makers.

UK scientists are prominent in global change programmes and in the European research area. The Joint Programming Initiative Connecting Climate Knowledge for Europe (JPI Climate), with support from ESRC, facilitates integrated climate knowledge and decision support services for societal innovation towards a climate-friendly and climate-proof Europe.

The International Council for Science (ICSU) Global Environmental Change programmes help to develop international consensus on the way science should develop, independent of funding and policy agencies, and provides an important research coordination function. ICSU is leading the development of Future Earth which will provide a global knowledge and collaboration platform and deliver a step-change in the way science for sustainability is produced and used. This will be achieved through effective cooperation with funders and research users, including decision makers and the private sector, to identify research priorities and deliver knowledge for solutions. CLIVAR (Variability and predictability of the ocean-atmosphere system) is one of four core projects in the World Climate Research Programme. CLIVAR, supported by NERC, focuses on ocean-atmosphere interactions.

The International Geosphere-Biosphere Programme (IGBP) coordinates international research on global-scale and regional-scale interactions between Earth's biological, chemical and physical processes and their interactions with human systems. UK-based academics co-chair the Analysis, Integration and Modelling of the Earth System (AIMES), the International Global Atmospheric Chemistry (IGAC), and the Global Carbon Project (GCP).

The UK and the USA have been integral in establishing the Belmont Forum, a group of high-level representatives from agencies and organisations that fund global environmental change research. The Belmont Forum became the high-level decision making body for the International Group of Funding Agencies (IGFA) in October of 2009. IGFA coordinates and collaborates in global environmental change research.

Through UK Space Agency funding the UK has a strong involvement in ESA programmes. A future mission to monitor the Earth's carbon cycle will help to improve understanding of climate change (ESA's Living Planet programme). The ESA Climate Change Initiative (CCI) will use Earth Observation (EO) to help generate Essential Climate Variables (ECVs) for our planet. The UK Space Agency has contributed £15 million over 6 years to the CCI programme. UK funded satellites include Envisat – the largest earth observation spacecraft ever built, CryoSat2 – ESA's Earth Explorer, SMOS – ESA's Soil Moisture and Ocean Salinity mission and MetOp-A – ESA's weather data satellite. Recent advances include the first global map of both soil moisture and ocean salinity.

A representative from Public Health England is Vice-Chair of the United Nations Office for the Disaster Reduction Science and Technical Advisory Group. The UN manages the Global Platform for Disaster Risk Reduction which is the world's foremost gathering of stakeholders committed to reducing disaster risk and building the resilience of communities and nations. A core function of the Global Platform is to support the implementation of the Hyogo Framework

of Action.[239] A report entitled Using Science for Disaster Risk Reduction[240] was published in 2013. The report includes case studies, which describe specific examples of scientific learning being employed to enhance disaster risk reduction, providing evidence that science is useable for this purpose.

Public Health England has been integral in addressing climate and health challenges at an international level. PHE was involved in developing the IPCC Special Report for Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation (SREX, 2012).[241]

The Atlas of health and climate[242] is a product of a unique collaboration between the meteorological and public health communities (World Health Organization/World Meteorological Organization 2012). It provides scientific information on the connections between weather and climate and major health challenges. These range from diseases of poverty to emergencies arising from extreme weather events and disease outbreaks.

7.9.1 Disaster risk reduction

In 2012, two key reports were published by the Government Office for Science which looked at the role of science in disaster risk reduction (DRR). The first of these reports, the *Use of Science in Humanitarian Emergencies and Disasters* (SHED) report,[243] primarily looked at how government could improve its use of science advice in predicting and preparing for disasters. The second report on *Reducing Risks of Future Disasters: Priorities for Decision Makers*[244] looked 20-30 years ahead to examine the future causes and impacts of disasters.

Following the publication of these reports, the Government Office for Science requested that the UK Collaborative on Development Sciences (UKCDS) undertake an exercise to detail and prioritise research gaps that constitute barriers to DRR delivery with the aim of developing a multi-partner, cross-disciplinary DRR research programme. The UKCDS report[245] outlines a series of thematic areas where research gaps have been identified.

7.9.2 Climate change and development

Climate variability and change have huge impacts on food security, water availability, human health and social and economic infrastructures, particularly in Africa where vulnerability to hazardous weather and the natural vagaries of the climate is already high. While it is possible to identify interventions that will increase the resilience of poor people's livelihoods to an uncertain climate future, the range and cost of adaptation options could be significantly lowered by developing better and more tailored climate forecasts.

It is impossible to tackle problems of this complexity without modelling likely scenarios, impacts and vulnerabilities. Gaps in climate data and deficiencies in climate and climate impact models have held up the assessment of likely climate impacts at country and sub-regional levels, especially in Africa. DFID is supporting research programmes that increase capacity in this area and advance knowledge of the science of climate change.

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239 http://www.unisdr.org/we/coordinate/hfa

240 http://www.unisdr.org/we/inform/publications/32609

241 http://ipcc-wg2.gov/SREX/report/full-report/

242 www.who.int/globalchange/publications/atlas/report/en/index.html

243 www.bis.gov.uk/assets/goscience/docs/u/12-848-use-of-science-inhumanitarian-emergencies-disasters

244 www.bis.gov.uk/foresight/our-work/policy-futures/disasters/reports-documents

245 http://www.ukcds.org.uk/sites/default/files/content/resources/Disasters%20004%20UKCDS_DRG_WP2%200_060613.pdf

Improved knowledge and evidence on adaptation to climate change on the 10-40 year timescale will be addressed by a new phase of the DFID/Met Office Climate Science Research Partnership (CSRP). The partnership will provide information that will underpin other DFID research initiatives such as Climate Change Adaptation in Africa (CCAA), the Agricultural Model Inter-comparison Project (AgMIP), the Ecosystem Services for Poverty Alleviation project (ESPA), as well as DFID's development assistance to the African Climate Policy Centre (ACPC).

Identifying pathways for adaptation and building resilience are key features of the development landscape. Developing countries will need to adapt to worsening droughts, crop failures, water shortages, rising sea levels, extreme weather events, the extinction of habitats, and other negative effects of climate change. DFID research is helping countries find different ways of adapting to climate change. The Economics of Adaptation to Climate Change (EACC) project – led by The World Bank – explored future economic costs associated with adapting to climate change and levels of funding needed for an effective response. The Collaborative Adaptation Research Initiative in Africa and Asia (CARIAA) aims to build the resilience of vulnerable populations and their livelihoods in three hot spots by supporting collaborative research to inform adaptation policy and practice.

Knowledge sharing and communicating climate change to policy makers is vital for focusing international efforts to combat climate change. Decision makers are supported in the Climate and Development Knowledge Network (CDKN) through designing and delivering climate compatible development. CDKN priorities range from risk analysis and strengthening resilience to supporting climate negotiators from least developed countries. The network is managed by an alliance of organisations led by PricewaterhouseCoopers LLP (PwC).

Protecting the world's forests and the livelihoods of the 1.2 billion people who depend on them is essential for combating climate change. DFID supports the CGIAR's Forests, Trees and Agroforestry Research Programme, which aims to enhance the management and use of forests, agroforestry and tree genetic resources across the landscape, with a view to building climate resilient agriculture and tree farming.

Promoting the development of low carbon technologies and encouraging the use of clean energy will help developing countries achieve a greener future that supports economic growth. A DFID report 'Moving Climate Innovation into the 21st Century' (2011) highlights the need for cheaper technologies that serve the needs of the poor, opportunities for technology development in and by developing countries, and the need to empower developing countries as partners in innovation.

Unlocking the potential of bioenergy will improve access to energy and livelihoods in poor communities The Policy Innovation Systems for Clean Energy Security (PISCES) initiative aims to provide policy makers with new information and approaches in bioenergy. The programme is working in partnership with Kenya, India, Sri Lanka and Tanzania.

The UK is an active participant in the Global Research Alliance (GRA) on agricultural GHGs. The UK is taking a leading role in a number of networks covering issues such as agricultural emissions modelling and the linkages between GHG emissions and improved animal health and welfare. On a European level the UK is also working to align research in this area with activities in the Joint Programming Initiative on Food Security and Climate Change (JPI FACCE). The UK has also provided support for a number of GRA capacity building workshops, most recently in Nairobi, Kenya.

There are two programmes which are partnerships between DFID, NERC and ESRC that are looking at environmental systems, their importance to poverty alleviation and the potential impact on them of future changes, including climate change. ESPA (Ecosystem Services for Poverty Alleviation), a £41 million programme (2007 – 2016), aims to provide new knowledge demonstrating how ecosystem services can reduce poverty and enhance well-being for the world's poor. UPGro (Unlocking the Potential for Groundwater in Africa) is a £12 million programme (2012 – 2019) to study groundwater processes and use in sub-Saharan Africa, which aims to improve water security for the poor in this region.

7.10 Introduction to systematic observations

The UK government is dedicated to the funding of observations and measurements needed to address climate-related issues. However climate research and procurement of climate-related observations are highly devolved activities in the UK. Systematic observations in the UK and its overseas territories are made by many national agencies and organisations. Efforts to maintain an overview of these activities are made through the LWEC Partnership which has a programme called the Environmental Observations Forum (EOF), founded in 2008 specifically to support better communication and sharing of information across the observations community. This was a significant development since the preparation of the 5th National Communication. The preparation, by the EOF, of the reports: *Coordinating Climate Science and Risk Assessment Observations* and *Consultation Responses to the GCOS Implementation Plan* was intended to assist in the task of gaining a national overview of activities and they provided much of the information in Annex 3.

Another important coordination mechanism is the Marine Science Coordination Committee (MSCC) which was formed in 2008 to develop and implement a Marine Science Strategy for the UK, and to improve UK marine science co-ordination.

The UK participates in many international programmes; some of the more important ones are listed in Annex 3.

Considerable effort is devoted to quality control, especially in those areas where the UK has particular expertise, for example, the comparison of radiosonde systems and the measurement of sea surface temperatures.

In a time of constrained budgets it can sometimes be difficult to secure sustained funding for long-term observation activities, to mitigate against this risk, the Government Chief Scientific Advisor's Environmental Observations Committee was set up in 2013. Its aim is to ensure that appropriate funding mechanisms are in place for priority programmes and that a coherent and robust environmental monitoring infrastructure exists to meet national needs.

A brief overview of the UK observations outlined in Annex 3 is given in the following sections.

7.10.1 Atmospheric observations

The UK's contribution to the GCOS Surface Network (GSN) comes from the national network (for the UK itself) of 29 stations within the UK's Regional Basic Climate Network (RBCN) and the 34 stations within the UK's Reference Climate Network. The 6 UK GSN stations run by the Met Office are Lerwick, Stornoway, Eskdalemuir, Valley, Waddington, Camborne and additionally two overseas stations: St Helena and Ascension Island.

The British Antarctic Survey (BAS) runs 4 overseas GCOS Surface Network stations: Halley, Rothera and Fossil Bluff and Grytviken, South Georgia. All four of the UK BAS GSN stations operate to GCOS standards and historic data have been supplied to the International Data Centre (IDC)s, for their operational periods where the data have been digitised.

There are three additional stations for which the UK is not directly responsible; these are Gough Island, Bermuda and Pitcairn. Gough Island is run by the South African Weather Service (SAWS); Bermuda is run by Serco for the Bermudan government; and Pitcairn is serviced by NZWS.

The UK land surface observing network currently comprises 239 ordinary climate stations and 161 synoptic stations. There are an additional 2633 rainfall-only stations. These stations are all compliant with GCOS standards, but are more subject to site changes or closures than those in the GSN, Regional Basic Climate Network and the UK's Reference Climate Network.

The Met Office contributes to the EUMETNET Surface Marine programme (ESURFMAR) (managed by Meteo-France), which deploys around 120 drifters per year in the North Atlantic, Nordic Seas and Mediterranean. The Met Office also procures and deploys around 10 drifters each year in the South Atlantic/Southern Ocean in support of the global drifter array; in 2013 a further 30 drifters were deployed by the Scottish Association for Marine Science (SAMS) as part of a research project.

The Met Office currently manages around 270 Voluntary Observing Ships (VOS) making manual observations of which around 185 meet climate (VOSClim) standards. It also operates the real time monitoring centre for VOSClim data. Over the last 3 years the Met Office has developed an Autonomous Marine Observing System (AMOS), which has now been installed on 42 ships, mainly operating around the British Isles. All VOS data are exchanged on the Global Telecommunication System (GTS) and available to the International Comprehensive Ocean-Atmosphere Data Set (ICOADS).[246] This includes the contribution from 2 ships operated by BAS.

The Met Office presently operates 11 moored buoys, mainly to the west of the UK and in Biscay, which contribute to the wider WWW/GOS surface network. These networks deliver data on many ECVs and there are time-series in excess of 20 years

The UK contributes to the Baseline Surface Radiation Network (BSRN) with two stations, at Lerwick and Camborne.

The Met Office Radiosonde Network is part of the full WWW/GOS Upper Air Network and GCOS Upper Air Network (GUAN) and provides measurements of air temperature, water vapour and wind speed and direction. There are 2 sites in the UK, at Lerwick and Camborne. There are 2 GUAN stations overseas: St Helena and Mt. Pleasant, and 2 GUAN stations in UK overseas territories: Gough Island (run by SAWS) and Bermuda. There is one BAS GUAN station at Halley, and its Rothera upper air programme is GCOS compliant in all respects except that it has flights on only 4 out of 7 days a week. It is not a GUAN station but still submits its data via GTS.

The shipborne radiosonde network is part of the full WWW/GOS Upper Air Network and also monitors upper air wind speed and direction, air temperature and water vapour. The UK Met Office no longer operates any upper air ASAP ships itself. These have now been integrated managerially and financially into the EUMETNET EASAP programme. The Met Office is a member nation of E-ASAP, to which it contributes financially based upon GNI.

The Global Positioning System (GPS) Water Vapour Programme provides vertical integrated water vapour data as part of the Ground-based GPS receiver network. Data from roughly 250 stations are processed by the UK (though this varies). Most sites are run by external bodies, so data and most site choice is third party. Most sites are chosen to be of a roughly equal spatial distribution, and some are chosen to be specifically near to radiosonde stations.

The Met Office operates six wind profilers (one is in conjunction with NERC) providing observations of the vertical and horizontal velocity upper air wind speed and direction (doppler winds) and is part of the EUCOS wind profiler network (E-PROFILE).

[246] http://icoads.noaa.gov/

The Met Office manages 1000+ AMDAR (Aircraft Meteorological Data Relay) equipped aircraft within E-AMDAR Programme. Commercial aircraft obtain upper air temperature and wind speed and direction measurements.

The Chilbolton Facility for Atmospheric and Radio Research (CFARR) in southern England is funded by NERC and operated by the Rutherford Appleton Laboratory. The activity collects water vapour density measurements. Co-located surface meteorological measurements including solar irradiance (relevant to the surface radiation budget) are taken. Continuous monitoring of cloud profiles has allowed evaluation of model biases/errors to be identified. Monitoring began in 1998 and is important for understanding the mechanisms by which aerosol in the atmosphere leads to the formation of different cloud types, which is important for predicting climate change. This approach, pioneered at Chilbolton, is being implemented at other observatories around the world, notably US ARM sites.

The Mesosphere-Stratosphere-Troposphere Radar Facility at Aberystwyth is operated by the Rutherford Appleton Laboratory. The facility measures cloud properties (cloud base height), upper air wind speed and direction and water vapour (at various heights). Co-located surface meteorological measurements of solar irradiance are taken.

The British Antarctic Survey routinely measures mesospheric temperatures at Rothera and Halley stations.

The UK funds or operates many stations contributing to the Global Atmospheric Watch; further details are given in Annex 3.

7.10.2 Oceanic observations

The Met Office routinely produces many ocean products which contribute to larger international observational programmes. Observations from Voluntary Observing Ships (VOS) provide measurements of sea surface temperature, sea ice and sea state (the latter two measurements being from manually observing VOS). Sub-surface observations are not made from any UK VOS.

The Drifting Buoys Programme provides sea surface temperature measurements to the Global Drifter Array. Sea surface currents are derived from buoy positions.

BAS ships observe sea-ice extent in an opportunistic manner through the VOS programme; it is observed as part of the 6-hourly meteorological synoptic observations disseminated via the WMO GTS/WWW system as part of BAS Antarctic operations.

The Met Office acts as one of two Global Collecting Centres (GCC) (alongside the German Met Service DWD) for VOS data, with responsibility for basic quality control of ship data, and collection of those data not available in real-time (e.g. ship's logbooks). As part of its role as a real-time monitoring centre for marine data the Met Office routinely monitors VOS data.

The Global Sea Level Observing System (GLOSS) Tide Gauges run by NOC, Liverpool, provides sea level and supporting measures of air pressure to the GLOSS Core Sea-Level Network. The UK contributes 3 from the UK itself (Lerwick, Newlyn and Stornoway) plus Gibraltar and 8 sites in the South Atlantic (which are in different states of working or needing maintenance visits). Assistance is also provided for some stations situated in Africa.

The three UK stations are part of the UK Tide Gauge Network.

The National Tidal and Sea Level Facility (NTSLF) is the UK centre of excellence for sea level measurement, computer modelling of tides and storm surges, and the statistical estimation of extreme sea levels. The core of NTSLF is based at the NOC in Liverpool and includes partners in top research universities, coastal engineering consultancies and the Met Office. The NTSLF

manages precision tide gauges at 44 sites around the UK. NTSLF is also responsible for monitoring sea level in the British Overseas Territories, and at strategic sites in the south Atlantic as part of its contribution to international climate research.

The Porcupine Abyssal Plain (PAP) Observatory is a sustained, multidisciplinary observatory in the North Atlantic coordinated by the National Oceanography Centre, Southampton. It is part of the international OceanSITES network and a GCOS reference mooring site. There are time-series in excess of 20 years and the observing meets the GCOS Climate Monitoring Principles (GCMPs).

The UK Argo Programme that contributes to the international Argo Array Network takes measurements of temperature and salinity in the water column. The UK presently has around 130 active floats contributing to the Argo float array. The UK Argo programme is managed by the Met Office and operated in partnership with NOC Southampton, BODC and UKHO.

All UK Argo float data are submitted in real-time to the WMO GTS and to the Argo Global Data Assembly Centres (GDACs). All UK Argo float data are subjected to delayed-mode QC by BODC and submitted to the GDACs. At present about 40% of eligible data (for floats that have expired or been operating for longer than 18 months) have been submitted.

Details of other programmes and surveys making measurements of water column Essential Climate Variables (ECVs) are given in Annex 3.

Details of oceanic observations made by satellite are given in Annex 3. One of the most notable of the UK's contributions has been DECC's (since 2008; previously Defra) support of the Advanced Along Track Scanning Radiometer (AATSR) satellite instrument, which monitored sea surface temperatures to within an accuracy of 0.3K, until the demise of ENVISAT in 2012. Ship-borne radiometer measurements are continuing to try to bridge the gap until the launch of the successor instrument.

7.10.3 Terrestrial observations

The UK reports river discharge measurements from seven UK gauging stations to the Global Terrestrial Network for River Discharge (GTN-R), which forms part of the GTN-H. All seven sites operate in accordance with GCMPs. The majority of sites have a complete historical record with the Global Runoff Data Centre (GRDC). Data will continue to be provided to the GTN-R for all seven sites as part of the larger UK contribution of over 200 sites to the GRDC.

The National Groundwater Level Archive (NGLA) is maintained by the British Geological Survey (BGS), part of the Natural Environment Research Council (NERC) and operated in close collaboration with the National River Flow Archive. The NGLA brings together water level data from across the UK for a set of boreholes chosen to provide a representative national network, with boreholes in all major aquifers, which can be used to assess seasonal resource variations and long term trends.

Water quality monitoring is carried out in the UK by various organisations in response to water management and regulatory requirements including the Water Framework Directive (WFD). The WFD Surveillance monitoring network is a fixed monitoring network designed to measure long term environmental changes in rivers, lakes, estuaries and coastal waters, with data collection of relevance to a range of terrestrial ECVs.

Of the stations in the Met Office land surface network, 68 synoptic sites have automatic snow depth sensors. Some ordinary climate stations also periodically report snow depth.

The British Antarctic Survey (BAS) monitors and maintains networks of GPS stations measuring the movement of key icestreams and glaciers.

Chapter 8:
Education, training and public awareness

8.1 Key developments

- Green Fund provides support to students on a range of different types of sustainability projects and approaches designed by the students' unions themselves to resolve key local issues.
- The Met Office recognised both the need and appetite for increased and informative communication on climate change and developed a range of information, videos, blogs, and engagement on innovative websites such as http://www.myclimateandme.com/ and http://www.metoffice.gov.uk/climate-guide.
- The Award winning 2050 calculator is a simple, user-friendly model of the UK's energy system, launched in 2010. It allows a wide variety of people to explore the full range of options for reducing (GHG) emissions to the year 2050 and is based on rigorous scientific evidence.

8.2 Introduction

Education, training, public awareness raising and communications on climate change are an essential component of action on climate change. While government has its part to play, the government considers that climate change messages are best delivered by experts.[247] As education, training and information raising is broadly a devolved area of competence, this chapter covers the actions that are supported by the UK government, devolved administrations and local government.

The climate is a complex system and raising public awareness of the basic science, its uncertainties and the risks of climate change are vital in order to engage the public in a debate about the actions needed to combat climate change and reduce the future risks. It is often difficult for people to understand that scientific debate is normal and does not mean that the scientists are uncertain about the big picture or the basic physics. Therefore, we consider it is vital that climate scientists communicate their science effectively to the public.

[247] James Painter *Climate Change in the Media: Reporting Risk and Uncertainty* https://reutersinstitute.politics.ox.ac.uk/publications/risj-challenges/

8.3 Education and training

8.3.1 England

8.3.1.1 The New National Curriculum and Sustainability

The programmes of study for geography and science cover sustainability and climate change in depth at key stage 3 and above. In order for children to develop a firm understanding of climate change, it is essential that it is taught as a carefully sequenced progression, starting with the fundamental concepts and relevant background knowledge that underpin this topic.

In science, primary school pupils will be taught the scientific concepts that underpin weather, climate and biodiversity. For instance, in key stage 1 pupils (ages 5-7) will be taught to observe changes across the four seasons, including the weather associated with the seasons and how the length of the day varies. In key stage 2 pupils (ages 7-11) will be taught about the part played by evaporation and condensation in the water cycle and to associate the rate of evaporation with elements such as temperature. They will learn that environments can change, and that this can pose dangers to living things.

All of these topics provide a firm foundation for the study of climate science in key stage 3 (ages 11-14) where pupils will be taught about the composition of the atmosphere, and the carbon cycle. Ecosystems and biodiversity will be covered again in more depth. Crucially, pupils will also be taught specifically about the production of CO_2 by human activity and the effect that this has on the climate. This coverage is more extensive and more precise than the previous national curriculum for science.

In geography, pupils will be given more information about the different types of weather and climate in particular parts of the world and about the processes that give rise to them. In key stage 1, pupils will be taught about seasonal and daily weather patterns in the UK, and the location of hot and cold areas of the world. In physical geography at key stage 2, pupils will learn about climate zones, biomes, vegetation belts and the water cycle.

The government reviewed the national curriculum and consulted extensively with the education sector and the wider community, which established powerful arguments that care should be taken not to limit the flexibility of schools to design their curricula locally in order to meet the needs of their pupils.

In response to consultation feedback and discussion with experts, the government has made changes to the geography curriculum to make sustainability and climate change more explicit and to strengthen teaching in this area. At key stage 3 of the geography curriculum, there is now explicit mention of 'change in the climate from the Ice Age to the present' and 'how human and physical processes interact to influence and change landscapes, environments and the climate'. This ensures that pupils will be taught about the temporal and spatial aspects of climate as part of their compulsory education.

8.3.1.2 Student green fund

Government vision for universities is for them to be widely recognised as leaders in society's efforts to achieve sustainability – through the skills and attitudes that students learn and put into practice, through research and knowledge exchange and through universities' own strategies and operations.

Spotlight: The Students' Green Fund (HEFCE)

The Students' Green Fund is a £5 million fund invested by the Higher Education Funding Council for England (HEFCE) and managed by the National Union of Students (NUS). In 2013-4 the fund is supporting 25 ambitious, transformative sustainability projects at students' unions across the country, focussed on legacy, impact, partnership and student engagement.

The projects comprise a range of different types of sustainability projects and approaches designed by the students' unions themselves to resolve key local issues – from training students to reduce energy bills and carbon by undertaking environmental audits of student houses in the community (Worcester), to innovative transformation projects, such as the first UK pilot of the coveted Maastricht Green Office model (Exeter), and to developing an institution-wide team of Green Course Ambassadors supporting the embedding of Education for Sustainable Development (ESD) into the curriculum (Liverpool). Other projects include the creation of growing spaces on campus, providing sustainable transport for the physically disabled, and establishing up-cycling cafes.

The fund has allowed students' unions to take a lead on local sustainability projects. There are fantastic levels of local community engagement, with a total of 82 supporting partners and £1.4 million of match and in-kind funding secured. The fund will see students' unions becoming hubs of sustainability at the heart of local communities.

Collectively the projects will engage 352,000 students in sustainability over the next two years, equivalent to about 15% of students in English Higher Education (HE). Together the projects will save at least 4,000 tCO_2/year, contributing to the sector's carbon targets.

8.3.2 Wales

The Welsh Baccalaureate Qualification (WBQ) is delivered to around 78,000 learners across Wales at three levels – Foundation, Intermediate and Advanced. Within the compulsory Core, there are opportunities to study the effects of climate change on the environment in both the Wales, Europe and the World element and also within Personal and Social Education (PSE).

Further to this, all learners undertake an Individual Investigation (in the form of an extended essay). Some learners have chosen to look at the effects of climate change and what policies are being adopted in Wales and comparing this with another country.

8.3.2.1 Live greener Wales

Starting in September 2013, Live Greener is a 12-month project which aims to put Welsh students at the heart of the sustainability agenda. NUS Wales, in partnership with TYF, was awarded a £68,000 contract substantially funded by the Welsh government and managed through the Higher Education Funding Council Wales (HEFCW). Some 6,000 students will be actively engaged, giving around 9,000 hours of their time to obtain real impacts, such as significant reductions in electricity and water usage in halls of residence, and in carbon emissions.

The project has the following targets: a 6% average electricity reduction in halls of residences, totalling 200 tCO_2e collectively; a 4% average increase in recycling rate in halls of residences, totalling c20 tonnes waste diverted from landfill; and a 4% decrease in water usage in halls of residence, totalling c10,000m^3 of water saved collectively.

The project will be delivered via the greening initiatives Green Impact; Student Switch Off; Blackout and Snap It Off. These will not only make measurable differences to participating institutions, students and the environment, but also save students' unions money, make students more employable and engage more students with their unions. The initiatives are:

Green Impact – An environmental accreditation and awards scheme, bringing staff and students together with their wider communities to enable and showcase positive changes in environmental practice;

Student Switch Off – A campaign encouraging student action on climate change that takes the form of an energy-saving competition between and within halls of residence;

Blackout – A student volunteering project where NUS provide students with training to conduct an energy audit of their campus and where students are encouraged to turn off non-essential equipment left on overnight and on weekends; and,

Snap It Off – Provides an opportunity for students to report lights that are left on unnecessarily and thus feel part of the solution to energy wastage.

The institutions involved in Live Greener are: Aberystwyth University; Bangor University; Cardiff University; Cardiff Met University; Swansea University and Trinity Saint David/Swansea Met University. The learning from the Live Greener project will be captured in order that other universities and colleges in Wales can replicate the project in their own institutions.

8.3.3 Scotland

'Learning for Change' – a web based action plan sets out the actions being taken forward in Scotland in the second half of the UN Decade of Education for Sustainable Development across schools, universities and colleges, and community learning and development.

8.3.3.1 Curriculum for excellence

Curriculum for Excellence (CfE) is the national approach to learning and teaching for young people aged 3–18 in Scotland, implemented from August 2010. The curriculum in Scotland is not statutory, and responsibility for what is taught rests with local authorities and schools, taking into account national guidelines and advice.

CfE enables young people to develop four capacities – successful learners, confident individuals, effective contributors and responsible citizens. It provides learners with a range of personalised learning experiences and qualifications that meet their individual needs and aspirations. It also frees teachers from prescription, providing a framework for learning through a set of experiences and outcomes in eight curricular areas.

CfE enables young people in Scotland to learn about sustainability, including climate change, in a holistic way across the whole curriculum. Learning related to a number of important cross-cutting themes, including sustainable development and global citizenship, is built into the experiences and outcomes across all eight curriculum areas in CfE.

Education Scotland promote climate change as a context for learning across the curriculum but in particular within sciences, technologies and social studies. Climate change is specifically referenced in the experiences and outcomes for the fourth level of the broad general education (which applies from age 3 up to 14/15) within the sciences and social studies. It will, therefore, typically, be introduced into a school's curriculum as an explicit topic from first year in secondary school or the last years of primary education, building on learning that has been acquired from the early years onwards. Education Scotland has a Community Resilience Development Officer who is responsible for helping schools become engaged in flood awareness and climate change activities. Education Scotland has also developed a number of online resources,

including a Weather and Climate Change website and Exploring Climate Change and Schools Global Footprint website. Links to websites are:

http://www.educationscotland.gov.uk/weatherandclimatechange/index.asp
http://www.educationscotland.gov.uk/exploringclimatechange/
http://www.educationscotland.gov.uk/schoolsglobalfootprint/index.asp

Learning for sustainability has been embedded within the suite of Professional Standards for teachers in Scotland to support teachers to actively embrace and promote principles and practices of sustainability in all aspects of their work. It has also been incorporated into the General Teaching Council of Scotland's accreditation of initial teacher education in Scotland.

The new National Qualifications Geography Courses, National 3 to Higher, include an option to study Global Issues. These are:

- Climate Change;
- Impact of Human Activity on the Natural Environment;
- Environmental Hazards;
- Trade and Globalisation;
- Tourism; and
- Health.

Similarly, the new Environmental Science Courses are explored through the following areas of study:

- Living Environment;
- Earth's Resources;
- Sustainability processes (which may contribute to climate change);
- The possible impact of atmospheric change on the survival of living things; and
- The causes and possible consequences.

8.3.3.2 Learning for Sustainability Scotland (LfS Scotland)

Scotland's United Nations University Regional Centre of Expertise (RCE) on Education for Sustainable Development (ESD) is a network of organisations and individuals working to harness the full potential of learning to create a sustainable world: where communities value the natural environment; societies are inclusive and equitable; and a vibrant economy contributes to flourishing ecosystems.

LfS Scotland was established in 2013, is hosted by the University of Edinburgh and is part of a growing global network of more than 115 RCE's. This international network allows regions to share and learn from each other, and establish or strengthen international partnerships. It was a major achievement by the ESD sector in Scotland that the Edinburgh University-led bid for an RCE was successful and the Scottish government see it as a fitting legacy for the UN Decade in Scotland when the Decade comes to an end in December 2014.

8.3.3.3 Community learning – Junior Climate Challenge Fund

Scotland's flagship Climate Challenge Fund provides support for communities throughout Scotland to reduce their carbon impact and move to low carbon living. Since it was established in 2008 the fund has awarded in over £52 million to 612 individual projects across 444 communities. As part of the 2011-2016 phase, a strand dedicated to young people, the Junior Climate Challenge Fund (JCCF), has been introduced. The JCCF gives young Scots funds and support needed to run projects to take action on climate change. To support the JCCF a youth panel, supported by Young Scot and Youthlink Scotland makes funding recommendations to Ministers, as well as helping to ensure the activity of the fund is appropriate for young people.

8.3.3.4 CIFAL Scotland

The United Nations Institute for Training and Research affiliated training centre for Northern Europe. CIFAL is a hub for capacity building, leadership and knowledge sharing between local and regional authorities, international organisations, the private sector and civil society.

8.3.4 Northern Ireland

8.3.4.1 Skills development

The Department for Employment and Learning recognises the importance of the renewable energy sector and engages strongly with employers and organisations such as Energy & Utility (gas, power and water), Summit Skills (building services engineering) and Sector Skills Councils (SSC) to encourage and facilitate skills in the renewable energy sector. SSCs are independent, employer-led organisations working to create the conditions for increased employer investment in skills to drive enterprise and create jobs. They are ideally placed to articulate the voice of employers on skills and develop innovative skills solutions. They are a key strategic partner of the Department in creating the conditions for increased investment in skills. The Department for Employment and Learning has funded and/or been involved in numerous projects/activities to help develop the skills of the workforce in this sector.

8.3.4.2 Further education (FE) provision

FE colleges are responsible for ensuring that their provision meets the needs of the local economy, including in the renewable energy sector. Colleges provide a range of courses specific to the needs of the sustainable energy sector – for example, foundation degrees specialising in wind technology and renewable energies. Colleges also offer a variety of more generic vocational courses at different levels that are relevant to the renewable energy sector.

Colleges provide dedicated industry support across a number of key sectors, one of which is Renewable Energy & Sustainable Technologies.

8.3.4.3 Environmental skills centre

All colleges have been increasing their provision in the renewable energy area. One particular example is the Environmental Skills Centre at the South Eastern Regional College's (SERC) Newtownards Campus which is a hub for sustainable development and renewable technology. This includes standalone curriculum and services as well as embedding new developments into existing areas such as motor vehicle, plumbing and engineering.

SERC also provides specialist training and support in: Heat Pump Installation; Biomass and Solar Technologies; Energy Assessment; The Code for Sustainable Homes; Wave and Tidal Energy; Deep Geothermal Power; Energy Storage; and Passive and Zero Carbon Homes. It is the only provider of the Building Research Establishment Energy Assessors (BREEAM) training in Northern Ireland.

8.4 Public awareness

8.4.1 Insight

DECC set up a tracking survey in early 2012 to understand and monitor public attitudes to the Department's main business priorities. The survey runs four times a year and consists of one longer, annual survey and three shorter, quarterly surveys which focus on a subset of questions where government perceives attitudes might shift quickly or be affected by seasonal changes.

Additional information was collected between 27– 31 March 2013 using face-to-face in-home interviews with a representative sample of 2,051 households in the UK. When respondents were asked directly, 66% were concerned about climate change (similar to 65% in wave one), with 12% attributing it to natural causes, down from 15% in wave one.

8.4.2 Met Office

As a world-leading weather and climate service, the Met Office works closely with governments, individuals and organisations to share its expert scientific knowledge and advice.

Climate change science is a complex area of research which often looks at issues in terms of risk and probability. Effectively capturing the subtlety of the science can be challenging, so the Met Office has established a range of channels and approaches to conveying everything from the basics of climate science to its very latest world-class research.

These include:

- the main Met Office website has a set of pages dedicated to helping the wider public find out more about the climate system and climate change http://www.metoffice.gov.uk/climate-guide;
- climate issues are also covered through news releases and more technical summaries are provided through a 'Research News' channel on the main website;
- the Met Office has a developed a multi-award winning social media platform for delivering targeted and engaging information, with more than 470,000 followers across Twitter, Facebook, Google+ and other channels (http://www.youtube.com/themetoffice, https://twitter.com/metofficenews);
- the Met Office's YouTube channel hosts a range of videos which have had more than 1.5 million views (http://www.youtube.com/user/TheMetOffice);
- a wordpress blog features more than 600 posts across a wide range of weather and climate issues which have had nearly 1.8 million views in total (http://metofficenews.wordpress.com/);
- a press office provides proactive and reactive responses to media requests across a range of campaigns and topical issues, dealing with around 10,000 calls a year on average as well as organising press conferences and briefings (often through the Science Media Centre) (http://www.metoffice.gov.uk/news; http://www.metoffice.gov.uk/research/news);
- the Met Office provides science expertise to EDF Energy's 'The Pod' project, which has delivered climate science to 9.5 million pupils across 17,000 schools (http://jointhepod.org/home);
- the new web and social media channel http://www.myclimateandme.com/ is being piloted by the Met Office to provide young people direct access to Met Office climate scientists, who can answer their specific questions; and

- direct public participation in climate and weather science through the WOW site http://wow.metoffice.gov.uk/ and citizen-science research projects such as Old Weather (http://www.oldweather.org/).

8.4.3 2050 Calculator

The 2050 Pathways Calculator is a simple, user-friendly model of the UK's energy system, launched in 2010. It allows a wide variety of people to explore the full range of options for reducing GHG emissions to the year 2050 and is based on rigorous scientific evidence.

People can use this open-source tool to see the impact of building nuclear power stations or wind farms, of reducing energy demand by insulating homes or driving less, and can build their own vision of the future. For each possible pathway the user can further investigate a range of impacts including on land-use, electricity, energy security, energy flows and costs. Supporting material about the assumptions involved with different levels of future abatement ambition is also provided.

Originally designed for policy makers to stimulate debate and simulate scenarios, the Calculator is now available in three different formats, with three different levels of detail, so it can be used by energy experts, members of the public and even children:

- My2050: This is a visual internet simulation that helps the public to imagine how the energy system may evolve and the secondary impact this may have. Users can make decisions about levels of effort in 14 simplified sectors, to make decisions about their own version of how their country will meet the energy and emissions challenge by 2050;
- The 2050 Webtool: Designed for use by expert users such as policy makers, industry experts and academics. Users are able to get instant results showing information on energy output, demand and emissions out to 2050. It enables quick comparison of the consequences and trade-offs of different scenarios; and
- The 2050 Excel Spreadsheet: Users can see all the underlying data of the 2050 Calculator, and very expert, technical users can explore and adapt the full range of assumptions and follow through all the calculations themselves. This spreadsheet generates the results of My2050 and the webtool.

As well as the 2050 Calculator's use within government (for example, using it to set strategic direction or to engage parliamentary staff, select committees and other government departments), the tool is also used by energy experts in a range of sectors. Several universities use it as part of their syllabus.

The Calculator has also been used as the basis of a public engagement programme, which aims to open up a debate around energy and climate change and is tailored towards different groups. Over 17,000 people have submitted their pathway using My2050. A recent academic study by Cardiff University used My2050 for a report called *Transforming the UK energy system – public values, attitudes and acceptability*, which explored people's views on change within the energy system.

DECC worked in partnership with Science Wise to hold a number of deliberative dialogue workshops in 2011 with young people and community leaders, which resulted in a much deeper understanding of the reasons behind people's decisions. DECC has also developed a My2050 schools toolkit for teachers, which includes lesson plans and activities aimed at key stage 3 and 4 pupils.

In 2013 DECC organised the British Energy Challenge roadshow, a series of nine events in cities around the UK attended by local community, business and political leaders, as well as the interested general public. The focus of these events was an interactive session involving the calculator, in which participants voted on the different options and worked together towards meeting the 2050 emissions reduction target. Nearly 2,000 people took part, with 89% learning something new about the energy challenge, 80% having a clearer understanding of the energy challenge facing Britain and a ten-fold increase in traffic to My2050 site following an event at the Hay Festival.

The calculator is also being used to increase awareness of climate change and energy issues internationally. China, Taiwan, South Korea and Wallonia in Belgium have already launched their own versions of the calculator. DECC is working in partnership with the Foreign and Commonwealth Office and the Department for International Development to help other countries develop their own calculators to match their own needs. More than ten other developing countries' calculators are in progress, supported by funding from the UK's International Climate Fund.

DECC is now leading a team of international experts to develop a Global Calculator. This will not only show what options are possible to reduce emissions on a global scale but will also show the effect these choices have on the world's climate. This scenario tool will be available online for anyone to use, but it is primarily aimed at influential policy makers and business leaders. The main goal of this calculator project is to raise awareness in the run up to the international climate change negotiations in 2015.

8.4.4 UK Climate Change Risk Assessment and National Adaptation Programme

Summaries of the UK Climate Change Risk Assessment 2012 (UK CCRA 2012) were produced to set out a succinct review of the risks and issues identified in 11 key sectors (for example infrastructure, built environment, transport, health) and help engage and raise awareness within the sector audiences. They also supported policy makers in outreach to partners (from across government, business, civil society, local government and academia) to enlist their engagement on the development of the UK's first National Adaptation Programme published in July 2013.[248]

In addition, to coincide with the publication of the UK CCRA 2012, the nine Climate Change Partnerships in England were commissioned to produce an information pack to highlight key risks and opportunities from climate change at the sub-national level (some links to packs are below). These packs were used to raise awareness of climate risks with local audiences and links to these are provided below.

http://www.climatenortheast.com/manageContent.aspx?object.id=16463
http://www.climatechangenorthwest.co.uk/news/nwccra.html
http://www.yourclimate.org/pages/uk-climate-change-risk-assessment

Social media has been used as a tool to generate wider awareness of the UK government's work on climate change adaptation. In the run up to the publication of the National Adaptation Programme the Department of Environment, Food and Rural Affairs (Defra) @defraclimateready twitter account was used to communicate key messages about the content of the Programme.

8.4.5 England

8.4.5.1 Climate Ready Support Service England

Defra and the Environment Agency (EA) provide the government's Climate Ready Support Service for England and collaborated on a series of themed co-creation workshops throughout

[248] Links to the summaries: http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=15747#RelatedDocuments

2012, after publication of the UK Climate Change Risk Assessment. This was part of the engagement process with stakeholders, working towards development of the UK's National Adaptation Programme report published in July 2013. Through 18 workshops, up to 650 individuals were engaged across 250 organisations.

In addition, the EA's Climate Ready Support Service produce a monthly e-bulletin/newsletter to around 1,400 organisations across the UK, which provides the latest updates from government, the EA and partners on work to adapt to a changing climate and the tools and guidance that are available to help.

8.4.5.2 Climate Local in England

Climate Local is the primary initiative for local government action on climate change. It succeeds the Nottingham Declaration on Climate Change and offers a framework that can reflect local priorities and opportunities for action. It supports councils' efforts both to reduce carbon emissions and to improve their resilience to the anticipated changes in the climate.

Getting involved in Climate Local will help councils across the country to capture the opportunities and benefits of action on a changing climate, through saving on their energy bills, generating income from renewable energy, attracting new jobs and investment in 'green' industries, reducing flood risks and managing the impacts of extreme weather.

75 councils have signed up to Climate Local and around 40 have submitted local action plans.

Spotlight: Bath and North East Somerset Council

Bath and North East Somerset Council is involved in an ambitious programme of work with schools including a comprehensive energy survey programme on all schools and in-depth Analysis, Migrate and Report (AMR) on each site to identify at what times of day energy is being wasted. In addition, the council has supported, through a partnership with Bath & West Community Energy (local renewable energy social enterprise) to install solar PV on a number of school roofs.

With the aim of supporting local schools to become more energy efficient and reduce their carbon emissions, the council has run training for staff and governors as well as curriculum/ pupil focussed work to encourage school families to get involved.

The council also have a successful Bath Green Homes event that is a collaboration between the Council, Bath Preservation Trust (local heritage body) and the Transition Bath group. Each year local residents open their homes to visitors, and a programme of events talks and activities are run in parallel over an extended period. The council provided support, in the form of training, advice and a loan library of resources to local groups under the Local Energy Champions Scheme. This is aimed at groups who want to work in their local area on energy-focused projects. The council also administer an online network to connect, inform and publicise local events for groups and individuals on environmental themes.

8.4.6 Scotland

8.4.6.1 Greener Together Campaign Scotland

The Scottish government's 'Greener Together' Campaign, running since January 2012, promotes 10 key behaviours to help householders reduce emissions. The campaign uses television, outdoor and digital social advertising, supported by a website and helpline. Through encouraging people to 'Go Greener Together' to create a cleaner, greener, healthier Scotland,

the campaign's focus on collective action is designed to have a significant and long-lasting impact on behaviours.

Other climate change public engagement and programmes which receive Scottish government support include:

- The Scottish Communities Climate Action Network (SCCAN) – a network of community groups and organisations that aims to empower and enable communities to create a low carbon future, and promote local resilience and wellbeing.
- Eco-Congregation Scotland – an ecumenical movement which helps congregations link environmental issues to their faith and take action in their church and local community.

8.4.7 Wales

8.4.7.1 Public awareness raising in Wales

The Welsh government has run several climate change campaigns since September 2008, which inform people across Wales about the daily actions that contribute to climate change, encourage people to adopt more sustainable lifestyles and behaviours, and provide information on how to achieve these actions. The campaigns have used a number of media, including press, radio, internet and other social media.

Young Climate Change Champions who were selected in 2008–2010 spoke to their friends, families, fellow young people and the general public about how to take action in tackling climate change and reducing carbon footprints. The teenage Champions also made an important contribution to the work of the Climate Change Commission for Wales by putting forward the views and aspirations of young people.

In 2011 and 2012, a Climate Change Challenge was organised, which involved pitting pubs and leisure centres against each other in a friendly rivalry to reduce energy and water use, and thereby reduce their carbon footprints.

During 2013, the 'Way to Go – Modd i Fyw' PR campaign has used a variety of initiatives including stunts, blogs, Twitter, Facebook, press articles and radio advertisements to highlight the work of six Way to Go Team Members in carrying out monthly challenges to make simple but achievable changes to their lifestyles and become more eco-savvy. The Team Members are all ordinary members of the public and worked on: adopting cycling and walking; washing clothes at 30 degrees; using public transport; saving water; and insulating their homes.

The Welsh government has also provided practical guides to business, public and voluntary sectors in Wales to help make a robust and sustainable case for tackling the causes and consequences of climate change.

In addition, a DVD has been produced to encourage Local Service Boards and other public bodies to adopt carbon reduction strategies.

8.4.7.2 Consumer transport advice

The Welsh government has also funded the Energy Saving Trust (EST) to provide advice on consumer transport. Callers to a general energy efficiency helpline are provided with advice on eco-driving and how to save fuel and reduce emissions. EST also run, awareness sessions in large companies and public bodies across Wales, using a driving simulator to help drivers adopt more fuel-efficient driving behaviours.

Annex 1: UK's first biennial report to the UNFCCC

1. Introduction

The UK is pleased to submit its first Biennial Report.

This provides information on GHG emissions and trends, including information on the UK national GHG inventory.

2. Information on greenhouse gas emissions and trends

2.1 Summary Information

In 2011 total emissions for the UK by UNFCCC coverage - including net emissions or removals from Land Use Land Use Change and Forestry (LULUCF) were 553 $MtCO_2$. This compares with emissions of 770 $MtCO_2$ in 1990, representing a decrease in emissions of around 28%. Common Tabular Format (CTF) Table 1 shows a summary of greenhouse gas emissions for the UK from 1990 to 2011 by gas and by sector. The data are presented under UNFCCC coverage with and without net emissions or removals from LULUCF.

Figure 2.2 shows shows the trend in emissions between 1990 and 2011 for the basket[1] of six greenhouse gases (GHGs) covered by the Kyoto Protocol, along with the emissions reduction target relating to the first commitment period under the Kyoto Protocol. Annual GHG emissions estimates for 2011 were an estimated 29.2% below the fixed base year[2] emissions. This has been driven by a number of factors such as a move away from coal-fired generation towards the use of natural gas and renewable sources, tighter regulation of landfills, increased utilisation of landfill methane in gas flares and engines and abatement technology in adipic acid and nitric acid manufacture. Further information can be in found in sections 2.8 and 2.9 of the UK's 6th National Communication.

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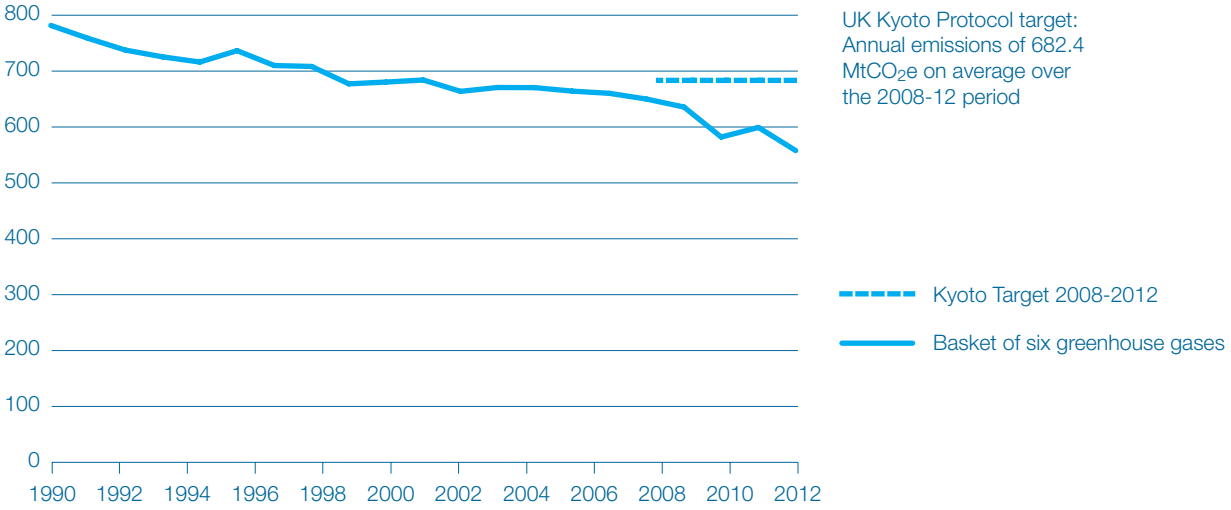
[1] The basket of greenhouse gases covered by the Kyoto Protocol consists of six gases: carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride.

[2] The Base Year for emissions of carbon dioxide, methane and nitrous oxide is 1990. The Base Year for emissions of fluorinated gases (F-gases) is 1995. The Fixed Base Year is taken from the UK's Initial Report under the Kyoto Protocol. This report was submitted in 2006, based on emissions reported in the 1990-2004 Greenhouse Gas Inventory, and was subject to official review in 2007. For the purposes of calculating achievement of the Kyoto Protocol target emissions occurring in this base year are now fixed, in $MtCO_2e$.

Figure 2.2: UK emissions of GHGs, 1990–2011, $MtCO_2$.



Source: 2011 UK Greenhouse Gas Emissions

Carbon dioxide had the largest share of UK greenhouse gas emissions in 2011, making up 83% of the inventory. Methane was the second largest with 8%, followed by nitrous oxide with 6%, other greenhouse gases made up 3% of emissions. Further information can be in found in section 2.7 of the UK's 6th National Communication. The Energy Supply sector had the largest share of UK greenhouse gas emissions in 2011, making up 35% of the inventory, further information can be found in 2.8 and 2.9 of the UK's 6th National Communication.

2.3 National inventory arrangements

The UK's GHG inventory is compiled under contract to the Department of Energy and Climate Change (DECC)[3] by a consortium led by the environment consultancy Ricardo-AEA. Ricardo-AEA[4] also compiles the UK's Air Quality Pollutant Inventory, used for reporting emissions to other international agreements, including the Gothenburg Protocol and the UNECE Convention on Long Range Trans boundary Air Pollution. Most of the underlying information is held on common databases and this helps ensure consistency between these inventories. Emissions estimates from the energy supply sector, industrial processes sector and waste management sector are produced under the Ricardo-AEA contract. Emissions from the agricultural sector are provided by Rothamsted Research under contract to Department for Environment, Food and Rural Affairs (Defra), and emissions and removals in the LULUCF sector are produced on behalf of DECC by the Centre for Ecology and Hydrology (CEH).

The GHG inventory is compiled annually according to Intergovernmental Panel on Climate Change (IPCC) Guidelines and Good Practice Guidance (IPCC, 1996, 2000 and 2003) and with regard to the 2006 Guidelines (IPCC, 2006)[5]. Methodological improvements take account of new data sources, updated guidance from IPCC, relevant work by organisations such as CORINAIR (the European inventory system for certain air pollutants) and specific research programmes sponsored by Government Departments including DECC, Defra and Department for Transport (DfT) together with the Devolved Administrations. All methodological improvements are applied back to 1990 to ensure a consistent time series.

[3] Department of Energy & Climate Change, 3 Whitehall Place, London, SW1A 2AW, Tel: +44 (0)3000604000, email: climatechange.statistics@decc.gsi.gov.uk

[4] Ricardo-AEA, The Gemini Building, Fermi Avenue, Harwell, Didcot, OX11 0QR, Tel: +44 (0)123575300, email: enquiry@ricardo-aea.com

[5] IPCC Guidelines: http://www.ipcc-nggip.iges.or.jp/public/index.html.

The UK operates an established national system for GHG emissions estimation, reporting and archiving. There are a wide range of activities that take place as part of this system. These activities include:

- collecting and processing data from a wide range of sources;
- selecting appropriate emissions factors and estimation methods according to IPCC guidance; compiling the inventory;
- managing all aspects of inventory Quality Assurance (QA) and Quality Control (QC) including the QC of raw and processed data and data management tools;
- documentation and archiving;
- prioritisation of methodology and data improvements; and
- completing uncertainty assessments.

Further information can be found in section 2.3 of the UK's 6th National Communication.

2.4 Changes since the last National Communication

Since the publication of the Fifth National Communication in 2009, various updates and revisions to methodologies have been implemented in the UK's GHG inventory that have impacted on the time-series of emissions. Summary information on the major revisions to the UK GHG since the publication of the UK's fifth National Communication can be found in section 2.11 of the UK's 6th National Communication.

Table 1 in Annex 2 provides further information on GHG emissions and trends. For more information see Chapter 2 of the UK's Sixth National Communication.

3. Quantified economy-wide emission reduction (QEWER) target

Chapter 3 of the Sixth National Communication provides information on the policies and measures that contribute to the UK meeting its quantified economy-wide emission reduction targets.

3.1 EU Target

Alongside the EU and its member States, the UK (including Gibraltar) communicated an independent quantified economy-wide emission reduction target of a 20% emission reduction by 2020 compared with 1990 levels (base year). The target for the European Union and its Member States is based on the understanding that it will be fulfilled jointly with the European Union and its Member States. The 20% emission reduction target by 2020 is unconditional and supported by legislation in place since 2009 (Climate and Energy Package).

The climate and energy package implements the goal of reducing EU GHG emissions to 20% below 1990 levels by 2020. The reduction effort is shared out as follows:

- a 21% reduction in emissions from sectors covered by the EU emissions trading system (EU ETS) compared to 2005 levels;
- around 10% reduction from most other sectors compared to 2005. These sectors are covered by the Effort Sharing Decision (ESD).

Since a single, EU-wide cap on EU ETS emissions has been introduced from 2013, the effort-sharing arrangement between Member States under the ESD has been determined solely for the reduction in emissions from non-traded sectors that are not covered by the EU ETS. Further information can be found in Section 3.4 of the UK's Sixth National Communication.

The ESD establishes binding annual GHG emission targets for Member States for the period 2013–2020. These targets concern emissions from most sectors not included in the EU ETS such as transport (except aviation and international maritime shipping), buildings, agriculture and waste. The UK's ESD target is a reduction of 16% compared to 2005 GHG emissions levels by 2020.

By 2020, the UK's national target along with other Member State targets will collectively deliver a reduction of around 10% in total EU emissions from the sectors covered compared with 2005 levels. Together with a 21% cut in emissions covered by the EU ETS, this will accomplish the overall emission reduction goal of the climate and energy package of a 20% cut below 1990 levels by 2020.

Detailed information on the EU target, including the gases regulated, GWP values and international market-based mechanisms in achieving its emissions reduction – are provided in Annex 2 (Table 2).

3.1.1 Geographical differences between the QEWER EU Target and the Chapter Projection of GHG emissions

Chapter 4 of the National Communication provides UK projections of GHG emissions, these projections are based on a different scope to the QEWER EU Target. Consequently these emissions do not directly align. The table below sets-out the accounting differences between the projections in chapter 4 and the QEWER EU Target.

Total Adjustments								
$MtCO_2e$	1990	1995	2000	2005	2010	2011	2020	2030
UK GHG including LULUCF (UNFCCC scope baseline)	**774.8**	**715.6**	**677.9**	**659.3**	**594.1**	**553.1**	**438.5**	**399.2**
Subtract LULUCF	-4.0	-3.3	-0.4	2.6	3.7	3.3	0.4	-2.2
Subtract CDs and OTs not in EU (excl. LULUCF)	-3.5	-3.6	-3.7	-3.8	-3.8	-3.9	-4.0	-4.2
Add International Aviation bunkers (CO_2 only)	15.4	20.1	30.1	34.9	31.3	32.6	36.4	40.2
Add flights from UK to non-EU CD+OT (CO_2 only)	0.2	0.1	0.1	0.2	0.2	0.2	0.2	0.3
Total GHG in scope of EU Target	**782.9**	**728.9**	**704.0**	**693.2**	**625.5**	**585.5**	**471.5**	**433.3**
Reduction from 1990		-7%	-10%	-11%	-20%	-25%	-40%	-45%
Reduction from 2005					-10%	-16%	-32%	-37%

The main differences in scope are:

Aviation:

The scope of the EU ETS is largely additional to the IPCC inventory as the EU ETS includes CO_2 emissions from flights between a EU member state and third party states, emissions which are otherwise included in the Memo Item: International Aviation Bunkers.

Geographical coverage:

The UK's EU target only applies to the UK and it's Overseas Territory of Gibraltar. As the UK's Crown Dependencies and it's other Overseas Territories that have signed up to the UNFCCC and the Kyoto Protocol are not in the EU, and EU targets do not apply, a geographical scope adjustment needs to be made to both inventory and projections to remain consistent with the scope of the target.

LULUCF:

LULUCF is excluded from the EU Target.

3.2 Domestic target

Introduction

The Climate Change Act 2008[6] established the world's first long-term legally-binding framework to reduce greenhouse gas emissions by at least 80% below the 1990 baselines levels by 2050, with an interim target to reduce greenhouse gas emissions by at least 34% compared to the 1990 baseline by 2020. To help set the trajectory, the Climate Change Act also introduced carbon budgets, which set legally binding limits on the total amount of GHG that the UK can emit for a given five-year period. This section discusses the carbon budgets and the UK's progress in achieving the limits.

The targets

The UK has established in law the first four carbon budgets, which cover the period from 2008 to 2027. The fifth carbon budget, covering the period 2028 to 2032, is due to be set in 2016.

These carbon budgets limit greenhouse gas emissions as set out in the following table:

	First carbon budget period (2008 to 2012)	Second carbon budget period (2013 to 2017)	Third carbon budget period (2018 to 2022)	Fourth carbon budget period (2023 to 2027)
Carbon budget level (million tonnes of carbon dioxide equivalent ($MtCO_2e$)	3,018	2,782	2,544	1,950
Percentage reduction below base year levels	23%	29%	35%	50%

The carbon budgets extend to UK territory only (i.e. England, Wales, Scotland and Northern Ireland) and not to the UK's Crown Dependencies or Overseas Territories.

3.3 Achieving the targets

The government has in place a clearly defined suite of policies to reduce emissions to meet the first three carbon budgets. These policies are described in Chapter 3 of the Sixth National Communication, and Table 3 of Annex 2. Based on the latest published projections (reference scenario), the UK is on track to meet its first three legislated carbon budgets – with emissions projected to fall under the cap by 54 $MtCO_2e$, 79 $MtCO_2e$ and 42 $MtCO_2e$ for the first three budgets respectively. These forecasts are based on the projected impact of policies that have already been announced and for which funding has already been agreed.

The fourth carbon budget (2023-27) was set in June 2011 at 1950 $MtCO_2e$, or around 50% below the baseline. The latest published projections identify an expected shortfall of 215 $MtCO_2e$ over the fourth carbon budget period, which reflects the fact that detailed policy has not yet been set out that far into the future. In December 2011, the Government published the Carbon Plan, which set out proposals for achieving the emissions reductions committed to in the first four carbon budgets, on a pathway consistent with meeting the 2050 target. The Carbon Plan sets out three main phases of action:

- Complete and prepare: From now until 2020, focusing on energy efficiency and preparing for the future through innovation support and building markets.
- Mass deployment: In the 2020s and 2030s, moving to large scale deployment of key technologies such as low carbon heating and electric vehicles.
- Finalising: From 2030 onward, tackling "harder to decarbonise" sectors such as industry, aviation, shipping and agriculture.

[6] http://www.legislation.gov.uk/ukpga/2008/27/contents

3.4 Monitoring progress and methodology

The UK government's approach to managing carbon budgets centres on a series of annually published reports:

- An annual statement of emissions which shows what emissions were in the past year and where they came from (Annual statement of emissions for 2011 - Publications – GOV.UK);
- An annual report from the independent Committee on Climate Change on progress against carbon budgets (Meeting Carbon Budgets – 2013 Progress Report to Parliament | Committee on Climate Change);
- Government's response to the Committee on Climate Change's annual progress report (Committee on Climate Change progress report: government response – Publications – GOV.UK); and
- Updated energy and emissions projections, which assess the expected impact of our policies on future emissions trends (Updated energy and emissions projections: 2013 – Publications – GOV.UK).

3.5 Historical performance

Each carbon budget is split into:

- a traded sector, which covers power and heavy industry and for which the limit is based on the UK's share of the EU ETS limit for the relevant period and
- a non-traded sector, which covers everything else, for example road transport, agriculture and buildings

To calculate UK performance against these targets, data is taken from the UK Greenhouse Gas Inventory (as detailed in Chapter 2 of the Sixth National Communication). These include emissions from LULUCF. The data are then adjusted to take into account removals of emissions from the atmosphere by carbon sinks associated with LULUCF activity.

This gives net UK emissions, which are further adjusted to account for:

a. carbon units which have been bought in from overseas by Government and others to offset UK emissions ("credits"), thereby reducing the net UK carbon account; and

b. UK carbon units which have been sold to a third party outside the UK or otherwise disposed of ("debits"), which increase the net UK carbon account as the recipient can use these units to offset their own emissions and it would lead to double counting if they were also used to offset UK emissions.

The effect of these adjustments is that the traded sector of the UK's net account is taken to be the same as the UK's share of the EU ETS cap. The detailed rules for these calculations are contained in the Carbon Accounting Regulations 2009[7].

Further details on the approach to counting emissions and removals from the LULUCF sector can be found in Chapter 2 of the Sixth National Communication. International aviation and shipping emissions are not currently included within the 2050 target defined by the Act or within the four carbon budgets. The Government has deferred a decision on whether to include

[7] http://www.legislation.gov.uk/ukdsi/2009/9780111478516/contents.

international aviation and shipping emissions in carbon budgets until the setting of the fifth carbon budget in 2016[8].

3.6 Projected performance

The UK estimates future performance against the targets using DECC's updated energy and emissions projections, as detailed in Chapter 4 of the Sixth National Communication.

3.7 Baseline

The level of emissions in the 'base year' is calculated on the basis of emissions of carbon dioxide, methane and nitrous oxide in 1990, and emissions of hydrofluorcarbons, perfluorocarbons and sulphur hexaflouride in 1995. The level of emissions in the base year also includes an allowance for net emissions from LULUCF sector in 1990. The baseline level of emissions is revised annually.

4. Progress in achievement of QEWER target

4.1 Performance against the first carbon budget, 2008 to 2012

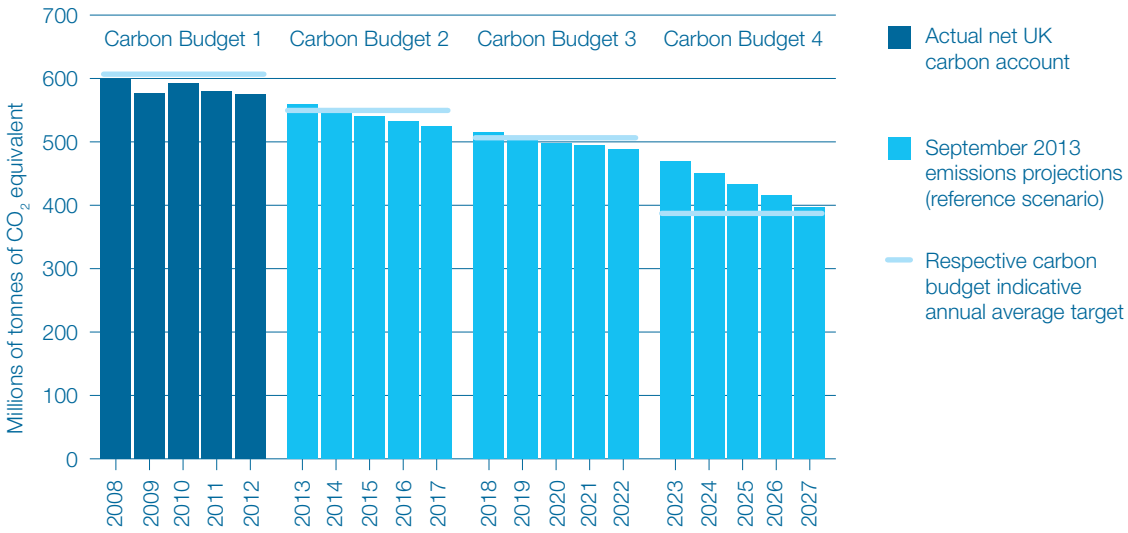
The first carbon budget requires that total UK greenhouse gas emissions do not exceed 3,018 $MtCO_2e$ over the five year budget period (2008-12), which equates to an average over the period of approximately 22% below the carbon budget baseline.

Provisional emissions estimates for 2012, published in March 2013 showed that UK greenhouse gas emissions were 568.2 $MtCO_2e$ excluding the impact of trading within the EU ETS and 581.8 $MtCO_2e$ when trading was included. UK greenhouse gas emissions including the impact of trading within the EU ETS decreased by 25% in 2012 relative to the carbon budgets baseline.[9]

4.2 Pace of emissions reductions

UK emissions are projected to continue to fall (see Figure 4.3 below).

Figure 4.3: Progress against carbon budgets



Source: UK greenhouse gas emissions statistics and Updated Emissions Projections, DECC

[8] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/65686/7334-int-aviation-shipping-emissions-carb-budg.pdf

[9] UK greenhouse gas emissions statistics, DECC https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/211907/Progress_towards_targets_2012_provisional_figures.pdf

As shown in Figure 4.4 below, the UK is projected to meet the first three carbon budgets based on current policies, and further policy action will be required to meet the fourth carbon budget.

Figure 4.4: Projected performance against the first four carbon budgets ($MtCO_2e$)

	First Carbon Budget (2008-12)	Second Carbon Budget (2013–17)	Third Carbon Budget (2018–22)	Fourth Carbon Budget (2023–27)
Carbon budget	3,018	2,782	2,544	1,950
Territorial emissions[10]	2,925	2,607	2,223	2,093
Net UK carbon account[11]	2,964	2,703	2,502	2,165
Projected performance against first four carbon budgets	-54	-79	-42	215
Uncertainty range[12]	-54 to -54	-114 to -49	-103 to 24	135 to 315

Source: Emissions projections derived from Updated Emissions Projections (published September 2013).
https://www.gov.uk/government/organisations/department-of-energy-climate-change/series/energy-and-emissions-projections

Tables 4a and 4b of Annex 2 provide further information on progress made in achieving emissions reduction targets, including mitigation actions relevant to the contribution of the LULUCF.

5. Projections, scenario with measures

5.1 Key developments

In 2011, UK emissions of the basket of six greenhouse gases covered by the Kyoto Protocol were estimated to be 553 $MtCO_2e$, 29% lower than the 1990 level of 775 $MtCO_2e$. UK emissions of the basket are projected to fall to 438 $MtCO_2e$ (43% below the 1990 level) by 2020 and 399 $MtCO_2e$ by 2030 (48% below the 1990 level).

Emissions of carbon dioxide, methane and nitrous oxide are projected to be 39, 63 and 52% respectively, below 1990 levels by 2020. Emissions of the fluorinated greenhouse gases (hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride) are collectively projected to be 32% below their 1990 level in 2020.

Since the 5th National Communication, the UK has announced further policies, for example:

- a major reform of the Electricity Market;
- the Renewable Heat Incentive for business and new measures to improve the energy efficiency of domestic buildings (The Green Deal and ECO) to help meet its EU effort sharing;
- renewable energy and energy efficiency targets; and
- the targets for the first three Carbon Budgets[13] (2008-12, 2013-17 and 2020-22) set under the 2008 Climate Change Act[14].

Policies adopted in the period between 2009 and 2013 are projected to deliver emissions savings of 122 $MtCO_2e$ by 2020 and 143 $MtCO_2e$ by 2030 and these savings are included in the projections. The UK's most recent national projections indicate that it will meet its first three

[10] "Territorial emissions" means all GHG emissions that take place on the UK mainland and therefore exclude international aviation and shipping and any impact of trading within the EU ETS.

[11] The "net UK carbon account" is defined as territorial emissions adjusted to take account of the impact of trading within the EU ETS, as described in Chapter 2 of the Biennial Report.

[12] At a confidence interval of 95%

[13] http://www.legislation.gov.uk/uksi/2009/1259/article/1/made

[14] http://www.legislation.gov.uk/ukpga/2008/27/contents

carbon budgets. A new much tighter target, equivalent to 390 $MtCO_2e$ in 2025, was also set in 2011 for the fourth carbon budget (2023-27) and a range of future policy options to meet this target identified[15].

5.2 Introduction

This section presents projections of GHG emissions for the scenario "with existing measures (WEM)" split by sector, by gas. We also show the contribution of policies adopted between 2009 and 2013.

Projections are presented for 2015, 2020, 2025 and 2030. For context we also show the corresponding inventory values for 1990, 1995, 2000, 2005, 2010 and 2011. All emissions and projections are displayed in CO_2 equivalents and include LULUCF unless otherwise indicated.

Our sectoral breakdown is based on National Communications categories, not on IPCC. The relationship between these is shown in Annex 5 of the 6th National Communication.

Projections of emissions related to fuel sold to ships and aircraft engaged in international transport are memo items in the CTF Tables (Annex 2) and not included in the totals reported in this section.

5.3 Context

The projections presented here are based on the UK national projections published in September 2013. Those projections were produced to monitor the UK's progress against its national Carbon Budget targets and use a more restricted geographical coverage (UK only) than is required for this report, which we refer to here as UNFCCC scope: United Kingdom; the Crown Dependencies of Guernsey, Jersey and the Isle of Man; and the dependant Overseas Territories (Bermuda, Cayman Islands, Falkland Islands, Gibraltar and Montserrat) that have signed up to the UK's instrument of ratification to the UNFCCC and the Kyoto Protocol.

Those projections have therefore been supplemented by custom projections for these Overseas Territories so projections totals match the required scope.

5.4 Scenarios

These projections are a 'with measures' projection and include the impact of the adopted and implemented policies and measures listed in CTF Table 3 in Annex 2. Further details of the policies and measures are provided in Chapter 3 (Policies and Measures) of the 6th National Communication.

5.5 Key parameters and assumptions

Our energy and emissions projections are based on a set of key assumptions about UK and world economic growth, demographic changes in the UK and future fuel price trajectories. The main sources of the projections are those made by the UK's Office for Budget Responsibility and Office of National Statistics, supplemented by IMF projections of world growth. Fuel Prices are those produced by the Department of Energy and Climate Change. The key parameter and assumptions are documented in CTF Table 5 in Annex 2 and in Section 4.7.7 (Key Assumptions) in the methodology section of the 6th National Communication.

[15] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48080/1685-ia-fourth-carbon-budget-level.pdf

5.6 Overall projections of GHG emissions

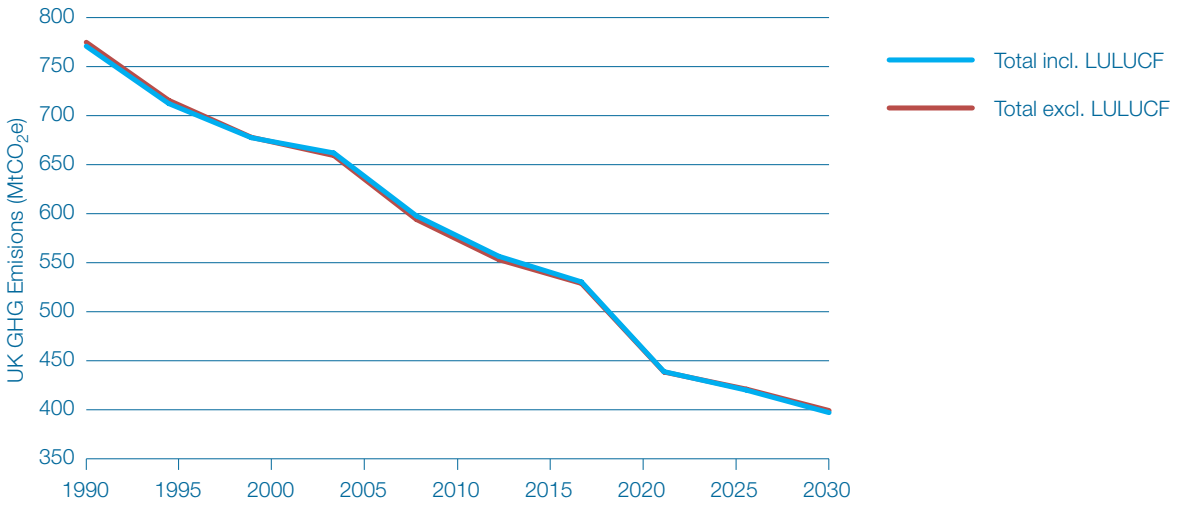
UK GHG emissions have declined throughout the period 1990-2011, the overall reduction being 28% over the period. In this 'with measures' scenario, UK emissions are projected to continue to decline by a further 20% relative to 1990 by 2030 and this is illustrated in Table 5.7 and Figure 5.8 below. More detail is available in Section 4.3 (Overall projections of greenhouse gas emissions) of the 6th National Communication.

Table 5.7 UK greenhouse gas emissions (UNFCCC coverage)

$MtCO_2e$	Inventory						Projection			
Gas	1990	1995	2000	2005	2010	2011	2015	2020	2025	2030
Total	**774.8**	**715.6**	**677.9**	**659.3**	**594.1**	**553.1**	**528.9**	**438.5**	**421**	**399.2**
Change from 1990		-8%	-13%	-15%	-23%	-29%	-32%	-43%	-46%	-48%

Source: 6th National Communication, Table 15

Figure 5.8 Total GHG projections



Source: CTF Table 6(a)

5.9 Projections by sector

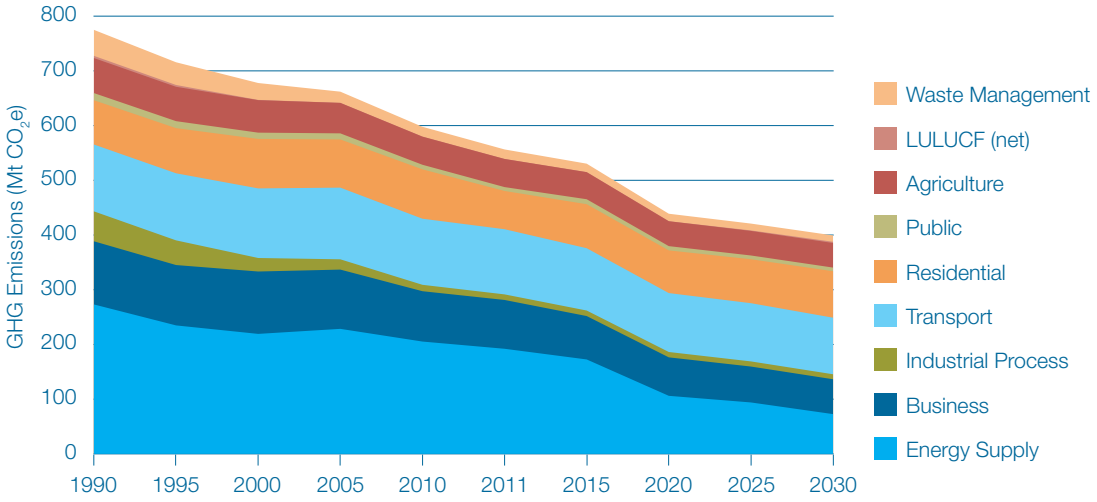
Breaking down emissions by National Communications (source) sector as shown in Table 5.10 and 5.11 below, it is clear that the largest reductions have come in the energy supply sector. Historically this was due to a switch from coal to gas as a power station fuel and in the projections the reduction is due to a policy-catalysed growth of the use of renewables and carbon capture, particularly in energy supply. Historical reductions in industrial processes and waste management emissions are projected to be more modest in future. Recent and future reductions are now coming in the transport sector through economic and policy-driven improvements in fuel efficiency.

Further details, of GHG emissions by sector can be found in Section 4.4 of the National Communications, where the projections in each sector are discussed in more detail. The summary in the CTF Table 6 (a) in Annex 2 also provides the projection by IPCC sectors.

Table 5.10 Greenhouse gas emissions by source (UNFCCC coverage)

$MtCO_2e$	Inventory						Projection			
Sector	1990	1995	2000	2005	2010	2011	2015	2020	2025	2030
Energy supply	273.1	234.8	219.3	228.5	205.3	192.1	172.6	106.1	94.0	72.7
Business	115.4	110.3	114.0	108.3	92.0	89.2	79.3	70.3	65.6	63.7
Industrial processes	54.7	45.1	24.7	18.8	11.7	10.2	10.1	9.8	9.4	9.1
Transport	122.2	122.6	127.2	131.0	120.8	119.1	113.9	107.7	106.4	103.4
Residential	80.9	82.5	90.4	88.1	90.2	69.9	80.4	78.0	80.3	84.9
Public	13.1	12.8	11.5	11.1	8.4	7.1	9.1	7.8	6.9	6.7
Agriculture	64.0	62.8	59.4	55.7	51.4	51.4	49.5	45.5	44.9	44.9
LULUCF (net)	4.0	3.3	0.4	-2.6	-3.7	-3.3	-1.5	-0.4	0.9	2.2
Waste management	47.5	41.5	30.9	20.5	18.0	17.4	15.5	13.7	12.5	11.7
Total net GHG emissions	**774.8**	**715.6**	**677.9**	**659.3**	**594.1**	**553.1**	**528.9**	**438.5**	**421.0**	**399.2**

Figure 5.11 Greenhouse gas emissions by source (UNFCCC coverage)



Source: CTF Table 6(a)

5.12 Projections by gas

UK GHG, both historically and as projected through to 2030 are dominated by combustion-related carbon dioxide emissions. Combustion also contributes to methane and nitrous oxide emissions, though methane emissions are dominated by emissions from the agricultural and waste management sectors.

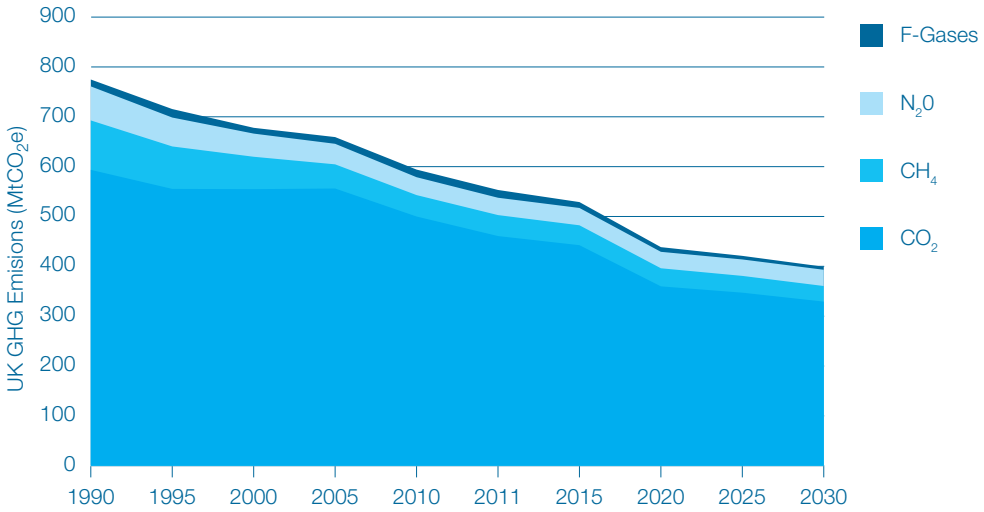
The main reduction in methane has been and is expected to come from improved recycling of waste, combustion of waste for heat and capture of methane from landfill.

Nitrous oxide emissions have and will continue to be dominated by agricultural emissions from soils, which have and are expected to continue to decline modestly as a result of nitrate reduction policies. Industrial process emissions were important but have already sharply reduced due both to plant closures and the application of best practice abatement technologies.

F-Gas emission have been dominated by the growth in use of HFCs as replacement for HCFC in refrigeration and air conditioning, but are projected to be progressively phased out and replaced by alternative with lower GWP as a result of the UK's implementation of EU legislation.

More sectoral detail for each gas is provided in Section 4.5 (Projections by gas) of the 6th National Communication, and totals for each gas are also summarised in the CRF Table 6 (a) in Annex 2.

Figure 5.13 Greenhouse gas emissions by GHG (UNFCCC coverage)



Source: CTF Table 6(a)

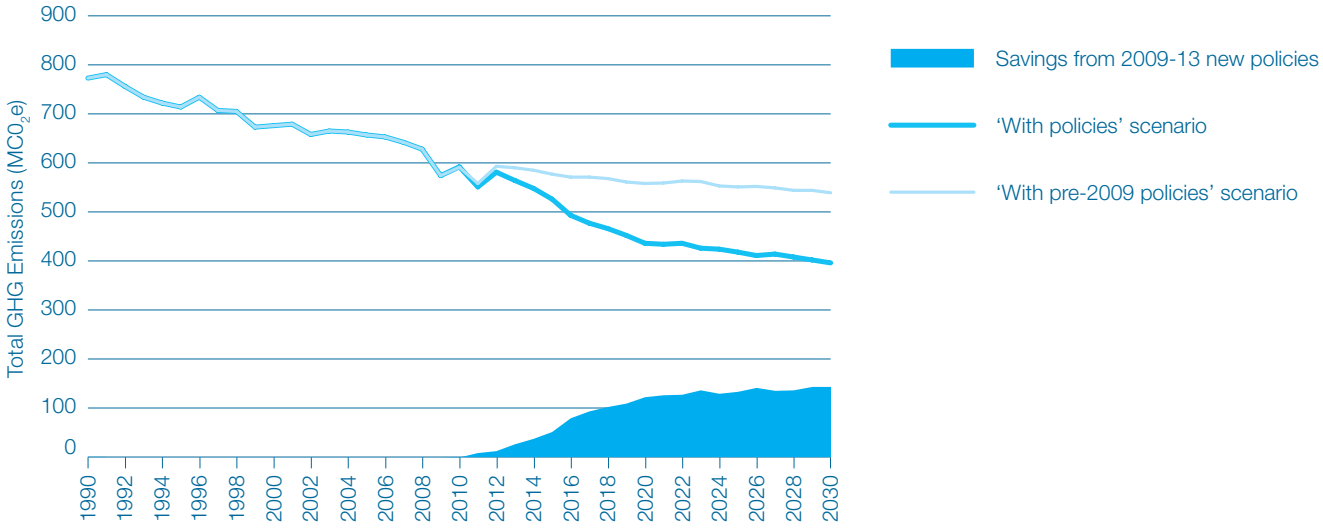
5.14 Assessment of total effect of policies and measures

Since the 5th Communication the UK has announced further policies to help meet its EU effort sharing and renewable energy targets, and the targets for the first three carbon budgets set under the 2008 Climate Change Act.

These newer climate mitigation policies are those marked with a 1 in CTF Table 3 in Annex 2 and their impact, where quantified, is shown in Section 4.6 (Assessment of total impact of policies and measures) of the 6th National Communication.

As Figure 5.15 below shows these new measures will result in a significant reduction in emissions below historic trend in the period up to 2020.

Figure 5.15 Projected impact of policies adopted in the period 2009-13



Source: 6th National Communication, Figure 38

5.16 Changes in projection methodologies

The UK's projections for the 6th National Communication are based on the latest update of its national projections, which are produced annually to monitor progress against the UK's National and International targets.

As part of that update the UK have a continuous program to improve its projections.

Since the Fifth National Communication there have been numerous detailed changes in the detail of the demand equations and emissions modelling. However the major methodological development has been the replacement of a cost-minimising electricity generation sub-model of the UK electricity supply industry with a profit maximising model (the Dynamic Dispatch Model, or DDM) that better simulates the behaviour of the privately owned utility companies that operate, build and decommission electric power stations in the UK power generation market. This has allowed us to considerably improve modelling of policy interventions in this sector.

Section 4.7 of the UK's 6th National Communication describes the methodologies used to produce the current projections.

This section also covers the key assumptions used in these projections (4.7.7), outlines the QA/QC processes used to produce them (4.7.8) and summarises the perceived strengths and weakness of the UK's projections methodologies (4.7.9).

5.17 Sensitivity analysis

In order to assess the robustness of its projections the UK carries out analyses of the sensitivity of its reference emissions projection to variant assumptions as to fuel prices and economic growth.

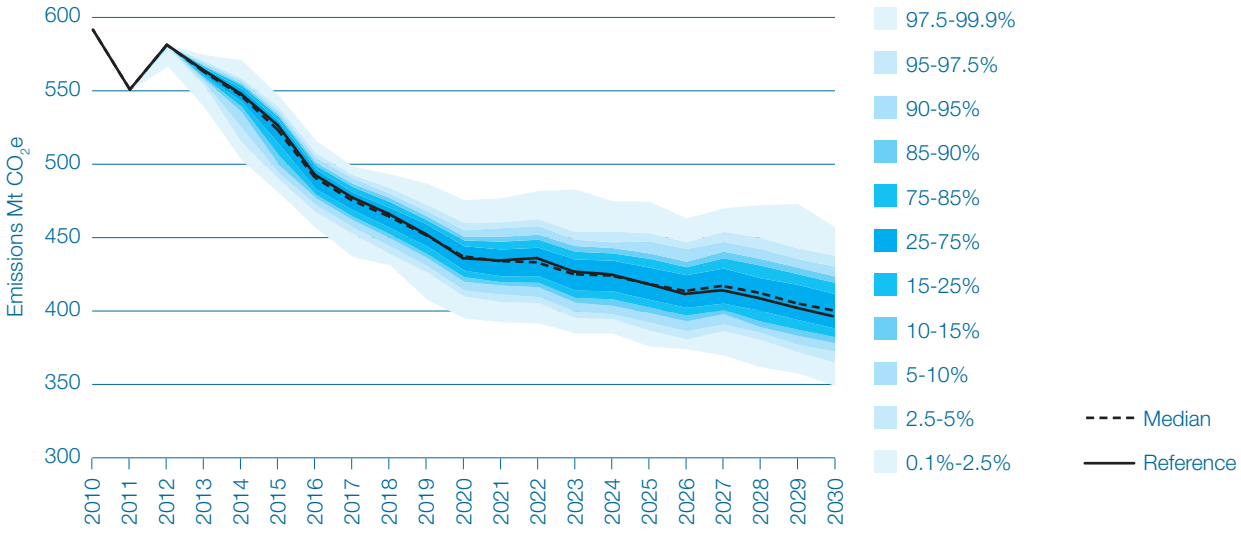
These sensitivities are described in Section 4.7 of the 6th National Communication.

A more detailed description of sensitivity analysis can be found in Section 4.8 of the 6th National Communication.

5.18 Uncertainty analysis

In addition to this sensitivity analysis modellers in the UK have undertaken a Monte Carlo simulation of the impact on the UK's emissions of simultaneously varying 10 key parameters, including GDP, population, fossil fuel prices, annual temperatures and policy savings. These simulations shows an uncertainty range of +/- 6% in emissions in 2020 and +10/-8% in emissions in 2030, as shown below in Figure 5.19.

Figure 5.19 Results of the probabilistic analysis – fan chart



Source: 6th National Communication, Figure 44

A more detailed description of this uncertainty analysis can be found in Section 4.8 of the 6th National Communication.

5.20 Differences from the 5th National Communication

Since the 5th National Communication there is a significant fall in the UK projected greenhouse gas emissions in 2020.

The changes are largest in CO_2 and secondarily N_2O. However HFCs are not projected to fall as rapidly.

These falls can mostly be attributable to new policies implemented or adopted since the 5th National Communication and to slower recovery from the 2008-9 recession.

Table 5.21 - Differences in 'with measures' projections between the fourth and fifth national communications, $MtCO_2e$. Including LULUCF

	Fifth National Communication			Sixth National Communication		
Gas	1990	2020	Projected Change	1990	2020	Projected Change
Carbon Dioxide	593.5	482.1	-19%	593.5	359.8	-39%
Methane	103.7	43.4	-58%	99.2	36.3	-63%
Nitrous Oxide	63.9	38.7	-39%	68.3	33.0	-52%
HFCs	11.4	6.9	-39%	11.4	8.6	-25%
PFCs	1.4	0.2	-86%	1.4	0.2	-84%
SF_6	1.0	0.7	-30%	1.0	0.6	-43%
Total GHG	**774.9**	**572.0**	**-26%**	**774.8**	**438.5**	**-43%**

Source: 6th National Communication, Table 39

These differences are also described in Section 4.10 of the 6th National Communication.

6. Provision of financial, technological and capability-building support to developing countries

6.1 Summary

Over the last three years, the UK has taken steps to make available new and additional resources to developing countries to tackle climate change, including delivering in full its 'Fast Start' financing pledge of £1.5 billion.

Recognising the growing importance and urgency of tackling climate change and its impact on growth and poverty reduction, in 2010 the UK government announced a new and additional 4 year (financial years 2011/12 to 2014/15) budget allocation for international climate finance of £2.9 billion known as the International Climate Fund (ICF). In 2013, this was increased by £969 million for financial year 2015-6, giving a total of £3.87 billion. The UK climate finance reported for the Fast Start years of 2011 and 2012 were funded from this budget.

Through the ICF, we aim to:

i. Demonstrate that low carbon, climate resilient growth at scale is feasible and desirable. This will build confidence that climate resilient growth and adaptation to climate change are achievable and it will also help to lay a key part of the foundations of a global climate change agreement;

ii. Support the international climate negotiations, particularly through providing support for adaptation in poor countries and building an effective international architecture for delivery of climate finance;

iii. Recognise that climate change offers real opportunities to drive innovation and new ideas for action, and create new partnerships with the private sector to support low carbon climate resilient growth.

We will aim to do this by:

i. Building global knowledge and evidence on how low carbon, climate resilient development, including Reducing Emissions from Deforestation and Forest Degradation (REDD), supports growth and reduces poverty;

ii. Developing, piloting and scaling up innovative low carbon, climate resilient programmes and approaches to reduce emissions, support adaptation and protect forests, including biodiversity;

iii. Supporting country level action on low carbon, climate resilient development, including REDD;

iv. Building an enabling environment for private sector investment and by engaging the private sector to leverage finance and deliver action on the ground;

v. Mainstreaming climate change into UK official development assistance, EU development assistance and Multilateral Development Bank (MDB) lending.

The ICF also demonstrates the UK's commitment to scaling up climate finance to meet its fair share of developed countries' goal of jointly mobilising $100 billion of public and private international finance per year from 2020 as set out in the Copenhagen Accord.

The ICF will aim for a balanced allocation between adaptation (50%), low carbon development (30%) and forestry (20%). So far the ICF has delivered approximately 60% of the funding through multilateral channels, as shown in Table 7a (Annex 2), and 40% through bilateral programmes (Table 7b in Annex 2).

Through these bilateral and multilateral channels the ICF reaches over 120 countries. A sample of programmes from the current ICF portfolio is expected to achieve the following results, as attributable to the UK:

- Help 20 million people cope with the effects of climate change
- Provide access to clean energy to 6.5 million people
- Prevent the emission of over 60 million tonnes of CO_2 equivalent
- Leverage an additional £1.25 billion in public finance
- Leverage an additional £955 million in private finance

6.2 Low Carbon Development and sustainable energy

The ICF is helping developing countries achieve economic growth in a sustainable way, and access to affordable, reliable and sustainable energy is central to this. Interventions are being supported at the regional, national, sub-national or sectoral level through ICF bilateral and multilateral support (see tables 7, 7a and 7b of Annex 2 for details of UK's financial contribution). Many of these interventions aim to lay the conditions for increasing investment at scale.

The UK is focusing on:

- Achieving greater private sector investment in low carbon infrastructure and service delivery to increase rates of deployment of technologies that are further along the innovation chain or where abatement costs are relatively low;

- Supporting technologies critical to supporting progress towards the 2°C goal, particularly where we are not on track globally and in countries where there is the greatest potential for deployment; as well as supporting the development and deployment of locally relevant technologies, which will also support local economic and social development;
- Enhancing the capacity of developing countries through provision of knowledge and monitoring tools.

6.3 Contributing to international climate change mitigation funds

The UK is supporting the Clean Technology Fund (CTF) – one of the Climate Investment Funds (CIFs). The CTF is supporting investment plans in 20 developing countries and is expected to leverage over $40 billion of investment in low carbon projects. Over the lifetime of the CTF it is expected to contribute towards delivering greenhouse gas emission savings of 1.6 billion tonnes CO_2e, the equivalent of Russia's annual emissions. It will also deliver significant development benefits, such as increased energy security, reduced local air pollution and job opportunities. For example, the CTF will support the creation of an enabling policy framework for the deployment of 20 GW of solar power in India by 2022. The UK has provided £610 million to the CTF.

The UK is supporting the Scaling Up Renewable Energy Programme (SREP) – another of the Climate Investment Funds (CIFs) – which aims to increase energy access through renewable energy use and demonstrates the economic, social and environmental viability of low carbon development pathways in the energy sector. SREP is supporting investment plans in 8 developing countries and is expected to leverage over $40 billion of investment in low carbon projects. The UK has provided £100 million to the SREP.

6.4 Forestry

Through the ICF, the UK is supporting global efforts to slow, halt and reverse deforestation. As well as the climate change mitigation benefits, tackling deforestation also offers big opportunities to reduce poverty and protect biodiversity, with corresponding benefits for resilience and adaptation.

The UK ICF forests strategy has four areas of focus:

i. Supporting progress towards an international REDD+ mechanism;

ii. Incentivising governance and market reforms to curb illegal and unsustainable use of forest resources;

iii. Facilitating increased public and private investment in sustainable forestry and agriculture, to reduce pressure on forests;

iv. Encouraging greater sharing of knowledge, tools, evidence and learning to enhance the effectiveness of deforestation interventions internationally.

Example programmes include;

The Forest Governance, Markets and Climate (FGMC) programme, which aims to reduce the illegal trade in forest resources by addressing forest sector governance and market failures that permit illegal forest practices. Over the next 25 years, the FGMC programme will help protect up to 39 million hectares of forest (13 million hectares more than the size of the UK). It will help avoid billions of tonnes of carbon (CO_2e) emissions, protect the livelihoods of tens of millions of forest-dependent communities and increase the incomes of 50 million men, women and children reliant on farming. The UK has committed £79 million to the FGMC programme between 2012 and 2016.

The Forest Investment Programme (FIP) – one of the CIFs – is supporting 8 pilot countries to implement programmes to reduce deforestation. FIP investments will enhance the wellbeing of forest dependent communities, increasing their resilience to climate change and providing new sources of income, whilst reducing greenhouse gas emissions associated with deforestation. The UK has contributed £100 million to FIP. Although impacts will vary project to project, examples of expected impact include a reduction in greenhouse gas emissions by 14.9 $MtCO_2e$ in Democratic Republic of the Congo and 5.3 $MtCO_2e$ in Laos through work with charcoal industries, with additional local benefits expected.

6.5 Private finance

Mobilising private investment in climate action is crucial to meeting the global goal to limiting temperature increase to 2 degrees. A key aim of the ICF is therefore to mobilise private finance.

The ICF provides an opportunity to use public finance to mobilise increased flows of private finance and test new and innovative approaches that can be replicated and scaled-up. In seeking to mobilise private finance, we are using the ICF to:

i. Test innovative approaches to mobilising private climate finance to better inform future UK or other international initiatives;

ii. Mobilise private climate finance in ICF priority countries that would not otherwise flow to those countries, and seek to create a sustainable climate investment market;

iii. Mobilise private sector engagement and finance in specific sectors and/or technologies that experience difficulties in accessing private finance or which pose long term financial risks;

iv. Create a better understanding of private finance within ICF priority country governments, HMG and internationally to inform future climate finance policy and climate projects, including the Green Climate Fund.

One such example is the Climate Public Private Partnership (CP3) programme. The UK is working alongside the Asian Development Bank and International Finance Corporation Asset Management Company in a joint effort to encourage new forms of private sector finance, into climate investments and boost economic growth in developing economies. The CP3 programme aims to demonstrate to major private sector investors that climate friendly investments are financially viable. The UK will provide £110 million as an anchor investor into two private equity funds. An additional contribution (up to £20 million) for technical assistance will provide support for first time fund managers and the development of the project pipelines, especially in poorer countries. Over the lifetime of the programme, CP3 is expected to save an estimated 265 $MtCO_2e$, install approximately 7,000 MW of clean, reliable energy, and support an estimated 40,000 jobs.

6.6 Global Carbon Market

The UK government considers that the development of a global carbon market is critical to securing a cost effective shift to low carbon development globally. In this context, the UK has promoted the use of market-based instruments both domestically and internationally. We now have a decade of experience developing policies using market approaches through initiatives such as our Climate Change Agreements, the Carbon Reduction Commitment Energy Efficiency Scheme and, of course, the UK Emission Trading Scheme of 2002, which helped shape the EU ETS that we have in operation today.

One example of the way the UK is aiming to improve access to carbon finance in least developed countries is by investing £49 million in the World Bank's Carbon Initiative for Development (Ci-Dev). Through Ci-Dev the UK aims to help some of the poorest countries participate in the international carbon market, through the Clean Development Mechanism (CDM), and in doing so provide clean energy for households and communities, particularly in Africa.

6.7 Adaptation: Assistance provided to developing countries particularly vulnerable to the adverse effects of climate change in meeting the costs of adaptation

As of September 2013, the UK is funding ICF adaptation programmes worth over £800 million, working with the poorest countries in the areas that are most important to those living livelihoods and are vulnerable to climate change.

These areas are:

- Agriculture (food and farming systems);
- Better preparation for disasters;
- Water resources management;
- Infrastructure and urban development;
- Coastal areas;
- Ecosystems;
- Social protection; and
- Health.

UK support provided through the ICF seeks to help build adaptation knowledge, capacity, institutions and evidence as well as support direct adaptation actions. It will also help with the development of effective national and international climate finance architecture which is needed for delivering adaptation finance.

Some examples of ICF support are:

The UK is providing up to £150 million (about $235 million) for the 'Adaptation for Smallholder Agriculture Programme' (ASAP). Implemented by the International Fund for Agriculture Development (IFAD), a specialised UN agency working on financing agriculture and rural development, ASAP will work in approximately 40 developing countries, investing in practices and knowledge sharing to help smallholder farmers adapt. ASAP will work with governments on improved policies to support economic growth and agriculture systems that help farmers adapt to climate change. We expect the UK's support will directly benefit 6 million small-holder farmers.

The UK is also providing £23.5 million to the South Asia Water Governance Programme, which helps countries work together to manage the Himalayan rivers for the benefit of 500 million people who live in the river basins.

6.8 Contributing to international climate change adaptation funds

The UK contributes to international adaptation funds that work to help developing countries adapt to climate change. The UK has provided £325 million to the Pilot Programme for Climate Resilience (PPCR), one of the Climate Investment Funds (CIFs). The PPCR pilots new approaches to adaptation in some of the most vulnerable countries in the world.

The UK has provided £30 million to the Least Developed Countries Fund (LDCF) which helps vulnerable countries undertake their long term National Adaptation Planning process as well as prepare and implement National Adaptation Programmes of Action.

6.9 ICF technology development and transfer programmes

Many ICF programmes actively support some form of technology development or transfer (Table 8 of Annex 2 details bilateral and regional financial contributions to such programmes and projects). These include:

Renewable Energy and Adapting to Climate Technologies (REACT): This is a window of the Africa Enterprise Challenge Fund which aims to stimulate private sector investment in developing and delivering low cost, clean energy and climate adaptation technologies, such as solar power, biogas, irrigation and water efficiency measures. Provisional estimates are that with the help of this funding, by 2015, REACT will have helped deliver access to cheaper, cleaner energy technologies to 200,000 people. The UK is contributing £11 million to the REACT programme.

Carbon Capture and Storage (CCS) technologies: The UK is providing £60 million to support developing countries to develop both the technical and institutional knowledge necessary to enable the deployment of Carbon Capture and Storage (CCS) technologies. Successful demonstration of CCS will help to deliver ambitious international climate action. This pledge will be channelled to trust funds operated by the World Bank and Asian Development Bank.

6.10 Securing policy commitments to accelerate low carbon technology deployment through multilateral initiatives

Her Majesty's Government (HMG) works broadly at a series of international forums to create the right regulatory environment and conditions for investment, in particular making the economic case.

We also support the UNFCCC regime's work to support low carbon technology deployment. This is done so through the UNFCCC's Technology Mechanism (its Climate Technology Centre (CTC) and CTC-Network (CTC-N) and Technology Executive Committee), which aims to support and facilitate the development and deployment of low carbon technology, primarily for developing countries. We are also trying to secure broader support for a focus on phasing down fossil fuel subsidies. This is under the UNFCCC work to raise mitigation effort in the years leading to 2020, building on commitments agreed by G20 but given blocks on this issue elsewhere it will likely be very challenging to make substantial progress.

We have continued to leverage the collective commitment of the international community in other key fora and institutions to deliver policy interventions and high level actions that encourage the promotion of low carbon technologies, including:

- International Energy Agency (IEA);
- International Renewable Energy Association (IRENA);
- Active membership of the Clean Energy Ministerial (CEM)
- The UK supports the UN Secretary General and World Bank President's jointly initiated Sustainable Energy for All initiative

Further details available in the Sixth National Communication under the UNFCCC, Chapter 6 Financial Assistance and Support for Technologies.

6.11 National approach to tracking and reporting provision of support

The UK Department For international Development compiles annual statistical reporting on UK aid flows to developing countries. Detailed information is submitted annually to the Organisation for Economic Cooperation and Development (OECD), for inclusion in its Creditor Reporting System. Financial reporting is also provided against the OECD's statistical markers for climate change, biodiversity and desertification (the 'Rio markers'). The Rio markers provide for the monitoring of flows that target the objectives of the Rio Conventions and were established by the DAC in close collaboration with the Secretariat of the United Nations Framework Convention on Climate Change (UNFCCC).

In 2011 the UK Government established the International Climate Fund (ICF) to reduce poverty by helping developing countries adapt to the impacts of climate change, take up low carbon growth and address deforestation. The ICF has a comprehensive reporting framework, consisting of 15 key performance indicators, to track the effects and value for money within the ICF portfolio. Regular monitoring will be complemented by timely and robust evaluations to help inform future policy and lesson learning.

6.12 Meeting developing country needs

To ensure that Climate Finance provided by the UK addresses the needs of developing countries in tackling climate change mitigation and adaptation, the UK supports a country-driven approach to aid delivery. This helps to ensure that activities supported are consistent with developing countries' needs and priorities as reflected in their national plans.

The UK is also supporting a number of key multilateral climate change Funds that provide support at the country and regional level.

The UK is committed to building capacity to enable countries to develop their own climate change response plans as well as proposals to access climate finance (please see Building Capacity section).

6.13 Private finance

Mobilising private investment in to climate projects and infrastructure will be crucial to meeting the global goal to limiting temperature increase to 2 degrees and will be an important part of the $100 billion target. A key aim of the ICF is therefore to create new partnerships with the private sector to support low carbon, climate resilient growth in developing countries.

The UK is using its public finance, through the ICF, to mobilise increased flows of private finance by helping to reduce barriers, correct existing market failures and create the right investment conditions, testing new and innovative approaches that can be replicated and scaled-up.

6.14 Technology transfer

The UK's ICF aims to help developing countries to reduce poverty and tackle climate change. A significant portion of UK Climate Finance is targeted towards low carbon development. It is used to support transformational projects that reduce GHG emissions and help support access to energy by decarbonising energy supply and supporting energy efficiency measures that will reduce energy demand.

Many ICF programmes actively support some form of technology development or transfer, (see Table 8 in Annex 2 for details of bilateral and regional financial contributions to such programmes and projects).

6.15 Building capacity

The UK recognises that increasing the capacity of countries to develop ambitious plans and programmes, and to access climate finance, is important. The UK provides support for capacity building through a number of bilateral and multilateral channels (see Table 9 in Annex 2 for examples). Several climate finance institutions have programmes to support capacity building to enable developing countries to access their funds. The UK supports these institutions and is committed to helping countries through these established channels. For example:

- The Global Environment Facility has a global support programme for developing countries undertaking national adaptation planning;
- The Board of the Adaptation Fund (AF) has a capacity building programme to support national & regional entities to access its funds directly.
- Climate and Development Knowledge Network (CDKN) which helps developing countries develop climate plans and to access finance.

Table 7 of Annex 2 provides an overview of the information contained in Tables 7a and 7b for UK Financial Year (FY) 2011/12:

- Table 7a of Annex 2 details the UK's international climate finance from public funds in UK FY 2011/12 provided through dedicated multilateral climate change funds. It also details UK core contributions from public funds to a number of multilateral financial institutions, including regional development banks and to specialised UN bodies.
- Table 7b of Annex 2 details the UK's international climate finance from public funds in UK FY 2011/12 delivered through bilateral country, regional and global programmes.
- Table 8 of Annex 2 provides some specific examples of programmes that are being supported through the UK Government's International Climate Fund that provide some form of technology development or transfer (to a greater or lesser extent, either directly or indirectly).
- Table 9 of Annex 2 provides some specific examples of programmes that are being supported through the UK Government's International Climate Fund that actively support some form of capacity building (to a greater or lesser extent, either directly or indirectly).

Annex 2: Common Tabular Format (CTF) Tables supporting the UK's first biennial report to the UNFCCC

Table 1
Emission trends: summary

GREENHOUSE GAS EMISSIONS	*Base year [a]*	*1991*	*1992*	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*Change from base to latest reported year*
	kt CO_2 eq	*kt CO_2 eq*	*kt CO_2 eq*	*kt CO_2 eq*	*kt CO_2 eq*	*kt CO_2 eq*	*kt CO_2 eq*	*kt CO_2 eq*	*kt CO_2 eq*	*kt CO_2 eq*	*kt CO_2 eq*	*kt CO_2 eq*	*kt CO_2 eq*	*kt CO_2 eq*	*kt CO_2 eq*	*kt CO_2 eq*	*kt CO_2 eq*	*kt CO_2 eq*	*kt CO_2 eq*	*kt CO_2 eq*	*kt CO_2 eq*	*kt CO_2 eq*	*(%)*
CO_2 emissions including net CO_2 from LULUCF	593,535.72	600,680.57	583,468.55	568,759.67	562,521.65	555,308.06	576,449.61	551,847.00	555,999.29	546,567.82	554,806.58	566,024.41	549,254.88	559,383.86	560,101.21	556,093.35	554,800.11	545,815.29	533,187.03	482,659.81	499,881.38	460,687.46	-22.38
CO_2 emissions excluding net CO_2 from LULUCF	590,383.88	597,426.07	580,983.10	567,305.24	561,265.85	552,930.18	574,750.92	550,298.61	555,350.41	546,444.29	555,248.64	566,937.24	551,052.86	561,510.70	563,258.45	559,452.11	558,526.10	549,889.90	537,678.95	487,161.02	504,190.38	464,618.44	-21.30
CH_4 emissions including CH_4 from LULUCF	99,157.42	98,335.15	96,554.40	93,324.13	85,964.70	85,245.85	83,028.24	78,493.84	74,251.83	69,252.83	65,017.81	59,327.05	56,253.75	52,261.35	50,677.00	48,500.04	47,485.67	46,364.02	45,023.42	43,718.66	43,016.32	42,063.39	-57.58
CH_4 emissions excluding CH_4 from LULUCF	99,133.31	98,308.41	96,533.49	93,301.96	85,943.07	85,207.34	82,998.83	78,459.75	74,224.55	69,229.85	64,986.73	59,301.05	56,224.58	52,204.68	50,645.38	48,461.42	47,452.62	46,323.41	44,991.68	43,686.88	42,991.75	42,034.89	-57.60
N_2O emissions including N_2O from LULUCF	68,295.64	68,478.83	63,650.20	58,995.95	59,471.58	58,021.90	57,821.42	58,135.74	57,929.05	47,376.27	46,487.69	43,790.58	42,027.12	41,563.37	42,136.11	41,226.41	39,096.07	38,409.71	37,381.40	35,347.84	35,917.61	34,810.93	-49.03
N_2O emissions excluding N_2O from LULUCF	67,449.38	67,627.80	62,802.11	58,145.83	58,620.71	57,155.44	56,961.33	57,271.37	57,068.26	46,518.86	45,652.13	42,987.71	41,244.40	40,769.98	41,394.85	40,499.07	38,384.27	37,707.74	36,709.30	34,694.26	35,298.61	34,217.81	-49.27
HFCs	11,385.62	11,862.09	12,347.19	13,019.84	13,937.22	15,327.78	16,565.60	18,995.69	16,903.03	10,261.68	9,342.35	10,266.85	10,732.61	11,929.69	11,208.54	12,110.40	12,793.78	13,102.31	13,686.61	14,033.29	14,388.34	14,653.91	28.71
PFCs	1,401.60	1,170.87	573.36	489.60	485.90	461.81	479.64	397.58	387.24	366.37	460.55	384.68	318.65	275.89	340.25	297.87	301.74	219.10	203.93	145.03	220.62	325.31	-76.79
SF_6	1,029.95	1,078.44	1,124.18	1,167.19	1,183.06	1,239.30	1,266.63	1,225.55	1,262.50	1,426.05	1,798.48	1,425.05	1,509.36	1,324.22	1,128.54	1,110.38	874.54	793.21	711.77	661.55	689.58	607.48	-41.02
Total (including LULUCF)	**774,805.94**	**781,605.95**	**757,717.89**	**735,756.38**	**723,564.11**	**715,604.71**	**735,611.14**	**709,095.40**	**706,732.94**	**675,251.02**	**677,913.47**	**681,218.61**	**660,096.36**	**666,738.37**	**665,591.66**	**659,338.45**	**655,351.90**	**644,703.64**	**630,194.15**	**576,566.18**	**594,113.85**	**553,148.47**	**-28.61**
Total (excluding LULUCF)	**770,783.73**	**777,473.68**	**754,363.44**	**733,429.65**	**721,435.82**	**712,321.85**	**733,022.95**	**706,648.55**	**705,195.98**	**674,247.10**	**677,488.88**	**681,302.58**	**661,082.45**	**668,015.16**	**667,976.02**	**661,931.25**	**658,333.04**	**648,035.67**	**633,982.23**	**580,382.04**	**597,779.29**	**556,457.83**	**-27.81**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	*Base year [a]*	*1991*	*1992*	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*Change from base to latest reported year*
	kt CO_2 eq	*kt CO_2 eq*	*kt CO_2 eq*	*kt CO_2 eq*	*kt CO_2 eq*	*kt CO_2 eq*	*kt CO_2 eq*	*kt CO_2 eq*	*kt CO_2 eq*	*kt CO_2 eq*	*kt CO_2 eq*	*kt CO_2 eq*	*kt CO_2 eq*	*kt CO_2 eq*	*kt CO_2 eq*	*kt CO_2 eq*	*kt CO_2 eq*	*kt CO_2 eq*	*kt CO_2 eq*	*kt CO_2 eq*	*kt CO_2 eq*	*kt CO_2 eq*	*(%)*
1. Energy	610,755.73	620,378.94	604,134.34	588,587.64	575,101.76	567,384.96	587,044.07	561,473.15	564,275.63	553,366.45	560,670.56	572,182.01	555,866.06	564,188.07	565,087.44	559,566.86	558,401.05	548,125.77	536,216.32	489,481.42	505,448.13	465,950.63	-23.71
2. Industrial Processes	54,395.13	52,579.89	47,197.87	43,887.59	46,415.07	46,591.86	48,440.00	50,611.42	49,003.91	32,247.51	31,811.04	30,512.93	28,672.56	30,530.07	30,928.65	31,295.76	30,681.50	32,331.66	31,482.89	26,110.68	27,647.71	26,470.00	-51.34
3. Solvent and Other Product Use	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,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	0.00
4. Agriculture	58,152.58	57,918.13	57,727.06	57,050.10	57,253.64	56,867.62	57,115.18	57,220.95	56,611.75	56,011.88	54,093.99	51,118.33	51,167.93	50,805.91	50,930.49	50,546.77	49,101.46	47,770.58	46,992.92	46,245.46	46,725.39	46,674.55	-19.74
5. Land Use, Land-Use Change and Forestry [b]	4,022.20	4,132.26	3,354.45	2,326.73	2,128.28	3,282.86	2,588.19	2,446.85	1,536.96	1,003.92	424.60	-83.97	-986.08	-1,276.79	-2,384.36	-2,592.80	-2,981.14	-3,332.03	-3,788.08	-3,815.85	-3,665.43	-3,309.36	-182.28
6. Waste	47,480.30	46,596.73	45,304.17	43,904.33	42,665.35	41,477.40	40,423.70	37,343.02	35,304.69	32,621.26	30,913.29	27,489.31	25,375.90	22,491.12	21,029.45	20,521.86	20,149.03	19,807.66	19,290.10	18,544.47	17,958.06	17,362.64	-63.43
7. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
Total (including LULUCF)	**774,805.94**	**781,605.95**	**757,717.89**	**735,756.38**	**723,564.11**	**715,604.71**	**735,611.14**	**709,095.40**	**706,732.94**	**675,251.02**	**677,913.47**	**681,218.61**	**660,096.36**	**666,738.37**	**665,591.66**	**659,338.45**	**655,351.90**	**644,703.64**	**630,194.15**	**576,566.18**	**594,113.85**	**553,148.47**	**-28.61**

Table 1 (continued)
Emission trends (CO_2)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year[a]	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Change from base to latest reported year
	kt	kt	kt	kt	kt	kt	kt	kt	kt	kt	kt	kt	kt	kt	kt	kt	kt	kt	kt	kt	kt	kt	%
1. Energy	573,375.24	582,661.83	566,936.88	553,342.67	546,096.90	537,523.63	558,713.43	534,910.61	539,739.64	531,233.81	540,192.44	552,890.74	537,298.28	547,070.60	548,422.39	544,334.70	543,961.61	534,198.97	523,005.39	476,867.31	492,967.91	453,745.24	-20.86
A. Fuel Combustion (Sectoral Approach)	566,740.90	576,428.87	560,349.54	546,437.84	538,974.27	528,868.99	549,434.88	527,461.65	532,662.55	525,146.07	534,406.26	546,880.59	531,594.09	541,653.14	543,016.07	538,371.22	538,872.24	528,916.96	518,467.06	472,227.88	488,324.22	449,384.31	-20.71
1. Energy Industries	235,521.31	233,316.19	222,166.68	205,961.90	203,759.67	201,977.62	203,658.64	190,983.75	196,639.08	187,575.78	197,890.74	207,874.90	205,878.20	213,407.15	212,682.55	211,163.96	218,038.13	212,655.52	208,674.70	185,612.37	191,356.51	178,522.96	-24.20
2. Manufacturing Industries and Construction	103,521.52	105,797.73	102,633.43	100,145.26	99,292.95	95,937.84	97,049.66	95,501.34	94,463.42	94,974.98	95,413.03	94,674.96	86,165.60	87,468.63	86,386.92	86,854.39	84,618.82	83,612.34	80,980.95	70,177.13	69,459.08	67,516.75	-34.78
3. Transport	114,363.30	113,573.62	115,024.88	116,207.21	116,705.59	115,886.58	120,436.85	121,971.61	121,559.37	122,626.39	121,926.99	122,102.68	124,544.70	124,331.11	125,832.49	126,692.10	126,918.43	128,021.73	122,646.45	118,198.57	116,651.46	115,208.50	0.74
4. Other Sectors	108,049.95	119,448.91	116,437.76	119,982.54	115,256.25	111,180.78	124,484.74	115,374.25	116,806.68	116,819.29	116,259.19	119,306.15	111,948.96	113,284.08	115,061.36	110,818.76	105,833.68	100,876.26	102,911.61	95,259.29	107,964.60	85,385.12	-20.98
5. Other	5,284.82	4,292.42	4,086.79	4,140.93	3,959.80	3,886.18	3,804.99	3,630.71	3,194.00	3,149.63	2,916.31	2,921.90	3,056.63	3,162.18	3,052.75	2,842.02	3,463.17	3,751.11	3,253.34	2,980.51	2,892.56	2,750.97	-47.95
B. Fugitive Emissions from Fuels	6,634.34	6,232.97	6,587.34	6,904.84	7,122.63	8,654.63	9,278.55	7,448.95	7,077.08	6,087.74	5,786.18	6,010.15	5,704.19	5,417.46	5,406.32	5,963.47	5,089.37	5,282.00	4,538.33	4,639.44	4,643.69	4,360.93	-34.27
1. Solid Fuels	856.42	519.42	450.00	344.83	163.25	225.84	366.77	459.63	158.41	112.08	102.36	101.68	107.49	111.87	168.08	111.98	138.47	197.58	236.18	149.11	219.68	258.25	-69.85
2. Oil and Natural Gas	5,777.92	5,713.55	6,137.34	6,560.01	6,959.38	8,428.80	8,911.79	6,989.33	6,918.67	5,975.66	5,683.82	5,908.47	5,596.70	5,305.59	5,238.24	5,851.50	4,950.90	5,084.43	4,302.16	4,490.32	4,424.01	4,102.68	-28.99
2. Industrial Processes	15,716.28	13,462.53	12,773.58	12,770.34	14,146.69	14,512.52	15,145.35	14,853.41	15,072.45	14,715.14	14,553.83	13,519.82	13,227.80	13,962.93	14,385.43	14,720.69	14,239.75	15,342.13	14,369.66	10,000.21	10,924.58	10,583.42	-32.66
A. Mineral Products	10,412.92	8,748.80	8,235.24	8,274.38	9,338.65	9,399.50	9,736.60	10,174.63	10,341.24	9,680.70	9,458.45	8,897.24	8,825.50	9,024.82	9,301.13	9,210.65	9,363.23	9,599.78	8,412.94	6,099.33	6,320.56	6,640.02	-36.23
B. Chemical Industry	2,994.08	3,030.02	3,087.88	3,130.99	3,168.69	3,174.78	3,183.31	2,716.88	2,944.38	2,945.49	3,110.62	3,108.82	3,231.47	3,092.01	3,030.81	3,054.30	2,751.58	3,085.00	2,893.47	2,667.11	2,922.15	2,559.68	-14.51
C. Metal Production	2,309.27	1,683.72	1,450.46	1,364.97	1,639.35	1,938.24	2,225.44	1,961.90	1,786.83	2,088.95	1,984.76	1,513.75	1,170.83	1,846.10	2,053.49	2,455.75	2,124.94	2,657.34	3,063.24	1,233.77	1,681.87	1,383.72	-40.08
D. Other Production	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.00
E. Production of Halocarbons and SF_6																							
F. Consumption of Halocarbons and SF_6																							
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
3. Solvent and Other Product Use	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.00
4. Agriculture																							
A. Enteric Fermentation																							
B. Manure Management																							
C. Rice Cultivation																							
D. Agricultural Soils																							
E. Prescribed Burning of Savannas																							
F. Field Burning of Agricultural Residues																							
G. Other																							
5. Land Use, Land-Use Change and Forestry	3,151.84	3,254.49	2,485.45	1,454.43	1,255.80	2,377.88	1,698.69	1,548.39	648.89	123.53	-442.05	-912.83	-1,797.97	-2,126.85	-3,157.23	-3,358.76	-3,725.99	-4,074.62	-4,491.92	-4,501.21	-4,309.00	-3,930.98	-224.72
A. Forest Land	-12,002.08	-12,348.43	-13,256.49	-13,552.66	-14,059.95	-12,898.38	-13,169.91	-12,792.50	-12,995.57	-13,415.70	-13,555.61	-14,002.21	-14,727.39	-15,345.92	-15,916.67	-15,161.43	-14,693.20	-13,768.87	-13,226.74	-12,395.92	-10,448.93	-10,221.62	-14.83
B. Cropland	15,752.87	15,955.15	15,994.76	15,598.05	15,684.39	15,855.67	15,921.44	15,685.45	15,583.30	15,502.84	15,097.69	14,733.33	14,462.26	14,257.43	13,909.03	13,574.73	13,378.69	13,217.68	12,891.17	12,743.99	11,938.16	11,454.22	-27.29
C. Grassland	-6,312.65	-6,276.10	-6,420.00	-6,793.75	-6,861.94	-6,855.88	-7,082.34	-7,089.43	-7,448.59	-7,626.19	-7,799.43	-7,965.96	-8,059.31	-7,969.15	-8,214.70	-8,323.84	-8,695.67	-8,794.63	-8,868.32	-8,878.16	-8,587.69	-8,484.39	34.40
D. Wetlands	481.73	489.31	483.23	476.50	594.64	681.11	587.28	524.93	404.97	540.93	537.03	582.92	391.16	628.83	459.14	517.64	538.91	377.28	335.69	375.20	402.63	402.68	-16.41
E. Settlements	6,942.64	6,881.18	6,820.00	6,772.36	6,729.88	6,672.95	6,649.20	6,631.02	6,594.89	6,614.75	6,570.29	6,535.51	6,475.57	6,443.19	6,401.47	6,355.77	6,293.01	6,254.00	6,206.09	6,184.60	6,249.72	6,319.92	-8.97
F. Other Land	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
G. Other	-1,710.68	-1,446.62	-1,136.06	-1,046.07	-831.24	-1,077.58	-1,206.98	-1,411.07	-1,490.11	-1,493.10	-1,292.02	-796.42	-340.27	-141.22	204.48	-321.64	-547.74	-1,360.08	-1,829.81	-2,530.92	-3,862.89	-3,401.78	98.86

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	*Base year* [a]	*1991*	*1992*	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*Change from base to latest reported year*
	kt	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*%*
6. Waste	1,292.36	1,301.71	1,272.64	1,192.22	1,022.26	894.04	892.14	534.59	538.32	495.34	502.36	526.68	526.77	477.17	450.63	396.72	324.74	348.81	303.90	293.49	297.89	289.77	-77.58
A. Solid Waste Disposal on Land	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	0.00
B. Waste-water Handling																							
C. Waste Incineration	1,292.36	1,301.71	1,272.64	1,192.22	1,022.26	894.04	892.14	534.59	538.32	495.34	502.36	526.68	526.77	477.17	450.63	396.72	324.74	348.81	303.90	293.49	297.89	289.77	-77.58
D. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
7. Other (as specified in the summary table in CRF)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
Total CO_2 emissions including net CO_2 from LULUCF	**593,535.72**	**600,680.57**	**583,468.55**	**568,759.67**	**562,521.65**	**555,308.06**	**576,449.61**	**551,847.00**	**555,999.29**	**546,567.82**	**554,806.58**	**566,024.41**	**549,254.88**	**559,383.86**	**560,101.21**	**556,093.35**	**554,800.11**	**545,815.29**	**533,187.03**	**482,659.81**	**499,881.38**	**460,687.46**	**-22.38**
Total CO_2 emissions excluding net CO_2 from LULUCF	**590,383.88**	**597,426.07**	**580,983.10**	**567,305.24**	**561,265.85**	**552,930.18**	**574,750.92**	**550,298.61**	**555,350.41**	**546,444.29**	**555,248.64**	**566,937.24**	**551,052.86**	**561,510.70**	**563,258.45**	**559,452.11**	**558,526.10**	**549,889.90**	**537,678.95**	**487,161.02**	**504,190.38**	**464,618.44**	**-21.30**
Memo Items:																							
International Bunkers	24,462.97	24,204.14	25,981.85	27,047.64	26,971.93	28,414.99	30,508.04	32,610.92	35,644.35	35,036.03	37,118.64	36,549.20	34,471.21	36,205.83	39,925.22	43,011.05	45,857.03	45,165.18	45,724.77	43,146.95	40,367.26	42,779.94	74.88
Aviation	15,674.66	15,427.14	17,040.75	18,224.79	18,994.26	20,192.47	21,366.63	22,710.32	25,262.58	27,442.77	30,256.23	29,470.17	28,931.57	29,620.07	32,479.06	35,081.65	35,587.71	35,406.55	34,817.06	32,769.44	31,565.09	32,878.37	109.75
Marine	8,788.31	8,777.00	8,941.10	8,822.85	7,977.67	8,222.53	9,141.41	9,900.60	10,381.77	7,593.26	6,862.41	7,079.03	5,539.64	6,585.76	7,446.16	7,929.40	10,269.31	9,758.63	10,907.71	10,377.51	8,802.18	9,901.57	12.67
Multilateral Operations	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.00
CO_2 Emissions from Biomass	3,105.58	3,253.94	3,663.06	3,814.66	5,026.15	5,353.67	5,612.25	5,884.50	5,969.55	6,774.56	7,159.32	8,196.83	9,385.67	11,493.70	11,114.55	12,533.36	13,108.45	14,205.11	16,767.04	18,340.80	20,610.31	21,938.16	606.41

Table 1 (continued)
Emission trends (CH_4)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	*Base year* [a]	*1991*	*1992*	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*Change from base to latest reported year*
	kt	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*%*
1. Energy	1,494.34	1,511.77	1,491.93	1,407.96	1,104.95	1,139.84	1,078.63	1,005.30	909.88	803.73	724.94	668.90	638.34	574.49	560.40	490.85	458.94	440.85	420.81	411.08	403.06	390.18	-73.89
A. Fuel Combustion (Sectoral Approach)	129.36	132.04	124.13	121.74	107.46	93.16	95.85	90.89	90.99	92.52	78.97	73.45	66.40	64.08	61.58	58.05	56.37	57.53	57.86	53.48	55.92	52.07	-59.75
1. Energy Industries	9.68	9.63	9.58	9.70	10.82	11.15	11.69	11.51	12.35	13.15	12.59	13.26	13.98	13.33	13.59	13.22	11.53	12.27	12.04	12.34	12.57	11.42	17.88
2. Manufacturing Industries and Construction	15.75	15.58	14.88	14.89	15.55	15.83	16.34	16.88	16.38	16.10	15.64	14.56	13.60	14.79	14.07	13.79	13.97	13.68	12.81	10.90	10.88	10.95	-30.46
3. Transport	30.57	30.20	29.07	27.35	25.42	23.51	21.90	20.09	18.41	16.81	14.62	12.76	11.41	10.18	9.14	8.28	7.55	6.75	5.91	4.38	3.75	3.31	-89.17
4. Other Sectors	73.21	76.51	70.49	69.69	55.55	42.55	45.82	42.31	43.75	46.38	36.04	32.78	27.34	25.70	24.70	22.68	23.21	24.72	27.00	25.78	28.63	26.32	-64.05
5. Other	0.15	0.12	0.11	0.12	0.11	0.11	0.11	0.10	0.09	0.09	0.08	0.08	0.09	0.09	0.08	0.08	0.10	0.11	0.09	0.08	0.08	0.08	-48.84
B. Fugitive Emissions from Fuels	1,364.98	1,379.74	1,367.80	1,286.22	997.49	1,046.68	982.78	914.41	818.89	711.21	645.96	595.46	571.94	510.40	498.82	432.81	402.58	383.32	362.95	357.60	347.14	338.12	-75.23
1. Solid Fuels	871.72	896.33	888.88	827.76	549.60	601.19	556.29	533.14	454.19	375.86	323.37	286.98	282.17	232.39	208.70	154.81	140.85	111.75	111.00	106.98	99.56	95.06	-89.09
2. Oil and Natural Gas	493.26	483.41	478.92	458.46	447.90	445.49	426.49	381.27	364.70	335.35	322.59	308.48	289.78	278.02	290.12	278.00	261.73	271.57	251.95	250.62	247.58	243.05	-50.73
2. Industrial Processes	9.97	9.48	9.92	8.71	10.28	8.31	9.51	8.02	6.14	5.35	5.04	4.69	4.79	5.78	5.34	4.86	4.68	5.35	4.26	4.19	4.83	4.14	-58.47
A. Mineral Products	1.12	0.91	0.82	0.69	0.77	0.77	0.72	0.71	0.71	0.59	0.59	0.58	0.59	0.62	0.61	0.51	0.83	0.88	0.43	0.26	0.27	0.25	-78.03
B. Chemical Industry	8.07	8.03	8.64	7.59	8.95	6.84	8.00	6.62	4.80	4.03	3.78	3.68	3.92	4.57	4.07	3.51	3.19	3.61	2.86	3.61	4.00	3.47	-57.00
C. Metal Production	0.78	0.53	0.46	0.44	0.56	0.70	0.79	0.69	0.63	0.73	0.68	0.42	0.29	0.59	0.66	0.84	0.66	0.87	0.97	0.31	0.56	0.43	-45.36
D. Other Production																							
E. Production of Halocarbons and SF_6																							
F. Consumption of Halocarbons and SF_6																							
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
3. Solvent and Other Product Use																							
4. Agriculture	1,075.08	1,060.85	1,057.89	1,051.56	1,053.26	1,036.29	1,043.22	1,029.13	1,023.96	1,018.24	979.94	928.23	913.16	916.36	924.23	912.86	910.77	891.60	871.09	854.90	858.44	854.14	-20.55
A. Enteric Fermentation	896.91	884.46	884.68	883.28	888.59	880.03	890.07	877.04	878.29	878.19	847.22	799.21	785.75	789.48	794.49	784.39	779.52	764.63	747.34	733.78	736.07	732.22	-18.36
B. Manure Management	165.51	165.83	165.42	168.22	164.67	156.25	153.15	152.08	145.67	140.05	132.72	129.02	127.40	126.88	129.74	128.48	131.25	126.97	123.74	121.12	122.37	121.91	-26.34
C. Rice Cultivation	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
D. Agricultural Soils	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	IE,NA,NE,NO	0.00
E. Prescribed Burning of Savannas	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
F. Field Burning of Agricultural Residues	12.66	10.56	7.79	0.06	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	-100.00
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
5. Land Use, Land-Use Change and Forestry	1.15	1.27	1.00	1.06	1.03	1.83	1.40	1.62	1.30	1.09	1.48	1.24	1.39	2.70	1.51	1.84	1.57	1.93	1.51	1.51	1.17	1.36	18.19
A. Forest Land	0.20	0.35	0.09	0.15	0.12	0.95	0.49	0.64	0.35	0.06	0.19	0.26	0.22	0.19	0.24	0.41	0.37	0.41	0.40	0.40	0.23	0.33	63.53
B. Cropland	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.01	0.01	0.01	0.02	0.02	0.02	0.01	0.01	101.62
C. Grassland	0.62	0.62	0.62	0.62	0.63	0.63	0.63	0.67	0.63	0.63	0.86	0.53	0.75	2.07	0.85	1.02	0.84	1.17	0.79	0.77	0.61	0.67	7.75
D. Wetlands	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,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	0.00
E. Settlements	0.32	0.30	0.28	0.27	0.28	0.25	0.28	0.31	0.31	0.40	0.41	0.43	0.40	0.41	0.41	0.39	0.35	0.34	0.30	0.32	0.32	0.34	7.51
F. Other Land	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
G. Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.00

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	*Base year* [a]	*1991*	*1992*	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*Change from base to latest reported year*
	kt	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*%*
6. Waste	2,141.24	2,099.26	2,037.10	1,974.72	1,924.03	1,873.06	1,820.97	1,693.74	1,594.52	1,469.35	1,384.69	1,222.04	1,121.07	989.31	921.71	899.11	885.25	868.07	846.30	810.17	780.90	753.20	-64.82
A. Solid Waste Disposal on Land	2,054.57	2,012.64	1,950.92	1,889.20	1,839.87	1,788.77	1,736.46	1,612.89	1,513.45	1,385.97	1,299.04	1,135.21	1,035.30	904.54	833.83	811.39	796.35	778.09	756.23	731.21	703.24	674.81	-67.16
B. Waste-water Handling	80.27	80.27	80.09	80.11	80.19	80.48	80.36	80.52	80.70	83.00	85.25	86.50	85.43	84.44	87.56	87.40	88.60	89.67	89.79	78.66	77.36	78.09	-2.71
C. Waste Incineration	6.40	6.35	6.09	5.41	3.98	3.81	4.15	0.33	0.37	0.38	0.40	0.34	0.33	0.33	0.32	0.32	0.31	0.31	0.29	0.29	0.30	0.29	-95.42
D. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
7. Other (as specified in the summary table in CRF)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
Total CH_4 emissions including CH_4 from LULUCF	**4,721.78**	**4,682.63**	**4,597.83**	**4,444.01**	**4,093.56**	**4,059.33**	**3,953.73**	**3,737.80**	**3,535.80**	**3,297.75**	**3,096.09**	**2,825.10**	**2,678.75**	**2,488.64**	**2,413.19**	**2,309.53**	**2,261.22**	**2,207.81**	**2,143.97**	**2,081.84**	**2,048.40**	**2,003.02**	**-57.58**
Total CH_4 emissions excluding CH_4 from LULUCF	**4,720.63**	**4,681.35**	**4,596.83**	**4,442.95**	**4,092.53**	**4,057.49**	**3,952.33**	**3,736.18**	**3,534.50**	**3,296.66**	**3,094.61**	**2,823.86**	**2,677.36**	**2,485.94**	**2,411.68**	**2,307.69**	**2,259.65**	**2,205.88**	**2,142.46**	**2,080.33**	**2,047.23**	**2,001.66**	**-57.60**
Memo Items:																							
International Bunkers	0.44	0.39	0.38	0.37	0.33	0.33	0.35	0.36	0.36	0.29	0.26	0.23	0.20	0.21	0.22	0.23	0.27	0.26	0.27	0.26	0.23	0.25	-44.01
Aviation	0.30	0.25	0.24	0.23	0.21	0.20	0.20	0.20	0.20	0.18	0.15	0.12	0.11	0.11	0.10	0.11	0.11	0.10	0.10	0.09	0.09	0.09	-69.54
Marine	0.14	0.14	0.14	0.14	0.13	0.13	0.14	0.16	0.16	0.12	0.11	0.11	0.09	0.10	0.12	0.12	0.16	0.15	0.17	0.16	0.14	0.15	11.63
Multilateral Operations	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.00
CO_2 Emissions from Biomass																							

Table 1 (continued)
Emission trends (N_2O)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	*Base year* [a]	*1991*	*1992*	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*Change from base to latest reported year*
	kt	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*%*
1. Energy	19.35	19.26	18.93	18.32	18.71	19.11	18.32	17.58	17.51	16.95	16.95	16.92	16.65	16.30	15.80	15.88	15.49	15.06	14.11	12.84	12.95	12.94	-33.13
A. Fuel Combustion (Sectoral Approach)	19.21	19.12	18.78	18.16	18.55	18.91	18.12	17.40	17.34	16.78	16.80	16.76	16.51	16.17	15.66	15.73	15.36	14.93	14.00	12.73	12.80	12.74	-33.68
1. Energy Industries	6.67	6.65	6.38	5.64	5.61	5.55	5.36	4.90	5.09	4.63	5.00	5.25	5.34	5.38	5.17	5.29	5.39	4.98	4.82	4.38	4.41	4.49	-32.66
2. Manufacturing Industries and Construction	5.23	5.13	5.17	4.93	4.97	4.83	4.71	4.57	4.45	4.45	4.37	4.37	4.34	4.24	4.20	4.37	4.13	4.27	3.99	3.32	3.30	3.09	-40.92
3. Transport	4.02	3.99	4.03	4.31	4.87	5.64	5.09	5.04	5.01	4.95	4.84	4.58	4.39	4.16	4.01	3.84	3.72	3.62	3.12	2.95	2.96	3.06	-23.87
4. Other Sectors	3.13	3.21	3.09	3.14	2.99	2.77	2.84	2.79	2.69	2.66	2.50	2.47	2.35	2.29	2.18	2.15	2.02	1.96	1.97	1.99	2.05	2.02	-35.60
5. Other	0.16	0.13	0.12	0.12	0.12	0.12	0.11	0.11	0.10	0.09	0.09	0.09	0.09	0.09	0.09	0.08	0.10	0.11	0.10	0.09	0.09	0.08	-48.28
B. Fugitive Emissions from Fuels	0.14	0.14	0.15	0.16	0.17	0.20	0.20	0.18	0.17	0.17	0.15	0.16	0.15	0.13	0.13	0.15	0.13	0.13	0.11	0.12	0.15	0.20	40.31
1. Solid Fuels	0.01	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	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	-18.85
2. Oil and Natural Gas	0.14	0.14	0.15	0.16	0.16	0.20	0.20	0.18	0.17	0.17	0.15	0.15	0.14	0.13	0.13	0.15	0.12	0.13	0.11	0.12	0.15	0.20	43.22
2. Industrial Processes	79.52	80.02	65.07	52.44	53.05	47.99	47.69	48.29	49.19	17.31	17.90	15.54	8.98	9.41	12.11	9.53	7.66	8.91	7.81	3.81	4.27	0.69	-99.14
A. Mineral Products	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.00
B. Chemical Industry	79.49	79.99	65.04	52.42	53.02	47.95	47.65	48.26	49.16	17.28	17.87	15.52	8.96	9.38	12.08	9.50	7.63	8.88	7.78	3.80	4.25	0.67	-99.16
C. Metal Production	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.03	0.03	0.02	0.03	0.03	0.02	0.02	0.02	-44.68
D. Other Production																							
E. Production of Halocarbons and SF_6																							
F. Consumption of Halocarbons and SF_6																							
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
3. Solvent and Other Product Use	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,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	0.00
4. Agriculture	114.76	114.97	114.55	112.80	113.34	113.24	113.57	114.87	113.25	111.71	108.11	102.02	103.20	101.81	101.68	101.21	96.69	93.70	92.58	91.27	92.57	92.70	-19.22
A. Enteric Fermentation																							
B. Manure Management	6.32	6.51	6.50	6.53	6.57	6.71	6.91	7.16	7.09	6.79	6.74	6.55	6.22	6.28	6.27	6.00	5.90	5.75	5.59	5.43	5.37	5.31	-15.97
C. Rice Cultivation																							
D. Agricultural Soils	107.90	107.96	107.60	105.98	106.48	106.24	106.37	107.42	105.87	104.64	101.09	95.16	96.68	95.28	95.16	94.97	90.53	87.68	86.73	85.58	86.95	87.15	-19.23
E. Prescribed Burning of Savannas	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
F. Field Burning of Agricultural Residues	0.26	0.21	0.16	0.00	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	-100.00
G. Other	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.28	0.28	0.30	0.30	0.26	0.26	0.25	0.26	0.27	0.27	0.25	0.25	0.25	-13.73
5. Land Use, Land-Use Change and Forestry	2.73	2.75	2.74	2.74	2.74	2.80	2.77	2.79	2.78	2.77	2.70	2.59	2.52	2.56	2.39	2.35	2.30	2.26	2.17	2.11	2.00	1.91	-29.91
A. Forest Land	0.18	0.19	0.18	0.18	0.18	0.23	0.20	0.21	0.20	0.18	0.19	0.20	0.20	0.20	0.20	0.21	0.21	0.21	0.21	0.21	0.20	0.20	10.68
B. Cropland	2.48	2.49	2.49	2.50	2.50	2.51	2.51	2.52	2.52	2.53	2.44	2.37	2.29	2.23	2.16	2.10	2.04	1.98	1.93	1.88	1.77	1.67	-32.66
C. Grassland	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.02	0.03	0.13	0.03	0.04	0.05	0.07	0.03	0.02	0.02	0.03	-30.21
D. Wetlands	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-87.21
E. Settlements	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	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.51
F. Other Land	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
G. Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.00

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	*Base year* [a]	*1991*	*1992*	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*Change from base to latest reported year*
	kt	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*%*
6. Waste	3.94	3.91	4.04	4.01	3.99	4.03	4.17	4.00	4.13	4.10	4.30	4.19	4.22	3.99	3.95	4.01	3.98	3.97	3.92	3.99	4.07	4.05	2.77
A. Solid Waste Disposal on Land																							
B. Waste-water Handling	3.76	3.73	3.86	3.83	3.85	3.88	4.00	3.90	3.95	3.91	4.11	4.00	4.02	3.81	3.76	3.83	3.80	3.79	3.76	3.83	3.90	3.89	3.51
C. Waste Incineration	0.18	0.18	0.18	0.18	0.15	0.15	0.16	0.10	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.18	0.18	0.18	0.15	0.16	0.17	0.16	-12.53
D. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
7. Other (as specified in the summary table in CRF)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
Total N_2O emissions including N_2O from LULUCF	**220.31**	**220.90**	**205.32**	**190.31**	**191.84**	**187.17**	**186.52**	**187.53**	**186.87**	**152.83**	**149.96**	**141.26**	**135.57**	**134.08**	**135.92**	**132.99**	**126.12**	**123.90**	**120.59**	**114.03**	**115.86**	**112.29**	**-49.03**
Total N_2O emissions excluding N_2O from LULUCF	**217.58**	**218.15**	**202.59**	**187.57**	**189.10**	**184.37**	**183.75**	**184.75**	**184.09**	**150.06**	**147.26**	**138.67**	**133.05**	**131.52**	**133.53**	**130.64**	**123.82**	**121.64**	**118.42**	**111.92**	**113.87**	**110.38**	**-49.27**
Memo Items:																							
International Bunkers	0.72	0.71	0.77	0.80	0.80	0.85	0.91	0.97	1.06	1.06	1.13	1.11	1.06	1.10	1.22	1.31	1.39	1.37	1.38	1.30	1.22	1.29	79.60
Aviation	0.50	0.49	0.54	0.58	0.60	0.64	0.68	0.72	0.80	0.87	0.96	0.94	0.92	0.94	1.03	1.11	1.13	1.12	1.11	1.04	1.00	1.04	109.75
Marine	0.22	0.22	0.22	0.22	0.20	0.21	0.23	0.25	0.26	0.19	0.17	0.18	0.14	0.16	0.19	0.20	0.26	0.24	0.27	0.26	0.22	0.25	11.63
Multilateral Operations	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.00
CO_2 Emissions from Biomass																							

Table 1 (continued)
Emission trends (HFCs, PFCs and SF_6)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	*Base year*[a]	*1991*	*1992*	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*Change from base to latest reported year*
	kt	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*%*
Emissions of HFCs[c] – (kt CO_2 eq)	11,385.62	11,862.09	12,347.19	13,019.84	13,937.22	15,327.78	16,565.60	18,995.69	16,903.03	10,261.68	9,342.35	10,266.85	10,732.61	11,929.69	11,208.54	12,110.40	12,793.78	13,102.31	13,686.61	14,033.29	14,388.34	14,653.91	28.71
HFC-23	0.97	1.01	1.05	1.09	1.13	1.19	1.22	1.33	1.03	0.41	0.22	0.20	0.17	0.16	0.03	0.03	0.02	0.01	0.01	0.00	0.00	0.00	-99.79
HFC-32	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.03	0.04	0.06	0.08	0.10	0.12	0.15	0.18	0.21	0.24	0.27	0.30	0.35	0.39	2,154,437.37
HFC-41	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	0.00
HFC-43-10mee	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	0.00	0.00	0.01	0.02	0.03	0.04	0.04	0.05	0.06	0.07	0.08	0.08	100.00
HFC-125	0.00	0.00	0.00	0.00	0.01	0.01	0.03	0.06	0.11	0.17	0.24	0.32	0.37	0.45	0.52	0.58	0.71	0.75	0.80	0.85	0.99	1.06	3,071,864.60
HFC-134	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	0.00	0.00	0.00	0.00	100.00
HFC-134a	0.01	0.01	0.03	0.18	0.50	1.00	1.60	2.30	3.06	3.18	3.79	4.26	4.49	5.04	5.27	5.69	5.87	5.96	6.23	6.29	6.20	6.18	65,082.34
HFC-152a	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.04	0.07	0.07	0.09	0.08	0.19	0.17	0.18	0.14	0.17	0.17	0.15	0.12	0.12	0.13	51,810.80
HFC-143	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	0.00
HFC-143a	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.06	0.10	0.15	0.20	0.26	0.31	0.37	0.42	0.46	0.51	0.55	0.57	0.60	0.62	0.64	1,263,552.53
HFC-227ea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.06	0.09	0.13	0.16	0.21	0.25	0.27	0.28	0.28	0.28	0.28	0.28	0.28	0.28	144,330.95
HFC-236fa	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	0.00
HFC-245ca	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	0.00
Unspecified mix of listed HFCs[d] – (kt CO_2 eq)	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	0.00
Emissions of PFCs[c] – (kt CO_2 eq)	1,401.60	1,170.87	573.36	489.60	485.90	461.81	479.64	397.58	387.24	366.37	460.55	384.68	318.65	275.89	340.25	297.87	301.74	219.10	203.93	145.03	220.62	325.31	-76.79
CF_4	0.18	0.14	0.07	0.05	0.05	0.04	0.04	0.03	0.03	0.03	0.04	0.03	0.02	0.02	0.02	0.02	0.02	0.01	0.02	0.01	0.02	0.02	-85.94
C_2F_6	0.03	0.02	0.01	0.01	0.01	0.01	0.02	0.02	0.01	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	-65.46
C_3F_8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.01	13,804.61
C_4F_{10}	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	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	0.00	IE,NA,NO	IE,NA,NO	0.00
c-C_4F_8	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	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	204.27
C_5F_{12}	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	0.00
C_6F_{14}	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	0.00
Unspecified mix of listed PFCs[(4)] – (Gg CO_2 equivalent)	10.90	10.91	10.96	27.23	49.01	70.79	54.30	21.05	14.59	5.99	7.80	3.41	5.21	1.26	2.05	2.50	2.05	1.24	0.26	0.26	0.88	1.98	-81.84
Emissions of SF_6[(3)] – (Gg CO_2 equivalent)	1,029.95	1,078.44	1,124.18	1,167.19	1,183.06	1,239.30	1,266.63	1,225.55	1,262.50	1,426.05	1,798.48	1,425.05	1,509.36	1,324.22	1,128.54	1,110.38	874.54	793.21	711.77	661.55	689.58	607.48	-41.02
SF_6	0.04	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.06	0.08	0.06	0.06	0.06	0.05	0.05	0.04	0.03	0.03	0.03	0.03	0.03	-41.02

[a] The Base Year for emissions of carbon dioxide, methane and nitrous oxide is 1990. The Base Year for emissions of fluorinated gases (F-gases) is 1995. The Fixed Base Year is taken from the UK's Initial Report under the Kyoto Protocol. This report was submitted in 2006, based on emissions reported in the 1990-2004 Greenhouse Gas Inventory, and was subject to official review in 2007. For the purposes of calculating achievement of the Kyoto Protocol target emissions occurring in this base year are now fixed, in MtCO2-eq.

Table 2(a)
Description of quantified economy-wide emission reduction target: base year

		Comments
Base year/ base period	1990	Legally binding target trajectories for the period 2013-2020 are enshrined in both the EU-ETS Directive (Directive 2003/87/EC and respective amendments) and the Effort Sharing Decision (Decision No 406/2009/EC). These legally binding trajectories not only result in a 20% GHG reduction in 2020 compared to 1990 but also define the EU's annual target pathway to reduce EU GHG emissions from 2013 to 2020. The Effort Sharing Decision sets annual national emission targets for all Member States for the period 2013-2020 for those sectors not covered by the EU emissions trading system (ETS), expressed as percentage changes from 2005 levels. In March 2013, the Commission formally adopted the national annual limits throughout the period for each Member State. By 2020, the national targets will collectively deliver a reduction of around 10% in total EU emissions from the sectors covered compared with 2005 levels. The emission reduction to be achieved from the sectors covered by the EU ETS will be 21% below 2005 emission levels.
Emission reduction target (% of 1990)	20%	
Period for reaching target	2020	

Table 2(b)
Description of quantified economy-wide emission reduction target: gases and sectors covered

Gases covered	*Base year for each gas (year)*
CO_2	1990
CH_4	1990
N_2O	1990
HFCs	1990
PFCs	1990
SF_6	1990
NF_3	1995/2000

Sectors covered	*Covered*
Energy	Yes
Transport	Yes
Industrial processes	Yes
Agriculture	Yes
LULUCF	No
Waste	Yes

Other sectors (specify)		
Aviation	Yes	Aviation in the scope of the EU-ETS: CO_2 emissions from all flights falling within the aviation activities listed in Annex I of the EU ETS Directive which depart from an aerodrome situated in the territory of a Member State and those which arrive in such an aerodrome from a third country, excluding small commercial emitters.

Table 2(c)
Description of quantified economy-wide emission reduction target: global warming potential values (GWP)

Gases	*GWP values*	*Comments*
CO_2	IPCC AR4	From 2013 onwards, we will use IPCC AR4 GWPs as adopted in UNFCCC reporting guidelines for national GHG inventories of Annex I Parties and as adopted under the EU Monitoring Mechanism Regulation.
CH_4	IPCC AR4	From 2013 onwards, we will use IPCC AR4 GWPs as adopted in UNFCCC reporting guidelines for national GHG inventories of Annex I Parties and as adopted under the EU Monitoring Mechanism Regulation.
N_2O	IPCC AR4	From 2013 onwards, we will use IPCC AR4 GWPs as adopted in UNFCCC reporting guidelines for national GHG inventories of Annex I Parties and as adopted under the EU Monitoring Mechanism Regulation.
HFCs	IPCC AR4	From 2013 onwards, we will use IPCC AR4 GWPs as adopted in UNFCCC reporting guidelines for national GHG inventories of Annex I Parties and as adopted under the EU Monitoring Mechanism Regulation.
PFCs	IPCC AR4	From 2013 onwards, we will use IPCC AR4 GWPs as adopted in UNFCCC reporting guidelines for national GHG inventories of Annex I Parties and as adopted under the EU Monitoring Mechanism Regulation.
SF_6	IPCC AR4	From 2013 onwards, we will use IPCC AR4 GWPs as adopted in UNFCCC reporting guidelines for national GHG inventories of Annex I Parties and as adopted under the EU Monitoring Mechanism Regulation.
NF_3	IPCC AR4	From 2013 onwards, we will use IPCC AR4 GWPs as adopted in UNFCCC reporting guidelines for national GHG inventories of Annex I Parties and as adopted under the EU Monitoring Mechanism Regulation. Base year not yet determined.

Table 2(d)
Description of quantified economy-wide emission reduction target: approach to counting emissions and removals from the LULUCF sector

Role of LULUCF	
LULUCF in base year level and target	Excluded
Contribution of LULUCF is calculated using	

Table 2(e)I
Description of quantified economy-wide emission reduction target: market-based mechanisms under the Convention

	Possible scale of contributions (estimated kt CO_2eq)	*Comments*
CERs	0	The exact number of units that can be used during the period 2013-2020 can only be determined following the availability of final data concerning the use of these units during the period 2008-2012 and relevant greenhouse gas emissions data. The use of these units under the ETS Directive and the Effort Sharing Decision is subject to the limits specified above which do not separate between CERs and ERUs, but include additional criteria for the use of CERs.
ERUs	0	The exact number of units that can be used during the period 2013-2020 can only be determined following the availability of final data concerning the use of these units during the period 2008-2012 and relevant greenhouse gas emissions data. The use of these units under the ETS Directive and the Effort Sharing Decision is subject to the limits specified abve which do not separate between CERs and ERUs, but include additional criteria for the use of ERUs.
AAUsb	0	AAUs for the period 2013-2020 have not yet been determined. The EU expects to achieve ist 20% target for the period 2013-2020 with the implementation of the ETS Directive and the ESD Decision in the non-ETS sectors which do not allow the use of AAUs from non-EU Parties.
Carry-over unitsc	0	The exact number of carry-over units for the EU and its Member States from the first commitment period that can be used for compliance during the period 2013-2020 can only be determined after the true-up period of the first commitment period. In the second commitment period the use of such units in the PPSR account depend on the extent by which emissions during the second commitment period exceed the assigned amount for that commitment period, which can only be determined at the end of the second commitment period. At CMP.9 the EU made a declaration when adopting the Doha amendment of the Kyoto Protocol that the European Union legislation on Climate-Energy Package for the implementation of its emission reduction objectives for the period 2013-2020 does not allow the use of surplus AAUs carried over from the first commitment period to meet these objectives.
Other mechanism units under the Convention (specify)d	0	There are general provisions in place in the EU legislation that allow for the use of such units provided that the necessary legal arrangements for the creation of such units have been put in placein the EU which is not the case at the point in time of the provision of this report.

Table 2(e)II
Description of quantified economy-wide emission reduction target: other market-based mechanisms

	Possible scale of contributions (estimated kt CO_2eq)	
—	0	

Table 2(f)
Description of quantified economy-wide emission reduction target: any other information

In December 2009, the European Council reiterated the conditional offer of the EU to move to a 30% reduction by 2020 compared to 1990 levels as part of a global and comprehensive agreement for the period beyond 2012, provided that other developed countries commit themselves to comparable emission reductions and that developing countries contribute adequately according to their responsibilities and respective capabilities.

Table 3
Progress in achievement of the quantified economy-wide emission reduction target: information on mitigation actions and their effects

Name of Mitigation Action	*Sectors affected*	*GHG affected*	*Objective and or activity affected*	*Type of Instrument*	*Status of implemention*	*Brief Description*	*Start Year of Implementation*	*Implementing Entity or Entitities*	*Greenhouse Gas Saving ($ktCO_2$ eq)*						
									2005	2010	2011	2015	2020	2025	2030
New Energy Supply policies[1,3]									0	-2,204	4,206	31,111	73,113	80,958	93,638
Renewables Obligation[1]	Energy Supply	CO_2, (CH_4, N_2O)	To increase in the proportion of electricity generation and supply from renewables	Regulatory, Economic	Implemented	Sets an annual obligation on electricity suppliers to produce a prooprtion of their generation from renewable sources. Targets can be met by renewable generation that accrue Renewable Energy Certificate (ROCs) or by trading.	2002	Department of Energy & Climate Change (DECC), Office of Gas and Electricity Markets (Ofgem)	IE	IE	IE	IE	IE	IE	IE
EU ETS Carbon Price[1]	Energy Supply, Business, Public, Industrial Processes	CO_2, (CH_4), N_2O, PFCs.	To reduce the use of emissions intensive fossil fuels and increase the use of renewables	Economic	Implemented	To set up a EU-wide market in emissions permits, with a decreasing cap on permits so as to (1) reduce the use of emissions intensive fossil fuels (2) increase the use of renewables	2005	European Commission. Department of Energy & Climate Change (DECC)	IE	IE	IE	IE	IE	IE	IE
Large Combustion Plant Directive[1]	Energy Supply, Business, Industrial Processes	CO_2, (CH_4, N_2O)	To improve air quality by limiting industrial emisions of nitrogen oxides, sulphur dioxide and dust. This indirectly acts to mitgate GHG emission by reducing the use of high carbon (coal) generation in the electricity supply industry.	Regulatory	Implemented	Transposes the Large Combustion Plant Directive (LCPD, 2001/80/EC) into UK law. Sets limits on emissions from combustion plants with a thermal capacity of 50 MW or greater in line with a National Emissions Reduction Plan. The directive specifies emission limits for sulphur dioxide, nitrogen oxides, and dust.	2007	Department for Food, Environment and Rural Affairs (DEFRA)	IE	IE	IE	IE	IE	IE	IE
Additional renewables in generation (Renewable Energy Strategy)[1,2,3]	Energy Supply	CO_2, (CH_4, N_2O)	To further increase in the proportion of electricity generation and supply from renewables	Regulatory, Economic	Implemented	Increases RO targets in electricity supply so as meet the UK's overall renewables target for 2020 as set out in the Renewables Directive (RED, 2009/28/EC).	2009	Department of Energy & Climate Change (DECC), Office of Gas and Electricity Markets (Ofgem)	IE	IE	IE	IE	IE	IE	IE

Name of Mitigation Action	*Sectors affected*	*GHG affected*	*Objective and or activity affected*	*Type of Instrument*	*Status of implemention*	*Brief Description*	*Start Year of Implementation*	*Implementing Entity or Entitities*	*Greenhouse Gas Saving ($ktCO_2$ eq)*						
									2005	2010	2011	2015	2020	2025	2030
Industrial Emissions Directive (as it applies to Large Combustion Plant)[1,2,3]	Energy Supply, Business, Industrial Processes	CO_2, (CH_4, N_2O)	Consolidates and strengthens several air quality measures, including the LCPD. Further reduce the use of high carbon (coal) generation in the electricity supply industry.	Regulatory	Adopted	Transposes the Industrial Emisions Directive (IED, 2010/75/EU) into UK law. Strengthens provisions of the LCPD. Sets lifetime operating hours limits on coal fired power plants that don't install abatement equipment.	2016	Department for Food, Environment and Rural Affairs (DEFRA)	IE	IE	IE	IE	IE	IE	IE
Electricity Market Reform (CfD and Capacity Mechanism)[1,2,3]	Energy Supply	CO_2, (CH_4, N_2O)	To increase the proportion of low carbon (Nuclear, CCS) and renewables generation	Economic	Adopted	To create CfDs (Contracts for Difference) in the electricity generation market for low carbon and renewable sources, and a capacity mechanism for the supply of backup generation capacity so as to to encourage the construction and use of low carbon and renewable generation in the electricity supply industry. CfDs will replace ROCs for new capacity from 2017.	2017	Department of Energy & Climate Change (DECC)	IE	IE	IE	IE	IE	IE	IE
Carbon Capture & Storage (CCS) Commercialisation Competition[1,2,3]	Energy Supply	CO_2	To encourage the use of CCS equipment in fossil fuel generation	Economic	Implemented	To set an agreed CfD strike price that is competitive with the strike prices for other low carbon generation technologies so that private sector electricity companies can take investment decisions to build CCS equipped fossil-fuel power stations, in the early 2020s, without Government capital subsidy.	2017	Department of Energy & Climate Change (DECC)	IE	IE	IE	IE	IE	IE	IE
Carbon Price Floor[1,2,3]	Energy Supply	CO_2, (CH_4, N_2O)	To reduce the use of emissions intensive fossil fuels and increase the use of renewables in lectrcity generation	Economic	Implemented	To set an increasing minimum floor to the carbon price for electricity supply so as to further (1) reduce the use of emissions intensive fossil fuels (2) increase in the proportion of electricity generation and supply from renewables	2013	Department of Energy & Climate Change (DECC)	IE	IE	IE	IE	IE	IE	IE

Name of Mitigation Action	*Sectors affected*	*GHG affected*	*Objective and or activity affected*	*Type of Instrument*	*Status of implemention*	*Brief Description*	*Start Year of Implementation*	*Implementing Entity or Entitities*	*Greenhouse Gas Saving ($ktCO_2$ eq)*						
									2005	2010	2011	2015	2020	2025	2030
Building Regulations Part L 2002, 2006, including 2005 condensing boiler update[1]	Business, Residential, Public	CO_2, (CH_4, N_2O)	Improve energy efficiency of buildings	Regulatory	Implemented	Building Regulations set standards for design and construction, which apply to most new buildings and many alterations to existing buildings. They can also set minimum standards for appliances e.g. boilers.	2002	Department of Energy & Climate Change (DECC)	1,363	5,680	6,793	8,879	10,421	7,992	5,279
Building Regulations Part L 2010[1,2]	Business, Residential, Public	CO_2, (CH_4, N_2O)	Improve energy efficiency of buildings	Regulatory	Implemented	Building Regulations set standards for design and construction, which apply to most new buildings and many alterations to existing buildings. They can also set minimum standards for appliances e.g. boilers.	2010	Department for Communities and Logal Government (DCLG)	0	0	0	3,127	5,849	7,246	5,136
National Products Policy (Tranche 1 – Implemented Measures)[1,2]	Business, Residential, Public	CO_2, (CH_4, N_2O)	Reducing energy use and emissions from appliances and products such as white goods, lighting, televisions, heating and cooling systems and electric motors by preventing the sale of the worst performing products and promoting the sale of the most efficient.	Regulatory	Implemented	UK legislation to set minimum energy efficiency standards for products on sale. Mandating energy efficiency labelling of appliances. Most recently implemented by the Eco-Design for Energy Related Products Regulations (SI 2010 No 2617). Implements EU Ecodesign Directive 2009/125/EC (amending 2005/32/EC).	2009	Department for Food, Environment and Rural Affairs (DEFRA)	0	621	1,518	4,278	5,043	2,654	227
National Products Policy (Tranche 2 – Adopted Measures)[1]	Business, Residential, Public	CO_2, (CH_4, N_2O)	Reducing energy use and emissions from appliances and products such as white goods, lighting, televisions, heating and cooling systems and electric motors by preventing the sale of the worst performing products and promoting the sale of the most efficient.	Regulatory	Adopted	Sets minimum energy efficiency standards for products on sale and mandates energy efficiency labelling of appliances. Implements EU Ecodesign Directive 2009/125/EC (amending 2005/32/EC). Includes standards voted on in EU but not yet transposed into UK law.	2013	Department for Food, Environment and Rural Affairs (DEFRA)	0	0	0	831	3,908	3,260	1,457
Renewable Heat Incentive[1,2]	Business, Residential, Public	CO_2, (CH_4, N_2O)	To encourage the generation of renewable heat in all sectors from large industrial sites down to the household level.	Economic	Implemented	Provides financial incentives for the the generation of renewable heat. Financial incentives vary by technology and unit size.	2011	Department of Energy & Climate Change (DECC)	0	0	0	1,228	5,631	5,763	5,947

Name of Mitigation Action	*Sectors affected*	*GHG affected*	*Objective and or activity affected*	*Type of Instrument*	*Status of implemention*	*Brief Description*	*Start Year of Implementation*	*Implementing Entity or Entitities*	*Greenhouse Gas Saving ($ktCO_2$ eq)*						
									2005	2010	2011	2015	2020	2025	2030
Smart Metering[1,2]	Business, Residential	CO_2, (CH_4, N_2O)	Reduce consumption of electricity and gas though provision of better management information.	Information	Adopted	Smart meters will be rolled out throuhout the UK in a phased program. Residential and Smal business consumers will be provided with near real-time information on energy consumption, enabling them to monitor and manage their energy consumption, save money and reduce carbon emissions. Bills will be more accurate and switching between suppliers will be smoother and faster.	2014	Department of Energy & Climate Change (DECC)	0	0	0	832	2,809	2,536	2,167
Carbon Trust measures[1]	Business, Public	CO_2, (CH_4, N_2O)	Improve energy efficiency in buildings	Information, Education	Implemented	The Carbon Trust provides a range of measures from general advice to in-depth consultancy and accreditation, to reduce emissions and save energy and money to businesses and public sector oganisations of all sizes.	2002	Carbon Trust	2,220	3,499	3,513	1,497	401	85	0
CRC Energy Efficiency Scheme[1,2]	Business, Public	CO_2, (CH_4, N_2O)	To drive emission reductions from large non-energy intensive private and public sector organisations.	Economic, Information	Implemented	A mandatory UK-wide trading scheme which encourages the uptake of energy efficiency measures in large non-energy intensive private and public sector organisations that use energy not covered by the EU ETS or Climate Change Agreements. The scheme covers 10% of the UK's greenhouse gas emissions, with all public and private sector organisations using more than 6 GWh of 1/2 hourly metered electricity a year required to participate. Participants must purchase allowances to cover their carbon emissions, and their aggregate energy use and emissions data is published annually.	2010	Department of Energy & Climate Change (DECC), Environment Agency (EA). Devolved administrations.	0	0	143	516	1,275	2,108	717

Name of Mitigation Action	*Sectors affected*	*GHG affected*	*Objective and or activity affected*	*Type of Instrument*	*Status of implemention*	*Brief Description*	*Start Year of Implementation*	*Implementing Entity or Entitities*	*Greenhouse Gas Saving ($ktCO_2$ eq)*						
									2005	2010	2011	2015	2020	2025	2030
The Green Deal and Energy Company Obligation[1,2]	Business, Residential	CO_2, (CH_4, N_2O)	To improve the energy efficiency of residential and commercial buildings and address fuel poverty.	Economic, Regulatory	Implemented	The Green deal will provide a mechanism for residential and small business consumers to make reccomended energy efficiency improvments to their buildings by paying for some or all of the work done from the savings expected to be made on energy bills. ECO (the energy company obligation) will require large energy suppliers to help disadvantaged groups and is aimed both at saving carbon and at getting efficient boilers and insulation into the homes of vulnerable people.	2012	Department of Energy & Climate Change (DECC), Large Energy Suppliers	0	0	0	1,455	3,906	2,854	1,996
Warm Front (In Scotland the Energy Assistance Package, in Wales Nest and in Northern Ireland the Warm Homes Scheme)[1]	Residential	CO_2, (CH_4, N_2O)	Tackling fuel poverty, improving energy efficiency for poorer households.	Economic	Implemented	Warm Front installs heating and insulation measures to make homes warmer and more energy efficient for households in or at risk of fuel poverty. The Scheme offers a package of heating and insulation measures of up to £3,500 (or £6,000 where oil central heating or other alternative technologies are recommended).	2000	Department of Energy & Climate Change (DECC), Devolved administrations, Carillion Energy Services.	167	304	298	212	180	310	304

Name of Mitigation Action	*Sectors affected*	*GHG affected*	*Objective and or activity affected*	*Type of Instrument*	*Status of implemention*	*Brief Description*	*Start Year of Implementation*	*Implementing Entity or Entitities*	*Greenhouse Gas Saving ($ktCO_2$ eq)*						
									2005	2010	2011	2015	2020	2025	2030
EEC 1 and 2, Original CERT[1]	Residential	CO_2, (CH_4, N_2O)	To require larger domestic energy supply companies to assist households to take-up cost-effective energy efficiency measures.	Regulatory	Implemented	Energy Efficiency Committment Phase 1 (EEC I): Required all electricity and gas suppliers with 15,000 or more domestic customers to achieve a combined energy saving of 62 TWh by 2005 by assisting their customers to take energy-efficiency measures in their homes. Energy Efficiency Commitment Phase 2 (EEC II) – Energy suppliers with more than 50,000 domestic customers required to deliver a total of 130 TWh lifetime energy use reductions in GB households, primarily through the promotion of energy efficiency measures. Carbon Emission Reduction Target (CERT) – requires all domestic energy suppliers with a customer base in excess of 50,000 customers to make savings in the amount of CO_2 emitted by householders.	2002	Department of Energy & Climate Change (DECC), Office of Gas and Electricity Markets (Ofgem). Large domestic energy suppliers.	1,562	5,327	4,817	4,389	2,941	2,645	1,999
Carbon Emissions Reduction Target (CERT) Uplift and Extension[1,2]	Residential	CO_2, (CH_4, N_2O)	To require larger domestic energy supply companies to assist households to take-up cost-effective energy efficiency measures.	Regulatory	Implemented	CERT – requires domestic energy suppliers with a customer base in excess of 250,000 customers to make savings in the amount of CO_2 emitted by householders.	2011	Department of Energy & Climate Change (DECC), Office of Gas and Electricity Markets (Ofgem). Larger Energy Suppliers.	0	522	1,284	1,782	1,700	1,487	1,308
Community Energy Saving Programme (CESP)[1,2]	Residential	CO_2, (CH_4, N_2O)	To require larger energy companies to encourage households in areas of low income to take-up cost-effective energy efficiency measures.	Regulatory	Implemented	CESP – targets households across Great Britain, in areas of low income, to improve energy efficiency standards, and reduce fuel bills. There are 4,500 areas eligible for CESP. CESP is funded by an obligation on larger energy suppliers and electricity generators.	2009	Department of Energy & Climate Change (DECC), Office of Gas and Electricity Markets (Ofgem). Larger Energy Suppliers.	0	0	18	103	95	73	57

Name of Mitigation Action	*Sectors affected*	*GHG affected*	*Objective and or activity affected*	*Type of Instrument*	*Status of implemention*	*Brief Description*	*Start Year of Implementation*	*Implementing Entity or Entitities*	*Greenhouse Gas Saving ($ktCO_2$ eq)*						
									2005	2010	2011	2015	2020	2025	2030
Zero Carbon Homes[1,2]	Residential	CO_2, (CH_4, N_2O)	To reduce residential energy use in new build properties	Regulatory	Adopted	The government has set a target of al new housing being zero carbon from 2016. This is intended to be achieved by (a) Energy Efficiency improvements to design (b) Carbon compliance through on-site zero carbon energy, such as PV (c) Allowable solutions, which are off-site offsets.	2016	Department for Communities and Logal Government (DCLG)	0	0	0	17	556	1,327	1,131
The Energy Performance of Buildings (Certificates and Inspections) Regulations, along with parallel measures in the devolved administrations[1]	Business, Residential, Public	CO_2, (CH_4, N_2O)	Encourage uptake of energy efficiency measures	Regulatory, Information	Implemented	Energy Performance Certificates (EPCs) are required when any building is sold, rented out or constructed, and sometimes after refurbishment work. EPCs give information on a building's energy efficiency in a sliding scale from 'A' (very efficient) to 'G' (least efficient). A recommendations report setting out how the rating could be improved accompanies every EPC. EPC can help occupants make their building more energy efficient by identifying costs and opportunities for improvement. Display energy certificate (DEC) must be produced every year for public buildings larger than 1,000m^2. The DEC shows the actual running costs of the building and must be displayed in a prominent place. Additionally the regulations require the regular inspection of air-conditioning installations and boilers above a certain size.	2007	Department for Communities and Logal Government (DCLG) and the devolved administrations.	0	749	740	702	636	544	416

Name of Mitigation Action	*Sectors affected*	*GHG affected*	*Objective and or activity affected*	*Type of Instrument*	*Status of implemention*	*Brief Description*	*Start Year of Implementation*	*Implementing Entity or Entitities*	*Greenhouse Gas Saving ($ktCO_2$ eq)*						
									2005	2010	2011	2015	2020	2025	2030
Salix, Public Sector Loans.[1]	Public	CO_2, (CH_4, N_2O)	To address funding barriers to achieving energy efficiency in the Public sector	Economic	Implemented	Salix Energy Efficiency Recycling Funds: A long-term recycling fund, whereby a public sector body is given match funding for a number of projects. The public sector body can continue to recycle energy savings returned to the fund into more projects, always maintaining the value of the fund at a constant level. Money is only returned to Salix (the funding body) only when no more suitable projects can be found. Loans targeted at specific projects, which when completed repay their costs to Salix from the energy savings. Salix Energy Efficiency Loans: interest free loans, repayable over a 4 year period. The Iona scheme was administered by the Carbon Trust.	2004	Department of Energy & Climate Change (DECC). Administered by the Carbon Trust.	1	29	41	33	40	33	0
Loans to SMEs by the Carbon Trust[1]	Business	CO_2, (CH_4, N_2O)	To address funding barriers to achieving energy efficiency by the small and medium enterprises (SMEs)	Economic	Implemented	The Carbon Trust provided interest free loans of £3000 – £100,000 for small and medium sized businesses to invest in energy efficiency equipment that pays for itself within four years. Projects had to meet a 'carbon threshold' of 2.5 tCO_2 saved per £1,000 loaned.	2004	Department of Energy & Climate Change (DECC). Administered by the Carbon Trust.	14	111	117	80	49	5	0
Climate change agreements (CCA) 2013-23[1,2]	Business	CO_2, (CH_4, N_2O)	To provide an incentive for energy-intensive industries to reduce energy consumption.	Economic, Voluntary Agreement/ negotiated agreement	Implemented	Climate Change Agreements offer participating energy-intensive industries a partial rebate from the Climate Change Levy on Industrial fuels in return for meeting targets for emission reductions. From 2013 these are a 90% rebate for electricity and a 65% rebate for other fuels. Target levels represent a cap on emissions if we assume compliance. We project that industries will meet these caps as a result of low economic growth and take up of other measures.	2013	Department of Energy & Climate Change (DECC). Industry Associations.	0	0	0	0	0	0	0

Name of Mitigation Action	*Sectors affected*	*GHG affected*	*Objective and or activity affected*	*Type of Instrument*	*Status of implemention*	*Brief Description*	*Start Year of Implementation*	*Implementing Entity or Entitities*	*Greenhouse Gas Saving ($ktCO_2$ eq)*						
									2005	2010	2011	2015	2020	2025	2030
Rail Electrification[1,2]	Transport	CO_2, (CH_4, N_2O)	To reduce travel times, costs and fossil fuel emissions	Economic	Implemented	Electrification of existing track and replacement of diesel traction.	2013	Department for Transport (DfT), Network Rail	0	0	0	10	269	320	392
Biofuels policy (8% by energy by 2020)[1,2]	Transport	CO_2	Reduce the fossil carbon content of transport fuels	Regulatory	Adopted	To set enhanced targets for biofuel use by diesel and petrol suppliers to be achieved by 2020. Current targets are by volume rather than by energy. Implements the EU Renewables Directive (2009/28/EC)	2013	Department for Transport (DfT)	0	0	0	1,103	4,215	0	0
Car policies (EU new car CO_2 emissions targets	Transport	CO_2, (CH_4, N_2O)	Improve fuel efficiency and reduce CO_2 emissions of cars	Regulatory, Information, Voluntary Agreement	Implemented	Sets fuel efficiency targets for new cars to be achieved by 2015 and 2020. Complementary measures are a collection of technologies that could improve 'real world' fuel efficiency of cars which wouldn't be fully captured in new car CO_2 target and could improve fuel efficiency within the existing fleet. These include gear shift indicators, tyre pressure monitoring systems more efficient mobile air-conditioning and low rolling resistance tyres. EC Regulation 661/2009 sets minimum requirements and introduce labelling for the rolling resistance, wet grip and external rolling noise of tyres.	2012	Department for Transport (DfT)	0	0	0	2,225	7,510	14,327	18,830
LGV Policies (EU new LGV CO_2 emissions targets: 175g CO_2/km by 2017 and 147 gCO_2/km by 2020; and compementary measures)[1,2]	Transport	CO_2, (CH_4, N_2O)	Improve fuel efficiency and reduce CO_2 emissions of light goods vehicles	Regulatory, Information, Voluntary Agreement	Adopted	Sets fuel efficiency targets for new Light Goods Vehicles (LGV) to be achieved by 2017 and 2020. EC Regulation 661/2009 sets minimum requirements and introduce labelling for the rolling resistance, wet grip and external rolling noise of tyres.	2012	Department for Transport (DfT)	0	0	0	293	1,073	2,480	3,601

Name of Mitigation Action	*Sectors affected*	*GHG affected*	*Objective and or activity affected*	*Type of Instrument*	*Status of implemention*	*Brief Description*	*Start Year of Implementation*	*Implementing Entity or Entitities*	*Greenhouse Gas Saving ($ktCO_2$ eq)*						
									2005	2010	2011	2015	2020	2025	2030
HGV policies (low rolling resistance tyres and industry-led action to improve efficiencies)[1,2]	Transport	CO_2, (CH_4, N_2O)	Improve fuel efficiency and reduce CO_2 emissions of heavy goods vehicles	Regulatory, Information, Voluntary Agreement	Adopted	EC Regulation 661/2009 sets minimum requirements and introduce labelling for the rolling resistance, wet grip and external rolling noise of tyres. Industry and Government are taking a range of actions to reduce freight emissions, including the Freight Transport Association's Logistics Carbon Reduction Scheme, recording and reporting emissions reductions from freight, and Mode Shift Revenue Support in England and Wales to support modal shift.	2012	Department for Transport (DfT), Transport Association.	0	0	0	611	1,318	2,080	2,123
Local Sustainable Travel Fund[1,2]	Transport	CO_2, (CH_4, N_2O)	To allow the delivery of sustainable transport solutions that support economic growth, and reduce carbon emissions	Economic	Implemented	Fund to support sustainable travel investments by Local Government. Awards are made by after a competitive bidding process. Projects are assessed against published criteria. Successful projects were those judged to perform well against the twin objectives of supporting the local economy and facilitating economic development, while reducing carbon emissions.	2011	Department for Transport (DfT), Local government.	0	0	348	975	535	0	0
Low Carbon Buses[1]	Transport	CO_2, (CH_4, N_2O)	Encourage the introduction of low carbon buses across England.	Economic	Implemented	The Green Bus Fund (GBF) allows bus companies and local authorities in England to compete for funds to help them buy new low carbon emission buses – both double decker and single decker buses, including midibuses (but not minibuses) capable of achieving an equivalent 30% reduction in their GHG emissions compared to the average Euro III diesel bus of the same total passenger capacity. The Fourth round of the fund will add to the 955 LCEB buses purchaed with the support of the previous three rounds of the GBF between 2009 and 2012.	2009	Department for Transport (DfT), Local government.	0	0	0	6	298	638	816

Name of Mitigation Action	*Sectors affected*	*GHG affected*	*Objective and or activity affected*	*Type of Instrument*	*Status of implemention*	*Brief Description*	*Start Year of Implementation*	*Implementing Entity or Entitities*	*Greenhouse Gas Saving ($ktCO_2$ eq)*						
									2005	2010	2011	2015	2020	2025	2030
English Agriculture sector Greenhouse Gas Action Plan (GHGAP)[1,2]	Agriculture	CH_4, N_2O	Reduce emissions from farming	Voluntary Agreement, Information, Education	Implemented	Range of resource-efficient and land management measures to reduce emissions to meet UK carbon budgets	2010	Department for Food, Environment and Rural Affairs (DEFRA), Industry Associations.	0	0	0	0	3,200	3,400	3,400
Nitrates Action Plan[1]	Agriculture	N_2O	Reduce nitrate pollution to water under the nitrates directive	Regulatory, Information	Implemented	Improved compliance with the Nitrate Directive (91/676/EEC). Designated revised "Nitrate Vulnerable Zones" (NVC); established a range of mandatory measures to reduce nitrate pollution to water in NVC. Also Code of Good Practice outside NVZs.	2013	Department for Food, Environment and Rural Affairs (DEFRA), Environment Agency (EA).	IE	IE	IE	IE	IE	IE	IE
Catchment Sensitive Farming[1]	Agriculture	N_2O	Reducing pollution to water	Economic, information	Implemented	Delivers practical solutions and targeted support to enable farmers and land managers to take voluntary action to reduce diffuse water pollution from agriculture to protect water bodies and the environment.	2006	Department for Food, Environment and Rural Affairs (DEFRA), Rural Development Programme for England (RDPE), Environment Agency (EA), Natural England (NE).	IE	IE	IE	IE	IE	IE	IE
Soils For Profit[1]	Agriculture	N_2O	Soil protection	Education	Implemented	Provides on farm reviews and training on soils manures and nutrients. The programme will close in 2013.	2009	Natural England (NE).	IE	IE	IE	IE	IE	IE	IE
Environmental Stewardship (Entry Level Schemes and Higher Level Stewardship)[1]	Agriculture	N_2O	Biodiversity and resource protection	Economic	Implemented	Provides income foregone support under Pillar 2 of the CAP for farmers to undertake management options that benefit biodiversity, resource protection and water quality.	2005	Department for Food, Environment and Rural Affairs (DEFRA), Rural Development Programme for England (RDPE)	IE	IE	IE	IE	IE	IE	IE
Landfill tax[1]	Waste	CH_4	reduce waste to landfill	Fiscal	Implemented	Reduce landfill of biodegradeable waste and associated CH_4 emissions through a financial mechanism: the Landfill Tax – an escalating tax on biodegradable waste.	2009	Department for Food, Environment and Rural Affairs (DEFRA)	IE	IE	IE	IE	IE	IE	IE
Ozone Depleting Substances Regulation[1]	Business, Industrial Processes	HFCs	Implement obligations under the Montreal Protocol and EU Regulations (2037/2000/EC and 1005/2009/EC) on ozone depleting substances. Indirectly reduced emissions of HFCs which are a manufacturing byproduct but increased their use as a substitute.	Regulatory	Implemented	With the exception of some critical use exemptions, CFC and halon use is banned and HCFC use will be banned from 2015. Most ozone depleting substances are also potent greenhouse gases, so reductions in use both protects the ozone layer and provides some climate protection.	2001	Department for Food, Environment and Rural Affairs (DEFRA)	IE	IE	IE	IE	IE	IE	IE

Name of Mitigation Action	*Sectors affected*	*GHG affected*	*Objective and or activity affected*	*Type of Instrument*	*Status of implemention*	*Brief Description*	*Start Year of Implementation*	*Implementing Entity or Entitities*	*Greenhouse Gas Saving ($ktCO_2$ eq)*						
									2005	2010	2011	2015	2020	2025	2030
Fluorinated GHG Regulation[1]	Business, Residential, Industrial Processes	HFCs, PFCs, SF_6	Implemention of EU MAC (2006/40) Directive and F-Gas Regulation (EC 842/2006) to reduce emissions of fluorinated greenhouse gases.	Regulatory	Implemented	Control (containment, prevention and reduction) of F-Gas emissions through recovery, leak reduction and repair and some very limited use bans. Mandatory certification requirements to work with F gases.	2009	Department for Food, Environment and Rural Affairs (DEFRA)	IE	IE	IE	IE	IE	IE	IE
Woodland Carbon Code[1]	LULUCF	CO_2	Increase rate of afforestation	Voluntary Agreement, Information	Implemented	Voluntary Code and associated carbon registry (2013) for UK-domestic woodland carbon scemes to encourage private sector funding for woodland creation projects.	2011	Forestry Commission	IE	IE	IE	IE	IE	IE	IE
Revised UK Forestry Standard[1]	LULUCF	CO_2	Enhance removals and reduce emissions through woodland creation and sustainable forest management.	Regulatory, Information	Implemented	Revised national standard for sustainable forest management to include a new guideline on climate change, covering both adaptation and mitigation.	2011	Forestry Commission	IE	IE	IE	IE	IE	IE	IE
Forestry Act, Felling Licence Regulations and Environmental Impact (Forestry) regulations[1]	LULUCF	CO_2	Regulatory framework to limit deforestation and forest degradation.	Regulatory	Implemented	Strong regulatory framework that controls felling, only allows deforestation for purposes of nature conservation and prevents afforestation of deep peat. Legislation updated 1999.	1999	Forestry Commission	IE	IE	IE	IE	IE	IE	IE
Grown in Britain[1]	LULUCF	CO_2	Industry-led action plan with the objective of increasing woodland creation and the use of harvested wood products.	Voluntary Agreement, Information, Education	Implemented	Industry-led action plan announced in Government's Forestry and Woodlands Policy Statement (2013) which aspires to encourage businesses to invest in woodland creation and sustainable forest management practice.	2013	Department for Food, Environment and Rural Affairs (DEFRA)	IE	IE	IE	IE	IE	IE	IE
Rural Development Programme[1]	LULUCF	CO_2	Grant aid for afforestation	Economic	Implemented	Woodland creation grants provided through EU co-financed Rural Development Programmes in all four countries of the UK.	2007	Department for Food, Environment and Rural Affairs (DEFRA)	IE	IE	IE	IE	IE	IE	IE
Woodfuel Implementation Plan[1]	LULUCF	CO_2	Strategy to increase woodfuel supply for renewable heat.	Information, Education, Economic	Implemented	Initiative to develop supply chains, including through support for harvesting/ processing and woodland access, to increase woodfuel supply from existing woodland.	2011	Forestry Commission	IE	IE	IE	IE	IE	IE	IE

[1] Indicates that a mitigation action has been included in the 'with measures' projection.
[2] indicates that a mitigation action was newly adopted or implemented 2009-13. The total impact of such policies is reported in Section 4.6.
[3] Emissions savings are included in 'New Energy Supply Policies'.
IE – included elsewhere. The impact of measure has been included in the UK's 'with measures' emissions projections, however no specific 'without-measure' counterfactual is available.

Table 4 – Reporting on progress

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

GREENHOUSE GAS SOURCE AND SINK ACTIVITIES	*Base year*	*Net emissions/removals*					*Accounting Parameters*	*Accounting Quantity*
		2008	*2009*	*2010*	*2011*	*Total*		
		(kt CO_2 eq)						
A. Article 3.3 activities								
A.1. Afforestation and Reforestation								-11,496.78
A.1.1. Units of land not harvested since the beginning of the commitment period		-2,668.61	-2,797.77	-2,971.60	-3,058.81	-11,496.78		-11,496.78
A.1.2. Units of land harvested since the beginning of the commitment period								NO
A.2. Deforestation		588.907	654.213	553.416	552.089	2348.624		2348.624
B. Article 3.4 activities								
B.1. Forest Management (if elected)		-10733.450	-9760.849	-7491.986	-7222.124	-35208.408		-6783.333
3.3 offset							0	0
FM cap							6783.333	-6783.333
B.2. Cropland Management (if elected)	0	NA	NA	NA	NA	NA	0	0
B.3. Grazing Land Management (if elected)	0	NA	NA	NA	NA	NA	0	0
B.4. Revegetation (if elected)	0	NA	NA	NA	NA	NA	0	0

Table 4(b) – Reporting on progress[a,b,c]

			Kyoto Protocol Units										*Other units*			
			kt CO_2 eq										*kt CO_2 eq*			
			AAUS		*ERUs*		*CERs*		*tCERs*		*lCERs*		*Units from market-based mechanisms under the Convention*		*Units from other market-based mechanisms*	
			2011	2012	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012
Austria	EU-15	EU-27	84,450	28,671	5	34	NO	NO	1,193	1,956	NO	NO		NO		
Belgium	EU-15	EU-27	49,458	39,938	75	551	NO	NO	566	5,680	NO	NO		NO		
Germany	EU-15	EU-27	418,523	907,807	4,195	33,232	NO	NO	33,374	41,123	NO	NO		NO		
Denmark	EU-15	EU-27	24,447	55,297	2	2,283	NO	288	823	1,197	NO	NO		NO		
Greece	EU-15	EU-27	56,267	44,279	8	2,710	NO	NO	3,650	7,472	NO	NO		NO		
Spain	EU-15	EU-27	105,878	105,190	3,573	6,836	NO	NO	12,174	20,601	NO	NO		NO		
Finland	EU-15	EU-27	39,383	31,402	150	633	NO	NO	1,767	3,048	NO	NO		NO		
France	EU-15	EU-27	110,182	76,854	681	3,339	NO	NO	4,406	24,181	NO	NO		NO		
Ireland	EU-15	EU-27	16,231	13,829	395	844	NO	NO	730	1,114	NO	NO		NO		
Italy	EU-15	EU-27	567,758	170,503	752	4,809	NO	NO	28,578	14,794	NO	NO		NO		
Luxembourg	EU-15	EU-27	2,065	1,810	NO	NO	NO	NO	188	242	NO	NO		NO		
Netherlands	EU-15	EU-27	84,411	187,737	NO	895	NO	NO	NO	7,387	NO	NO		NO		
Portugal	EU-15	EU-27	22,566	21,983	320	93	NO	NO	1,278	2,898	NO	NO		NO		
Sweden	EU-15	EU-27	21,846	18,594	0	19	NO	NO	791	1,595	NO	NO		NO		
United Kingdom	EU-15	EU-27	456,830	204,600	1,846	1,339	NO	NO	11,034	14,632	NO	NO		NO		
EU-15			2,060,296	1,908,493	12,003	57,618	NO	288	100,552	147,921	NO	NO		NO		
Bulgaria	0	EU-27	30,528	0	704	0	NO	NO	2,296	0	NO	NO		NO		
Cyprus	0	EU-27														
Croatia			NO	NO	NO	NO	NO	NO	NO	NO	NO	NO		NO		
Czech Republic	0	EU-27	219,836	67,795	754	3,085	NO	NO	9,383	3,113	NO	NO		NO		

			Kyoto Protocol Units										*Other units*			
			kt CO_2 eq										*kt CO_2 eq*			
			AAUS		*ERUs*		*CERs*		*tCERs*		*lCERs*		*Units from market-based mechanisms under the Convention*		*Units from other market-based mechanisms*	
			2011	2012	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012
Estonia	0	EU-27	14,345	15,072	NO	141	NO	NO	NO	17	NO	NO		NO		
Hungary	0	EU-27	21,454	20,459	486	687	NO	NO	1,146	1,357	NO	NO		NO		
Lithuania	0	EU-27	5,563	4,076	183	1,165	NO	NO	648	363	NO	NO		NO		
Latvia	0	EU-27	3,011	2,848	18	22	NO	NO	212	54	NO	NO		NO		
Malta	0	EU-27														
Poland	0	EU-27	184,382	0	1,816	0	NO	NO	13,912	1	NO	NO		NO		
Romania	0	EU-27	39,011	51,239	4,151	0	NO	NO	4,325	0	NO	NO		NO		
Slovenia	0	EU-27	7,626	7,204	379	631	NO	NO	121	166	NO	NO		NO		
Slovakia	0	EU-27	17,818	21,251	12	104	NO	NO	4,363	1,018	NO	NO		NO		
EU-28			2,603,870	2,098,438	20,507	63,453	NO	288	136,958	154,009	NO	NO		NO		

Table 5
Summary of key variables and assumptions used in the projection analysis[a]

				Historical[b]				*Projected*			
Key Underlying assumptions	*1990*	*1995*	*2000*	*2005*	*2010*	*2011*	*2012*	*2015*	*2020*	*2025*	*2030*
UK GDP Growth rate (per cent/per annum)	1.8	3.2	4.2	2.8	1.8	0.9	0.2	2.3	2.8	2.5	2.5
World GDP Growth rate (per cent/per annum)	3.2	3.3	4.8	4.6	5.1	3.9	3.2	4.4	4.5	4.3	4.3
UK population growth (per cent/per annum)	0.3	0.3	0.3	0.7	0.8	0.7	0.7	0.7	0.6	0.5	0.4
UK Households growth (per cent/per annum)	1.0	0.7	0.9	1.0	1.1	1.0	1.1	1.1	0.9	0.8	0.7
Crude Oil (Brent dated) ($/bbl, 2013 pricies)	41.1	25.1	38.1	65.2	84.2	115.2	114.0	112.9	119.9	127.3	135.3
Gas (NBP) (p/therm, 2013 prices)	NE	NE	23.9	48.5	44.9	58.4	60.9	69.7	73.8	73.8	73.8
Coal (Rotterdam fob) ($/tonne, 2013 Prices)	75.2	65.7	48.2	72.4	98.0	125.8	94.4	103.9	122.9	122.9	122.9
EU ETS Carbon Price (£/tCO_2, 2013 prices)	NO	NO	NO	20.5	13.3	11.7	6.4	3.7	4.9	5.5	6.2
Electricity Generation Carbon Price (£/tCO_2, 2013 prices)	NO	NO	NO	20.5	13.4	11.7	5.7	19.0	32.7	72.0	111.7
Pound Sterling to US Dollars exchange rate ($ per £)	1.785	1.578	1.516	1.820	1.546	1.604	1.587	1.587	1.587	1.587	1.587
Pound Sterling to Euros exchange rate (€ per £)	1.372	1.190	1.642	1.462	1.165	1.153	1.175	1.175	1.175	1.175	1.175

[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 projections under a 'with measures' scenario

	GHG Emissions & Removals							*GHG Projections*	
	(kt CO_2 eq)							*(kt CO_2 eq)*	
	Base Year[4]	*1990*	*1995*	*2000*	*2005*	*2010*	*2011*	*2020*	*2030*
Sector									
Energy [1]	610,756	610,756	567,385	560,671	559,567	505,448	465,951	366,068	328,287
Transport [1,3]	122,157	122,157	122,642	127,225	131,025	120,775	119,126	107,651	103,408
Industry/Industrial Processes [1]	54,395	54,395	46,592	31,811	31,296	27,648	26,470	17,182	15,736
Agriculture [1]	58,153	58,153	56,868	54,094	50,547	46,725	46,675	46,702	42,907
Forestry/LULUCF [1,2]	4,022	4,022	3,283	425	-2,593	-3,665	-3,309	-430	2,162
Waste management/waste [1]	47,480	47,480	41,477	30,913	20,522	17,958	17,363	15,541	13,711
National Communication									
NC: Energy Supply [2]	273,135	273,135	234,782	219,314	228,480	205,350	192,065	106,138	72,661
NC: Business [2]	115,366	115,366	110,302	114,048	108,267	91,984	89,224	70,266	63,730
NC: Industrial Processes [2]	54,657	54,657	45,090	24,689	18,807	11,736	10,234	9,801	9,068
NC: Transport [2]	122,157	122,157	122,642	127,225	131,025	120,775	119,126	107,651	103,408
NC: Residential [2]	80,910	80,910	82,450	90,368	88,107	90,190	69,925	78,024	84,942
NC: Public [2]	13,130	13,130	12,783	11,502	11,052	8,418	7,142	7,826	6,737
NC: Agriculture [2]	63,950	63,950	62,797	59,432	55,674	51,369	51,380	45,482	44,862
NC: LULUCF [2]	4,022	4,022	3,283	425	-2,593	-3,665	-3,309	-430	2,162
NC: Waste [2]	47,479	47,479	41,476	30,912	20,521	17,957	17,362	13,710	11,663
Gas									
CO_2 Emissions including Net CO_2 from LULUCF	593,536	593,536	555,308	554,807	556,093	499,881	460,687	359,762	329,184
CO_2 excluding Net CO_2 from LULUCF	590,384	590,384	552,930	555,249	559,452	504,190	464,618	360,719	327,403
CH_4 Emissions including Net CH_4 from LULUCF	99,157	99,157	85,246	65,018	48,500	43,016	42,063	36,272	31,316
CH_4 excluding Net CH_4 from LULUCF	99,133	99,133	85,207	64,987	48,461	42,992	42,035	36,230	31,283
N_2O Emissions including Net N_2O from LULUCF	68,296	68,296	58,022	46,488	41,226	35,918	34,811	33,042	32,649
N_2O excluding Net N_2O from LULUCF	67,449	67,449	57,155	45,652	40,499	35,299	34,218	32,557	32,301
HFCs	11,386	11,386	15,328	9,342	12,110	14,388	14,654	8,580	5,236
PFCs	1,402	1,402	462	461	298	221	325	226	250
SF_6	1,030	1,030	1,239	1,798	1,110	690	607	584	599
Other (specify e.g. NF_3)	NE	NE	NE	NE	NE	NE	NE	NE	NE
Total with LULUCF	**774,806**	**774,806**	**715,605**	**677,913**	**659,338**	**594,114**	**553,148**	**438,467**	**399,233**
Total without LULUCF	**770,784**	**770,784**	**712,322**	**677,489**	**661,931**	**597,779**	**556,458**	**438,897**	**397,071**

Note
1. IPCC sector definitions
2. Transport is a sub-sector of Energy
3. UK National Communications sectors (see Annex 5 for definitions)
4. Base year of 1990

Table 7
Provision of public financial support: summary information in UK FY 2011/12

	Sterling (£m)					*USD ($m)*				
Allocation channels	*Core/ General*	*Climate-specific*				*Core/ General*	*Climate-specific*			
		Mitigation	*Adaptation*	*Cross-cutting*	*Other*		*Mitigation*	*Adaptation*	*Cross-cutting*	*Other*
Total contributions through multilateral channels:										
Multilateral climate change funds	31.500	42.000	32.000	0.017		48.677	64.903	49.450	0.026	
Other Multilateral climate change funds		200.000	57.000	4.201			309.060	88.082	6.492	
Multilateral financial institutions, incl. regional development banks	1,295.571									
Specialised UN bodies	434.461									
Total contributions through bilateral, regional and other channels		41.393	11.993	65.835			63.965	18.532	101.735	
TOTAL	**1,761.532**	**283.393**	**100.993**	**70.053**		**48.677**	**437.928**	**156.064**	**108.253**	

Note
1. Exchange rate is £1 = USD1.5453 (as at 31 12 2011)
2. Figures quoted are for UK Financial Year 2011/12.

Parties to provide an indication of what 'new and additional' financial resources they have provided, and clarify how they have determined that such resources are new and additional. This support has been met from the UK's £3.87 billion International Climate Fund, which is funded from the rising UK aid budget.

Table 7a
Provision of public financial support: contributions through multilateral channels in UK FY 2011/12

	Total amount				*Status*	*Funding source*	*Financial Instrument*	*Type of support*	*Sector*
	Core/general		*Climate Specific*		*Provided/ committed/ pledged*	*ODA/OOF/ Other*	*Grant/ Concessional loan/non-concessional loan/equity/ other*	*Mitigation/ Adaptation, Cross-cutting/ Other*	
	Sterling (£m)	*USD ($m)*	*Sterling (£m)*	*USD ($m)*					
Multilateral Climate Change funds									
1. GEF	31.5	48.677	42	64.903	Provided	ODA	Grant	Mitigation	Cross-cutting
2. LDCF			22	33.997	Provided	ODA	Grant	Adaptation	Cross-cutting
3. Special CC Fund									
4. Adaptation Fund			10	15.453	Provided	ODA	Grant	Adaptation	Cross-cutting
5. Green Climate Fund			0.017	0.026	Provided	ODA	Grant	Cross-cutting	Cross-cutting
6. UNFCCC Trust Fund for Supplementary Activities									
7. Other multi CC funds									
7a. CIFs: PPCR			57	88.082	Provided	ODA	Mixture	Adaptation	Cross-cutting
7b. CIFs: SREP			25	38.633	Provided	ODA	Other (capital)	Mitigation	Energy
7c. CIFs: Clean Technology Fund			150	231.795	Provided	ODA	Other (capital)	Mitigation	Energy
7d. Forest Investment Programme			25	38.633	Provided	ODA	Other (capital)	Mitigation (REDD+)	Forestry
7e. Climate Development Knowledge Network			4.201	6.492	Provided	ODA	Grant	Cross-cutting	Cross-cutting
Sub-total	**31.500**	**48.677**	**335.218**	**518.012**					
Multilateral financial institutions incl regional dev banks									
1. World Bank Group	1,038.568	1,604.899			Provided				
2. International Finance Corporation									
3. African Development Bank	204.728	316.366			Provided				
4. Asian Development Bank	35.941	55.540			Provided				

	Total amount				*Status*	*Funding source*	*Financial Instrument*	*Type of support*	*Sector*
	Core/general		*Climate Specific*		*Provided/ committed/ pledged*	*ODA/OOF/ Other*	*Grant/ Concessional loan/non-concessional loan/equity/ other*	*Mitigation/ Adaptation, Cross-cutting/ Other*	
	Sterling (£m)	*USD ($m)*	*Sterling (£m)*	*USD ($m)*					
5. EBRD									
6. IADB	5.377	8.309			Provided				
7. Other	10.957	16.932			Provided				
Sub-total	**1,295.571**	**2,002.046**							
Specialised UN bodies									
1. UNDP (specific programmes)	55	84.992			Provided				
2. UNEP (specific programmes)									
3. Other	379.461	586.381			Provided				
Sub-total	**434.461**	**671.373**							
TOTAL	**1,761.532**	**2,722.095**	**335.218**	**518.012**					

Note
1. Exchange rate is £1 = USD1.5453 (as at 31 12 2011)
2. Figures quoted are for UK Financial Year 2011/12.
3. The data on multilateral financial institutions and Specialised UN bodies represents the total UK core contributions to these organisations during the UK 2011/12 financial year. It encompasses ODA and non-ODA eligible flows.
4. The figures for 'core/general' support for the African Development Bank and Asian Development Bank includes the UK's general capital and development fund contributions.

Table 7b
Provision of public financial support – contribution through bilateral, regional and other channels 2011

	Total Amount		*Status*	*Funding source*	*Financial Instrument*	*Type of support*	*Sector*	*Additional Information*
	Climate Specific		*Provided/ committed/ pledged*	*ODA/OOF/ Other*	*Grant/ Concessional loan/non-concessional loan/equity/ other*	*Mitigation/ Adaptation, Cross-cutting/ Other*	*Energy/ Transport/ Industry/ Agriculture/ Forestry/WASH/ Cross-cutting/ Other*	
Recipient country/region/project programme	*Sterling (£m)*	*USD ($m)*						
IDEAS Energy Enterprise Innovation Contest	0.141	0.218	Provided	ODA	Grant	Mitigation		An Energy Innovation Contest intended to support the development of innovative projects and ideas promoting renewable energies, and improving energy efficiency and the access to energy in the Caribbean region.
Africa Risk Capacity pool (ARC)	0.400	0.618	Provided	ODA	Grant	Adaptation		An African Union project to improve responses to drought food security emergencies.
Community Adaptation Learning Programme (CARE)	1.054	1.628	Provided	ODA	Grant	Adaptation		CARE International will develop and pilot community-based adaptation (CBA) approaches for vulnerable communities in Ghana, Kenya, Mozambique and Niger. They will be incorporated into development policies and programmes, and disseminated for replication across Africa.
Cooperation in International Waters in Africa	0.112	0.173	Provided	ODA	Grant	Adaptation		To strengthen cooperative management and development of international waters witnin selected basins
Nile Basin Discourse	1.361	2.104	Provided	ODA	Grant	Adaptation		Regional and national engagement of civil society organisations on river Nile management and development related issues, especially in conjunction with the Nile Basin Initiative.
Southern Africa Regional Climate Change Programme (RCCP)	0.774	1.196	Provided	ODA	Grant	Adaptation		RCCP will generate and disseminate information for policy makers and planners in the Southern Africa Development Community (SADC) region. It will help make informed choices and respond to climate change implications for development and support the capacity of regional negotiators in global climate fora. It has a particular focus on Southern Africa transboundary issues.

	Total Amount		*Status*	*Funding source*	*Financial Instrument*	*Type of support*	*Sector*	*Additional Information*
	Climate Specific		*Provided/ committed/ pledged*	*ODA/OOF/ Other*	*Grant/ Concessional loan/non-concessional loan/equity/ other*	*Mitigation/ Adaptation, Cross-cutting/ Other*	*Energy/ Transport/ Industry/ Agriculture/ Forestry/WASH/ Cross-cutting/ Other*	
Recipient country/region/project programme	*Sterling (£m)*	*USD ($m)*						
Vulnerability analysis (RHVP)	1.100	1.700	Provided	ODA	Grant	Adaptation		Regional Hunger and Vulnerability Programme.
Climate Asia	0.532	0.822	Provided	ODA	Grant	Adaptation		Create an evidence base for knowledge and attitudes on climate change across seven countries in Asia which will provide the information and tools to enable vulnerable communities and influencers make informed decisions and take effective action on climate change.
Brazilian Panel on Climate Change	0.147	0.227	Provided	ODA	Grant	Adaptation		Helping to establish an expert scientific Panel modelled on the IPCC as the definitive source of knowledge and policy advice on climate change in Brazil; to support their engagement with international knowledge processes (IPCC) and negotiations (UNFCCC); and encourage their efforts to help other developing countries to develop robust plans and actions to address climate change.
CARIBSAVE (Caribbean Climate Change, Tourism and Livelihoods: A Sectoral approach to vulnerability and resilience)	0.034	0.053	Provided	ODA	Grant	Adaptation		Develop scenarios for changes in climate on the Caribbean tourism sector at a national and destinational scale and assess the vulnerability, resilience and adaptive capacity of the sector
CDEMA CDM HIP (Caribbean Comprehensive Disaster Management (CDM) – Harmonised Implementation Programme)	0.554	0.855	Provided	ODA	Grant	Adaptation		Provide institutional support for CDM implementation at national and regional level and community resilience to mitigate, respond and recover from the adverse effects of climate variability, change and disasters. Implementing agency – Caribbean Disaster Emergency Management Agency CDEMA)

	Total Amount		Status	Funding source	Financial Instrument	Type of support	Sector	Additional Information
	Climate Specific		Provided/ committed/ pledged	ODA/OOF/ Other	Grant/ Concessional loan/non-concessional loan/equity/ other	Mitigation/ Adaptation, Cross-cutting/ Other	Energy/ Transport/ Industry/ Agriculture/ Forestry/WASH/ Cross-cutting/ Other	
Recipient country/region/project programme	Sterling (£m)	USD ($m)						
Adaptation knowledge and tools on impacts	4.635	7.162	Provided	ODA	Grant	Adaptation		This includes support to Adaptation Partnerships (£400k), Climate Resilient growth case studies (£100k), Social Protection (£500k), Adaptation contact group (£600k), Aid effectiveness lessons learned for climate finance (£500k), support to AfDB (£300k), M&E methodology (£2m), Economic guidance tools (£35k), Incentivising Private Sector action on adaptation (£100k) and Support to conflict-proofing ADA investments (£100k)
Climate Resilient Agriculture in Africa	1.000	1.545	Provided	ODA	Grant	Adaptation		Working with the Tripartite RECs to address the food security and agriculture impacts of climate change.
Micro Insurance Pilot	0.250	0.386	Provided	ODA	Grant	Adaptation		Micro insurance pilot
Enhancing Capacity for Adaptation to Climate Change' (ECACC) in UK Overseas Territories in the Caribbean	0.040	0.062	Provided	ODA	Grant	Adaptation		ECACC supports participation of UK Overseas Territories in GEF funded CARICOM regional programme.
South Asia Water Initiative	0.400	0.618	Provided	ODA	Grant	Adaptation/ Mitigation		SAWI focuses on the shared Himalayan Rivers of Afghanistan, Bangladesh, Bhutan, China, India, Pakistan and Nepal, where 700 million people live.
Nepal Climate Change Support Programme	0.352	0.544	Provided	ODA	Mix	Adaptation/ Mitigation		Ensure that three million of the poorest and most vulnerable women and men in Nepal are able to adapt to climate change effects.
Overseas Territories Environment Programme' (OTEP) – Joint DFID/FCO Environmental Challenge Fund	0.570	0.881	Provided	ODA	Grant	Adaptation/ Mitigation		OTEP addresses priority environmental issues, including adaptation to climate change and renewable energy issues in Overseas Territories.
Drafting a National Climate Change and Low Carbon Development Strategy	0.231	0.357	Provided	ODA	Grant	Adaptation/ Mitigation		The strategy will explore how Rwanda can move to a low carbon economy.

	Total Amount		*Status*	*Funding source*	*Financial Instrument*	*Type of support*	*Sector*	*Additional Information*
	Climate Specific		*Provided/ committed/ pledged*	*ODA/OOF/ Other*	*Grant/ Concessional loan/non-concessional loan/equity/ other*	*Mitigation/ Adaptation, Cross-cutting/ Other*	*Energy/ Transport/ Industry/ Agriculture/ Forestry/WASH/ Cross-cutting/ Other*	
Recipient country/region/project programme	*Sterling (£m)*	*USD ($m)*						
Support to Preparatory Process for UN Framework Convention on Climate Change Conference of Parties 17	0.190	0.294	Provided	ODA	Grant	Adaptation/ Mitigation		Logistical and technical support to the Government of South Africa's Department for International Relations and Cooperation (DIRCO) to enable them to deliver a successful preparatory process for the UNFCCC Conference of Parties (COP) 17 meeting in Durban.
AECF Renewable Energy and Adapting to Climate Technologies (REACT) Private Sector Challenge Fund Tanzania Window	0.564	0.872	Provided	ODA	Grant	Adaptation/ Mitigation		Catalytic fund to stimulate private sector investment and innovation on renewable energy and climate adaptation technology, particularly in rural areas.
Oxfam Climate Action Network (Climate Advocacy Officer)	0.264	0.408	Provided	ODA	Grant	Adaptation/ Mitigation		Support to the Climate Action Network of Uganda by funding the post of National Climate Advocacy Officer hosted at Oxfam. The aim is to support Civil Society to enable them to influence climate change policy , to initiate and support national debates and campaigns on climate change.
Parliamentary Forum on Climate Change (PFCC)	0.084	0.130	Provided	ODA	Grant	Adaptation/ Mitigation		Working with Parliamentary Forum on Climate Change (PFCC) to help build their capacity, advocate and promote dialogue on mainstreaming climate change in local districts and building the capacity of local government officials on climate change issues.
UNDP Territorial Approach to Climate Change (TAAC) in Eastern Uganda	0.100	0.155	Provided	ODA	Grant	Adaptation/ Mitigation		Co-funding this programme with UNDP and the Welsh Assembly Government in Mbale region. This will assist Mbale region, encompassing 3 districts of Mbale, Manafwa and Bududa, to realise low carbon and climate change resilience. The project will help the region develop their Integrated Territorial Climate Plan (ITCP) to fully integrate Climate change and mitigation into their regional development planning, acting as a pilot for Uganda. It is aligned to the Uganda National Adaptation Programme of Action (NAPA) and plans to develop projects for financing from international carbon markets.

	Total Amount		*Status*	*Funding source*	*Financial Instrument*	*Type of support*	*Sector*	*Additional Information*
	Climate Specific		*Provided/ committed/ pledged*	*ODA/OOF/ Other*	*Grant/ Concessional loan/non-concessional loan/equity/ other*	*Mitigation/ Adaptation, Cross-cutting/ Other*	*Energy/ Transport/ Industry/ Agriculture/ Forestry/WASH/ Cross-cutting/ Other*	
Recipient country/region/project programme	*Sterling (£m)*	*USD ($m)*						
VNCLIP	0.516	0.797	Provided	ODA	Grant	Adaptation/ Mitigation		The overall goal of the DFID-WB Climate Change Partnership (VNCLIP) is to ensure that Vietnam is less negatively affected by climate change and transitions to a low-carbon growth path. The purpose is to prepare Vietnam better to deal with climate change impacts and to contribute to climate change mitigation.
Strategic Climate Institutions Programme (SCIP)	3.562	5.505	Provided	ODA	Grant	All		Activities to build Ethiopia's institutional capacity to respond to climate change. Includes working with private sector, government and civil society.
Climate Change and Environmental Governance	0.193	0.298	Provided	ODA	Grant	All		Technical assistance to complement multi-donor sector budget support on Natural Resources and Environmental Governance (with WB, EU, Netherlands and France) and development of National Climate Change Policy Framework
Advocacy Fund	1.392	2.151	Provided	ODA	Grant	All		To strengthen the voice of the poorest countries in international negotiations ensuring that their needs are reflected in international agreements.
Learning Hub	0.293	0.453	Provided	ODA	Grant	All		The Learning Hub for Low Carbon Climate Resilient Development linked up internal DFID knowledge with external expertise through reflection and joint problem solving on climate change and development
Research and Evidence Programmes	35.676	55.130	Provided	ODA	Grant	All		International Research and Evidence Programmes
Strengthening Adaptation and Resilience to Climate Change in Kenya (StARCK)	4.057	6.269	Provided	ODA	Grant	All		The intended outcome of the programme is that new mechanisms are established by the Govt. of Kenya, private sector and civil society to enable substantially expanded investments for increased resilience to climate change.

	Total Amount		*Status*	*Funding source*	*Financial Instrument*	*Type of support*	*Sector*	*Additional Information*
	Climate Specific		*Provided/ committed/ pledged*	*ODA/OOF/ Other*	*Grant/ Concessional loan/non-concessional loan/equity/ other*	*Mitigation/ Adaptation, Cross-cutting/ Other*	*Energy/ Transport/ Industry/ Agriculture/ Forestry/WASH/ Cross-cutting/ Other*	
Recipient country/region/project programme	*Sterling (£m)*	*USD ($m)*						
Climate Change Institutional Strengthening Programme	0.470	0.726	Provided	ODA	Grant	All		The programme will provide strategic support in key areas such as the development of a National Climate Change strategy and climate financing mechanism to better position Tanzania to access climate finance and then ensure its effective delivery. It will also look at mainstreaming climate change in the budgeting and planning process.
Support for Climate Change Forum – CS Network	0.074	0.114	Provided	ODA	Grant	All		Establishment of a platform for CS organisation for advocacy, lobbying and raising awareness on climate change.
Renewable Energy and Adapting to Climate Technologies (REACT)	0.564	0.872	Provided	ODA	Grant	Mitigation		A new window of the existing Africa Enterprise Challenge Fund to catalyse private sector investment and innovation in low cost, clean energy and climate change adaptation technologies.
Indonesia Low Carbon Growth Project	0.913	1.411	Provided	ODA	Mix	Mitigation		Programme of support to the Ministry of Finance to support it to develop policies, structures and financing mechanisms integral to Indonesia's low-carbon growth strategy.
Promoting Low Carbon Development in Indonesia	5.013	7.747	Provided	ODA	Mix	Mitigation		To demonstrate the viability of low carbon investment in Indonesia and which will then be funded by international and domestic capital.
UK-Indonesia Programme on Climate Change	0.031	0.048	Provided	ODA	Grant	Mitigation		Design funds for future programmes

	Total Amount		*Status*	*Funding source*	*Financial Instrument*	*Type of support*	*Sector*	*Additional Information*
	Climate Specific		*Provided/ committed/ pledged*	*ODA/OOF/ Other*	*Grant/ Concessional loan/non-concessional loan/equity/ other*	*Mitigation/ Adaptation, Cross-cutting/ Other*	*Energy/ Transport/ Industry/ Agriculture/ Forestry/WASH/ Cross-cutting/ Other*	
Recipient country/region/project programme	*Sterling (£m)*	*USD ($m)*						
Capital Markets Climate Initiative (CMCI)	0.059	0.091	Provided	ODA	Grant	Mitigation		The CMCI innovation platform will provide a forum whereby specific government proposals and ideas for using the UK's International Climate Fund (ICF) to mobilise private finance into low carbon, climate friendly solutions can be tested with CMCI participants. The objective is to: - encourage constructive challenge and feedback that can be directly used to refine and strengthen ICF projects at the design stage - enhance understanding amongst CMCI participants of the priorities, objectives and constraints associated with ICF funding - provide updates on government funding decisions and climate finance policy positions
Carbon Markets Readiness Fund (Partnership for Market Readiness)	7.000	10.817	Provided	ODA	Grant	Mitigation		The Department of Energy & Climate Change (DECC) has given £7 million to the PMR, which is a grant-based trust fund that helps middle-income countries develop and pilot market-based policies to reduce greenhouse gas emissions. The PMR brings together policy makers from governments with experts and stakeholders to provide a platform for piloting these market-based policies. It builds on developing countries' own mitigation priorities and recipient countries include Chile, Colombia, Costa Rica, Mexico, China, Indonesia, Thailand, Turkey and the Ukraine.
CDM: Encouraging civil society engagement in the CDM	0.100	0.155	Provided	ODA	Grant	Mitigation		Development of network and support services to encourage greater participation of civil society in the CDM
CDM: Piloting standardised approaches in the CDM	0.100	0.155	Provided	ODA	Grant	Mitigation		Development of three standardised CDM methodologies for project types particularly suited to Least Developed Countreis.

	Total Amount		*Status*	*Funding source*	*Financial Instrument*	*Type of support*	*Sector*	*Additional Information*
	Climate Specific		*Provided/ committed/ pledged*	*ODA/OOF/ Other*	*Grant/ Concessional loan/non-concessional loan/equity/ other*	*Mitigation/ Adaptation, Cross-cutting/ Other*	*Energy/ Transport/ Industry/ Agriculture/ Forestry/WASH/ Cross-cutting/ Other*	
Recipient country/region/project programme	*Sterling (£m)*	*USD ($m)*						
Climate Public Private Partnership (CP3)	0.119	0.184	Provided	ODA	Grant	Mitigation		The UK will invest £130 million in 2 commercial private equity funds, which will aim to leverage private co-investment. These funds will be run on a strictly commercial basis by professional fund managers. As well as an equity investment of £110 million, the project will include technical assistance to support the development of the project pipeline and facilitate pioneering projects.
Energy and Environment Partnership Programme with Southern and Eastern Africa	4.500	6.954	Provided	ODA	Grant	Mitigation		The programme aims to provide low carbon private sector development through awarding co-financing to viable projects focusing on improving energy access for poor people, improving energy supply and energy efficiency by demonstrating new technologies.
GVEP (Global Village Energy Partnership)	0.678	1.047	Provided	ODA	Grant	Mitigation		To reduce poverty through accelerated access to modern energy services.
World Bank LCD Post	0.278	0.429	Provided	ODA	Grant	Mitigation		Funding for a low carbon development post at the World Bank
Congo Basin Forestry Start Up Fund	0.437	0.676	Provided	ODA	Grant	REDD+		Five projects in advance of the main Congo Basin Project Fund, with a goal of increasing the capacity of the people and institutions in Congo Basin forest communities to manage and protect their forests sustainably. The projects were initiated whilst the mechanisms of the main CBFF Fund were being established. Their intention was to signal the range and type of projects the CBFF could support.
CIFOR Scientist	0.145	0.225	Provided	ODA	Grant	REDD+		Expertise to the Centre for International Forestry Research to monitor REDD projects worldwide for outcome and impact – piloting and implementing the methodology

	Total Amount		*Status*	*Funding source*	*Financial Instrument*	*Type of support*	*Sector*	*Additional Information*
	Climate Specific		*Provided/ committed/ pledged*	*ODA/OOF/ Other*	*Grant/ Concessional loan/non-concessional loan/equity/ other*	*Mitigation/ Adaptation, Cross-cutting/ Other*	*Energy/ Transport/ Industry/ Agriculture/ Forestry/WASH/ Cross-cutting/ Other*	
Recipient country/region/project programme	*Sterling (£m)*	*USD ($m)*						
Forest governance and trade (FLEGT)	3.412	5.273	Provided	ODA	Grant	REDD+		Current support to tackling illegal logging and related trade in support of the EU Forest Law Enforcement Governance and Trade (FLEGT) Action Plan – ends September 2011.
Forest Governance Markets and Climate (FGMC)	3.938	6.085	Provided	ODA	Grant	REDD+		To reduce the illegal use of forest resources and benefit poor people through better governance and market reforms in developing countries.
Forest tenure	1.527	2.360	Provided	ODA	Grant	REDD+		To increase the global forest area under community tenure by supporting a civil society coalition Rights and Resources Initiative (RRI) that includes grassroots community and indigenous organisations.
Nepal Multi-stakeholder Forestry Programme	0.175	0.270	Provided	ODA	Grant	REDD+		Supporting Nepal's forestry sector contributing to inclusive economic growth, poverty reduction and tackling climate change.
Rapid Response Facility on Climate Change	0.110	0.170	Provided	ODA	Grant	REDD+/ Mitigation		Fund to support the Government of Indonesia meet its climate objectives
Spatial Planning and Low Carbon Development in Papua	0.092	0.143	Provided	ODA	Grant	REDD+/ Mitigation		Support to entrepreneurs to bring forward their low carbon investment proposals and support to the spatial planning function of the provincial government in Papua to avoid deforestation. Long-term design work for a three year programme starting in 12/13.

	Total Amount		*Status*	*Funding source*	*Financial Instrument*	*Type of support*	*Sector*	*Additional Information*
	Climate Specific		*Provided/ committed/ pledged*	*ODA/OOF/ Other*	*Grant/ Concessional loan/non-concessional loan/equity/ other*	*Mitigation/ Adaptation, Cross-cutting/ Other*	*Energy/ Transport/ Industry/ Agriculture/ Forestry/WASH/ Cross-cutting/ Other*	
Recipient country/region/project programme	*Sterling (£m)*	*USD ($m)*						
Reducing Deforestation in the Brazilian Cerrado	10.000	15.453	Provided	ODA	Grant	REDD+		This project aims to reduce rates of deforestation by supporting registration of land ownership under the Rural Environment Register to ensure compliance with the Brazilian Forest Code. It also provides technical assistance to help farmers with the restoration of vegetation on illegally cleared land. It promotes the gathering and marketing of products from natural Cerrado vegetation and supports measures to prevent and deal with forest fires – a major driver of deforestation.
ADB Solar Loan Guarantee Facility (India)	2.000	3.091	Provided	ODA	Grant	Mitigation		Partnership with ADB to establish a partial loan guarantee facility to leverage private financing of projects under the India National Solar Mission. The facility will mitigate the many risks currently preventing solar developers from accessing commercial loans, by providing guarantees up to 50% of political, commercial and technology risks, and will be complemented by a technical assistance prigramme to build capacity of domestic commercial banks to appraise and understand solar power projects. DFID grant assistance will play a crucial role in enabling the guarantees to be priced at an acceptable rate to banks, and therefore underpinning the success of the entire facility.
India: Solar Capital Market Climate Initiative (CMCI)	0.060	0.093	Provided	ODA	Grant	Mitigation		Funding to reduce barriers to private investment in the solar market.
Bangladesh Climate Change Programme I	6.530	10.091	Provided	ODA	Grant	All		Climate change adaptation and risk reduction measures protect and improve the lives and livelihoods of 15 million poor and vulnerable people by 2013.

	Total Amount		*Status*	*Funding source*	*Financial Instrument*	*Type of support*	*Sector*	*Additional Information*
	Climate Specific		*Provided/ committed/ pledged*	*ODA/OOF/ Other*	*Grant/ Concessional loan/non-concessional loan/equity/ other*	*Mitigation/ Adaptation, Cross-cutting/ Other*	*Energy/ Transport/ Industry/ Agriculture/ Forestry/WASH/ Cross-cutting/ Other*	
Recipient country/region/project programme	*Sterling (£m)*	*USD ($m)*						
FCO Prosperity Fund	10.317	15.942	Provided	ODA	Grant	All		The Prosperity Fund supports projects to create the political and economic conditions for sustainable global growth and development. The portion of spend recorded here relates to spend on climate change in the major industrialising countries.
TOTAL	**119.221**	**184.232**						

Note
1. Exchange rate is £1 = USD1.5453 (as at 31 12 2011)

Mitigation =	41.393	63.965
Adaptation =	11.993	18.532
Cross-cutting (all) =	65.835	101.735
Total =	119.221	184.232

Table 7
Provision of public financial support: summary information in 2012 (1 April – 31 Dec)

	Sterling (£)					*USD ($)*				
Allocation channels	*Core/ General*	*Climate-specific*				*Core/ General*	*Climate-specific*			
		Mitigation	*Adaptation*	*Cross-cutting*	*Other*		*Mitigation*	*Adaptation*	*Cross-cutting*	*Other*
Total contributions through multilateral channels:										
Multilateral climate change funds	31.500	21.000	8.000			50.882	33.921	12.922		
Other Multilateral climate change funds		71.000	30.000	4.000			114.686	48.459	6.461	
Multilateral financial institutions, incl. regional development banks			100.000					161.530		
Specialised UN bodies										
Total contributions through bilateral, regional and other channels		218.544	5.964	35.947			353.014	9.633	58.065	
TOTAL	**31.500**	**310.544**	**143.964**	**39.947**		**50.882**	**501.621**	**232.544**	**64.526**	

Note
1. Exchange rate is £1 = USD1.6153 (as at 31 12 2012)
2. Figures quoted are for period 1 April 2012 – 31 December 2012.
3. Figures for general/core contributions to multilateral financial institutions and specialised UN bodies for UK Financial Year 2012/13 are not yet available.

Parties to provide an indication of what 'new and additional' financial resources they have provided, and clarify how they have determined that such resources are new and additional. This support has been met from the UK's £3.87 billion International Climate Fund, which is funded from the rising UK aid budget.

Table 7a
Provision of public financial support: contributions through multilateral channels in 2012 (1 April – 31 Dec)

	Total amount				*Status*	*Funding source*	*Financial Instrument*	*Type of support*	*Sector*
	Core/general		*Climate Specific*		*Provided/ committed/ pledged*	*ODA/OOF/ Other*	*Grant/ Concessional loan/non-concessional loan/equity/ other*	*Mitigation/ Adaptation, Cross-cutting/ Other*	
	Sterling (£m)	*USD ($m)*	*Sterling (£m)*	*USD ($m)*					
Multilateral Climate Change funds									
1. GEF	31.5	50.882	21.000	33.921	Provided	ODA	Grant	Mitigation	Cross-cutting
2. LDCF			8.000	12.922	Provided	ODA	Grant	Adaptation	Cross-cutting
3. Special CC Fund									
4. Adaptation Fund									
5. Green Climate Fund									
6. UNFCCC Trust Fund for Supplementary Activities									
7. Other multi CC funds									
7a. CIFs: PPCR			30.000	48.459	Provided	ODA	Mixture	Adaptation	Cross-cutting
7b. CIFs: SREP			25.000	40.383	Provided	ODA	Mixture	Mitigation	Energy
7c. CIFs: Clean Technology Fund			46.000	74.304	Provided	ODA	Other (capital)	Mitigation	Energy
7d. Forest Investment Programme									
7e. Climate Development Knowledge Network			4.000	6.461	Provided	ODA	Grant	Cross-cutting	
Sub-total	**31.500**	**50.882**	**134.000**	**216.450**					
Multilateral financial institutions incl regional dev banks									
1. World Bank									
2. International Finance Corporation									
3. African Development Bank									
4. Asian Development Bank									
5. EBRD									

	Total amount				*Status*	*Funding source*	*Financial Instrument*	*Type of support*	*Sector*
	Core/general		*Climate Specific*		*Provided/ committed/ pledged*	*ODA/OOF/ Other*	*Grant/ Concessional loan/non-concessional loan/equity/ other*	*Mitigation/ Adaptation, Cross-cutting/ Other*	
	Sterling (£m)	*USD ($m)*	*Sterling (£m)*	*USD ($m)*					
6. IADB									
7. Other									
7a. International Fund for Agricultural Development			100.000	161.530	Provided	ODA	Grant	Adaptation	Agriculture
Sub-total			100.000	161.530					
Specialised UN bodies									
1. UNDP (specific programmes)									
2. UNEP (specific programmes)									
3. Other									
Sub-total									
TOTAL	**31.500**	**50.882**	**234.000**	**377.980**					

Note
1. Exchange rate is £1 = USD1.6153 (as at 31 12 2012)
2. Figures quoted are for period 1 April 2012 – 31 December 2012.
3. Figures for general/core contributions to multilateral financial institutions and specialised UN bodies for UK Financial Year 2012/13 are not yet available.

Table 7b
Provision of public financial support – contribution through bilateral, regional and other channels 2012 (1 Apr – 31 Dec)

	Total Amount		*Status*	*Funding source*	*Financial Instrument*	*Type of support*	*Sector*	*Additional Information*
	Climate Specific		*Provided/ committed/ pledged*	*ODA/OOF/ Other*	*Grant/ Concessional loan/non-concessional loan/equity/ other*	*Mitigation/ Adaptation, Cross-cutting/ Other*	*Energy/ Transport/ Industry/ Agriculture/ Forestry/WASH/ Cross-cutting/ Other*	
Recipient country/region/project programme	*Sterling (£m)*	*USD ($m)*						
2050 Pathways	0.027	0.044	Provided	ODA	Grant	Mitigation		A dedicated team in DECC's Strategy Directorate will provide direct technical support to 10 priority countries to develop their own in-house version of the UK's 2050 Calculator.
International Carbon Capture and Storage Capacity Building	49.920	80.636	Provided	ODA	Grant	Mitigation		Build developing country capacity to deploy carbon capture and storage technologies. The UK will provide £60 million of finance from the International Climate Fund (ICF) to support developing countries to develop both the technical and institutional knowledge necessary to enable the deployment of CCS technologies. Financial support would be channelled toward a range of projects with the aim of ensuring sufficient political support is created to pave the way for full scale demonstration and ultimately the deployment of CCS
Climate Public Private Partnership (CP3) Platform	51.300	82.865	Provided	ODA	Grant	Mitigation		The UK will invest £130 million in 2 commercial private equity funds, which will aim to leverage private co-investment. These funds will be run on a strictly commercial basis by professional fund managers. As well as an equity investment of £110 million, the project will include technical assistance to support the development of the project pipeline and facilitate pioneering projects.

	Total Amount		*Status*	*Funding source*	*Financial Instrument*	*Type of support*	*Sector*	*Additional Information*
	Climate Specific		*Provided/ committed/ pledged*	*ODA/OOF/ Other*	*Grant/ Concessional loan/non-concessional loan/equity/ other*	*Mitigation/ Adaptation, Cross-cutting/ Other*	*Energy/ Transport/ Industry/ Agriculture/ Forestry/WASH/ Cross-cutting/ Other*	
Recipient country/region/project programme	*Sterling (£m)*	*USD ($m)*						
Forest Governance Markets and Climate (FGMC)	11.697	18.894	Provided	ODA	Grant	REDD+		This programme aims to reduce the illegal use of forest resources and benefit poor people through better governance and market reforms in developing countries. It combines support to actions by forest nations to tackle illegal logging and forest clearance for agriculture, with progress in consumer countries to curb demand for illegally-sourced products. It will expand the lessons learnt under past work on timber to other commodity markets that drive deforestation, such as palm oil, soy, beef and leather.
Climate Research	15.400	24.876	Provided	ODA	Grant	All		Funding for a range of international research and evidence programmes
Climate Resilient Agriculture in Africa	1.410	2.278	Provided	ODA	Grant	Adaptation		This DFID programme aims to improve knowledge, policies and longer-term incentives to drive increased use of 'climate smart' agriculture in eastern and southern Africa.
Forest and Climate Knowledge	5.790	9.353	Provided	ODA	Grant	REDD+		UK investment in developing the latest knowledge and tools on forestry through organisations such as Rights and Resources Initiative (RRI), Global Programme on Forests (PROFOR), International Tropical Timber Organisation (ITTO) and the Centre for International Forestry research (CIFOR).
Support to trans-boundary water resource management in Southern Africa	1.300	2.100	Provided	ODA	Grant	Adaptation		Strengthening the management of trans-boundary water resources in the Southern Africa Development Community region. Facilitating infrastructure investment and water demand management to increase the access of people to water, protection from flooding and efficient use of the scarce resource.
Nepal Multi-stakeholder Forestry Programme	0.070	0.113	Provided	ODA	Grant	REDD+		A programme to support Nepal's forestry sector contributing to inclusive economic growth, poverty reduction and tackling climate change.

	Total Amount		*Status*	*Funding source*	*Financial Instrument*	*Type of support*	*Sector*	*Additional Information*
	Climate Specific		*Provided/ committed/ pledged*	*ODA/OOF/ Other*	*Grant/ Concessional loan/non-concessional loan/equity/ other*	*Mitigation/ Adaptation, Cross-cutting/ Other*	*Energy/ Transport/ Industry/ Agriculture/ Forestry/WASH/ Cross-cutting/ Other*	
Recipient country/region/project programme	*Sterling (£m)*	*USD ($m)*						
South Asia Alliance for Climate Resilient Landscapes & Livelihoods (SAACRLL)	0.177	0.286	Provided	ODA	Grant	All		The South Asia Alliance for a Greener Revolution (SAAGR) will build a multi-stakeholder regional coalition to increase food and water security whilst reducing emissions from land use.
Energy Sector Management Assistance Program and Asia Energy Policy Trust Fund	4.500	7.269	Provided	ODA	Grant	Mitigation		The Energy Sector Management Assistance Program (ESMAP) is a global, multidonor trust fund administered by the World Bank and funded by 13 bilateral donors – including the UK. ESMAP assists its clients – low- and middle-income countries – to increase know-how and institutional capacity in order to achieve environmentally sustainable energy solutions for poverty reduction and economic growth.
South Asia Water Initiative (phase 2)	1.540	2.488	Provided	ODA	Grant	Adaptation		Continued UK support to provide funding for additional regional collaboration on the Sundarbans, Mt Kailash and for building broader accountability on hydropower and water management in the region.
Strengthening Adaptation and Resilience to Climate Change in Kenya (StARCK)	0.890	1.438	Provided	ODA	Grant	Adaptation		The intended outcome of the programme is that new mechanisms are established by the Govt. of Kenya, private sector and civil society to enable substantially expanded investments for increased resilience to climate change.
Ghana climate change programme	0.200	0.323	Provided	ODA	Grant	All		A programme to integrate climate change responses into Ghanan policy making.
Strategic Climate Institutions Programme (SCIP)	0.220	0.355	Provided	ODA	Grant	All		Activities to build Ethiopia's institutional capacity to respond to climate change. Includes working with private sector, government and civil society.
Support to South Africa's low-carbon transition	0.050	0.081	Provided	ODA	Grant	Mitigation		A programme focused on catalysing private sector innovation and investment in low-carbon technologies

	Total Amount		*Status*	*Funding source*	*Financial Instrument*	*Type of support*	*Sector*	*Additional Information*
	Climate Specific		*Provided/ committed/ pledged*	*ODA/OOF/ Other*	*Grant/ Concessional loan/non-concessional loan/equity/ other*	*Mitigation/ Adaptation, Cross-cutting/ Other*	*Energy/ Transport/ Industry/ Agriculture/ Forestry/WASH/ Cross-cutting/ Other*	
Recipient country/region/project programme	*Sterling (£m)*	*USD ($m)*						
Advocacy Fund	1.989	3.213	Provided	ODA	Grant	All		To support the very poorest developing countries to fully participate in the international climate change negotiations.
Cooperation in International Waters	0.084	0.135	Provided	ODA	Grant	Adaptation		Strengthen the cooperative management and development of trans boundary river basins in Africa (selection of priority basins to be determined). The programme is funded through and managed by the World Bank.
Nepal Climate Change Support Programme	0.480	0.775	Provided	ODA	Mix	Adaptation		A programme to ensure that three million of the poorest and most vulnerable women and men in Nepal are able to adapt to the effects of climate change.
Improving Governance of Land Use, Land-Use Change and Forestry (LULUCF) in Indonesia	0.990	1.599	Provided	ODA	Grant	REDD+		Strengthen capacity of civil society and other non-state stakeholders to influence decision, policies and legislation on land-use and low carbon development
AECF Renewable Energy and Adapting to Climate Technologies (REACT) Private Sector Challenge Fund Tanzania Window	0.978	1.580	Provided	ODA	Grant	Adaptation/ mitigation		Contribution to a catalytic fund to stimulate private sector investment and innovation on renewable energy and climate adaptation technology, particularly in rural areas.
Caribbean Climate Change Resilience Implementation Programme	0.080	0.129	Provided	ODA	Grant	All		UK support for the Caribbean Community (CARICOM) Climate Change Resilience Programme.
Community Adaptation Learning Programme (CARE)	0.880	1.421	Provided	ODA	Grant	REDD+		To increase the capacity of vulnerable households in sub-Saharan Africa to adapt to climate variability and change.
Vietnam DFID-WB Climate Change Partnership (VNCLIP)	0.900	1.454	Provided	ODA	Grant	Adaptation/ mitigation		A programme to support adaptation to the impacts of climate change and low carbon development in Vietnam.
Degraded Land Mapping in Indonesia	0.500	0.808	Provided	ODA	Grant	REDD+		Funding for mapping degraded land in Kalimantan, Borneo.

	Total Amount		*Status*	*Funding source*	*Financial Instrument*	*Type of support*	*Sector*	*Additional Information*
	Climate Specific		*Provided/ committed/ pledged*	*ODA/OOF/ Other*	*Grant/ Concessional loan/non-concessional loan/equity/ other*	*Mitigation/ Adaptation, Cross-cutting/ Other*	*Energy/ Transport/ Industry/ Agriculture/ Forestry/WASH/ Cross-cutting/ Other*	
Recipient country/region/project programme	*Sterling (£m)*	*USD ($m)*						
Indonesia Multistakeholder Forestry Programme II	1.360	2.197	Provided	ODA	Grant	REDD+		Support to Indonesia to implement EU/Indonesia agreement on timber accreditation
Civil Society Climate Change and Environment Fund (with DANIDA and USAID)	0.340	0.549	Provided	ODA	Grant	All		The purpose of this fund is to improve public access to information, build support for action and strengthen accountability and advocacy around climate finance and delivery, through engagement with civil society, media and parliament.
Climate Change Institutional Strengthening Programme	0.500	0.808	Provided	ODA	Grant	All		This programme will provide strategic support, such as the development of a National Climate Change strategy and climate financing mechanism to better position Tanzania to access climate finance and then ensure its effective delivery. It will also look at mainstreaming climate change in the budgeting and planning process.
Climate Technology Innovation Support Package	0.062	0.100	Provided	ODA	Grant	All		Piloting a global platform for applied innovation into climate technologies relevant to developing countries
Forest tenure	0.960	1.551	Provided	ODA	Grant	REDD+		Increasing global forest area under community tenure by supporting a civil society coalition Rights and Resources Initiative (RRI) that includes grassroots community and indigenous organisations
Nile Basin Discourse	0.260	0.420	Provided	ODA	Grant	Adaptation		Regional and national engagement of civil society organisations on river Nile management and development related issues, especially in conjunction with the Nile Basin Initiative.
Sothern Africa Regional Climate Change Programme (RCCP)	0.090	0.145	Provided	ODA	Grant	All		A programme to generate and disseminate climate change information for policy makers and planners in the Southern Africa Development Community (SADC) region.
Funding for a scientist post at the Centre for International Forestry Research	0.100	0.162	Provided	ODA	Grant	REDD+		Funding expertise to the Centre for International Forestry Research to monitor REDD projects worldwide for outcome and impact.

	Total Amount		*Status*	*Funding source*	*Financial Instrument*	*Type of support*	*Sector*	*Additional Information*
	Climate Specific		*Provided/ committed/ pledged*	*ODA/OOF/ Other*	*Grant/ Concessional loan/non-concessional loan/equity/ other*	*Mitigation/ Adaptation, Cross-cutting/ Other*	*Energy/ Transport/ Industry/ Agriculture/ Forestry/WASH/ Cross-cutting/ Other*	
Recipient country/region/project programme	*Sterling (£m)*	*USD ($m)*						
Encouraging civil society engagement in the Clean Development Mechanism	0.100	0.162	Provided	ODA	Grant	Mitigation		Development of network and support services to encourage greater participation of civil society in the Clean Development Mechanism.
Oxfam Climate Action Network (Climate Advocacy Officer)	0.190	0.307	Provided	ODA	Grant	All		Support to the Climate Action Network of Uganda by funding the post of National Climate Advocacy Officer hosted at Oxfam. The aim is to support Civil Society to enable them to influence climate change policy , to initiate and support national debates and campaigns on climate change.
Brazilian Panel on Climate Change	0.441	0.712	Provided	ODA	Grant	All		Helping to establish an expert scientific Panel modelled on the IPCC as the definitive source of knowledge and policy advice on climate change in Brazil; to support their engagement with international knowledge processes (IPCC) and negotiations (UNFCCC); and encourage their efforts to help other developing countries to develop robust plans and actions to address climate change.
Parliamentary Forum on Climate Change (PFCC)	0.560	0.905	Provided	ODA	Grant	All		Working with Uganda's Parliamentary Forum on Climate Change (PFCC) to help build their capacity, advocate and promote dialogue on mainstreaming climate change in local districts and building the capacity of local government officials on climate change issues.
Energy and Environment Partnership Programme with Southern and Eastern Africa	5.100	8.238	Provided	ODA	Grant	Mitigation		The programme aims to provide low carbon private sector development through awarding co-financing to viable projects focusing on improving energy access for poor people, improving energy supply and energy efficiency by demonstrating new technologies.
REACT Kenya	0.980	1.583	Provided	ODA	Grant	Adaptation/ mitigation		A catalytic fund to stimulate private sector investment and innovation on renewable energy and climate adaptation technology, particularly in rural areas.

	Total Amount		*Status*	*Funding source*	*Financial Instrument*	*Type of support*	*Sector*	*Additional Information*
	Climate Specific		*Provided/ committed/ pledged*	*ODA/OOF/ Other*	*Grant/ Concessional loan/non-concessional loan/equity/ other*	*Mitigation/ Adaptation, Cross-cutting/ Other*	*Energy/ Transport/ Industry/ Agriculture/ Forestry/WASH/ Cross-cutting/ Other*	
Recipient country/region/project programme	*Sterling (£m)*	*USD ($m)*						
Silvopastoral systems for climate change mitigation	15.000	24.230	Provided	ODA	Grant	REDD+		The UK is providing a £15m grant over 2012 to 2016 to support the growth of silvopastoral systems (SPS) in Colombia to reduce greenhouse gas emissions, improve the livelihood of farmers, protect local forests and increase biodiversity.Agriculture is one of the biggest sources of greenhouse gas emissions in Colombia and many other developing countries, and a key driver of deforestation. Addressing this fact, the UK and partners are working with cattle ranchers to improve degraded grazing land by using SPS. This means managing the land in a different way: planting trees, shrubs, fodder crops and living fences and conserving existing forest.
Green Africa Power	25.000	40.383	Provided	ODA	Grant	Mitigation		Green Africa Power (GAP) has been developed jointly by the UK Department of Energy and Climate Change (£25m) and UK Department for International Development (£53m) and in total the UK is contributing £98million over 2012 to 2015 to tackle specific constraints to private sector investment in renewable power generation in Africa. The UK will provide £95 million to capitalise GAP – a new company that will be established under the Private Infrastructure Development Group (PIDG) Trust. GAP will invest in renewable energy projects to demonstrate the viability of renewable energy in Africa so that future projects are more likely to happen and attract private developers and investors. A further £3 million will be used to set up the project, monitor and evaluate these impacts and capture and disseminate this knowledge. GAP aims to support projects that will install ~270MW of renewable energy in Africa in 4 years, avoiding an estimated 2.3m tonnes of CO2 emissions.

	Total Amount		*Status*	*Funding source*	*Financial Instrument*	*Type of support*	*Sector*	*Additional Information*
	Climate Specific		*Provided/ committed/ pledged*	*ODA/OOF/ Other*	*Grant/ Concessional loan/non-concessional loan/equity/ other*	*Mitigation/ Adaptation, Cross-cutting/ Other*	*Energy/ Transport/ Industry/ Agriculture/ Forestry/WASH/ Cross-cutting/ Other*	
Recipient country/region/project programme	*Sterling (£m)*	*USD ($m)*						
Nationally Appropriate Mitigation Actions (NAMA) Facility	25.000	40.383	Provided	ODA	Grant	Mitigation		The NAMA Facility is designed to support developing countries that show strong leadership in tackling climate change and want to implement transformational Nationally Appropriate Mitigating Actions (NAMA). Transformational NAMAs are projects, policies, or programmes that shift a whole technology or sector in a country onto a low-carbon development trajectory. Developing countries are preparing NAMAs as part of their national strategies. However, it is difficult to access finance through existing commercial and public channels to finance implementation, particularly for the most innovative NAMAs. By applying a competitive selection process the Facility will improve the value for money and quality of NAMAs and enable their implementation. It is intended that the Facility will support investments across a range of countries and sectors with grant funding as well as loan finance.
FCO Prosperity Fund	6.300	10.176	Provided	ODA	Grant	All		The Prosperity Fund supports projects to create the political and economic conditions for sustainable global growth and development. The portion of spend recorded here relates to spend on climate change in the major industrialising countries.
India: Solar Capital Market Climate Initiative (CMCI)	0.200	0.323	Provided	ODA	Grant	Mitigation		Funding to reduce barriers to private investment in the solar market.
Bangladesh Climate Change Programme I	6.540	10.564	Provided	ODA	Grant	All		Climate change adaptation and risk reduction measures protect and improve the lives and livelihoods of 15 million poor and vulnerable people by 2013.

	Total Amount		*Status*	*Funding source*	*Financial Instrument*	*Type of support*	*Sector*	*Additional Information*
	Climate Specific		*Provided/ committed/ pledged*	*ODA/OOF/ Other*	*Grant/ Concessional loan/non-concessional loan/equity/ other*	*Mitigation/ Adaptation, Cross-cutting/ Other*	*Energy/ Transport/ Industry/ Agriculture/ Forestry/WASH/ Cross-cutting/ Other*	
Recipient country/region/project programme	*Sterling (£m)*	*USD ($m)*						
Low Carbon Agriculture in Brazil and Avoided Deforestation to Reduce Poverty in Brazil	20.000	32.306	Provided	ODA	Grant	REDD+		This project will restore deforested and degraded land on small and medium sized farms in the Amazon and Atlantic Forest regions, contributing to the Government of Brazil's Sectorial Plan for the Mitigation and Adaptation of Climate Change for a Low Carbon Emissions Agriculture. It will achieve significant greenhouse gas emissions abatement, biodiversity conservation benefits and poverty reduction and involves work with farmers to develop and implement restoration and low carbon agriculture plans to unlock in-country credit from Brazilian banks.
TOTAL	**260.454**	**420.712**						
Mitigation =	218.544	353.014						
Adaptation =	5.964	9.633						
Cross-cutting (all) =	35.947	58.065						
Total =	260.454	420.712						

Notes
1. Exchange rate is £1 = USD1.6153 (as at 31 12 2012)

Table 8
Provision of technology development and transfer support

	Targeted area		*Sector*	*Source of funding*	*Activities undertaken by*	*Status*	*Additional Information*
Recipient country and/or region	*Mitigation/ Adaptation/ Cross-cutting*	*Measures and activities related to technology transfer*	*Energy/ Transpport/ Industry/ Agriculture/ Water and Sanitation/Other*	*Private/Public/ Private and Public*	*Private/Public/ Private and Public*	*Implemented/ planned*	
Kenya	Mitigation	Climate Innovation Centre	Mixed – mostly energy	Public	Private	Implemented	The first Climate Innovation Centre (CIC) was launched in Kenya in September 2012 with a total of £9.5m support from the UK, Denmark and the World Bank. As of August 2013, the Kenyan CIC is supporting 47 clean technology ventures with mentoring, training and proof-of-concept funding, from over 200 applications in the following sectors: renewable energy, agribusiness, and water and sanitation. Within the first five years, the Kenyan CIC aims to support over 70 climate technology enterprises and provide over 104,000 households with low carbon energy by 2015. It will help create up to 4,650 new 'green' jobs and support the development of local partnerships, supply chains and collaborations. The UK is contributing £4 million to the CIC.
Global	Cross-cutting	Climate and Development Knowledge Network (CDKN)	Cross-cutting	Public	Public	Implemented	The Climate and Development Knowledge Network (CDKN) is a five year initiative, launched in March 2010, and led by the UK, to enhance developing country access to high quality, reliable and policy-relevant information, based on cutting edge knowledge and research evidence on climate change and development. It intends to achieve this through a combination of knowledge management, research, technical assistance and advice, and partnership support. CDKN is an alliance of 6 private and non-governmental organisations. The UK is contributing £57 million to CDKN.
Africa	Cross-cutting	Renewable Energy and Adapting to Climate Technologies (REACT) programme	Energy/ Agriculture	Public	Public and private	Implemented	The Renewable Energy and Adapting to Climate Technologies (REACT) programme is a window of the Africa Enterprise Challenge Fund which aims stimulate private sector investment in developing and delivering low cost clean energy and climate adaptation technologies, such as solar power, biogas, irrigation and water efficiency measures. Provisional estimates (currently under review) are that by 2015, the REACT programme will have helped to deliver access to cleaner energy technologies to around 150,000 households. The UK is contributing £11 million to the REACT programme. Other donors are Sweden and Denmark.

	Targeted area		*Sector*	*Source of funding*	*Activities undertaken by*	*Status*	*Additional Information*
Recipient country and/or region	*Mitigation/ Adaptation/ Cross-cutting*	*Measures and activities related to technology transfer*	*Energy/ Transpport/ Industry/ Agriculture/ Water and Sanitation/Other*	*Private/Public/ Private and Public*	*Private/Public/ Private and Public*	*Implemented/ planned*	
Africa and Asia	Mitigation	Policy Innovation Systems for Clean Energy Security (PISCES) research programme	Energy	Public	Public	Implemented	The UK is supporting the Policy Innovation Systems for Clean Energy Security (PISCES) research programme that aims to develop innovative knowledge on energy from biomass to support improved access to energy and better livelihoods for poor people in sub-Saharan Africa and South Asia. For example, in Tanzania the private sector is partnering with PISCES on field trials of the most promising local modified plant oils to replace diesel in small generators, power tillers and irrigation pumps. PISCES is also working in partnership with Kiwia and Laustsen, a local company, who are manufacturing agricultural waste gasifier stoves, which PISCES helped to develop and test, as a clean energy solution that will help reduce the numbers of people with poor health caused by indoor air pollution and reduce extensive wood use for cooking. The UK is contributing £4.5 million to the PISCES programme.

Notes:

1. In 2011, the UK Government established the £3.87 billion International Climate Fund to help reduce poverty and tackle climate change in developing countries. The ICF aims to help the poorest people adapt to the effects of climate change on their lives and livelihoods and to support countries to develop in ways that avoid or reduce harmful greenhouse gas emissions. Many of the ICF programmes actively support some form of technology development or transfer (to a greater or lesser extent either directly or indirectly). Some specific examples are detailed on this submission.

Table 9
Provision of Capacity-building support

	Targeted area		
Recipient country and/or region	*Mitigation/Adaptation/ Cross-cutting*	*Programme or project title*	*Description of programme or project*
Global	Cross-cutting	Climate and Development Knowledge Network (CDKN)	The Climate and Development Knowledge Network (CDKN) is a five year initiative, launched in March 2010, to support 40 developing countries build their knowledge, capacity and action plans on climate change, CDKN is an alliance of 6 private and non-governmental organisations that helps decision makers to design and deliver climate and environmental policies and programmes, introduce new technologies and mobilise new funding sources. The UK is contributing £57 million to CDKN.
China, Indonesia and South Africa	Mitigation	International CCS Capacity Building programme	The International CCS Capacity Building programme aims to build developing country capacity to deploy carbon capture and storage (CCS) technologies. The UK will provide £60 million of finance from the International Climate Fund (ICF) to support developing countries to develop both the technical and institutional knowledge necessary to enable the deployment of CCS technologies. Financial support would be channelled toward a range of projects in China, South Africa and Indonesia with the aim of ensuring sufficient political support is created to pave the way for full scale demonstration and ultimately the deployment of CCS.
Global	Mitigation (REDD+)	Forest Governance Markets and Climate (FGMC)	The programme aims to reduce the illegal use of forest resources and benefit poor people through better governance and market reforms in developing countries. It will combine support to actions by forest nations to tackle illegal logging and forest clearance for agriculture, with progress in consumer countries to curb demand for illegally-sourced products. It will expand the lessons learnt under our past work on timber to other commodity markets that drive deforestation, such as palm oil, soy, beef and leather. The programme helps governments, civil society groups and small enterprises in forest countries build their capacity to meet market demands, including new legislation, to supply legally-produced products. The UK is providing £79 million of funding through the International Climate Fund to the programme.
Kenya	Cross-cutting	Strengthening Adaptation and Resilience to Climate Change in Kenya Plus (StARCK+)	The intended outcome of the programme is the rapid scale-up of innovation and investment in low carbon and adaptation/resilience products, services and assets. The programme has three outputs: i) Private sector delivery of a rapid scale up of innovation and investment in low carbon and adaptive technologies, services and assets; 2) Critical targeted climate change governance reforms; 3) Enhanced capacity of civil society and media to hold local and central government to acount on Climate Change delivery. Under this programme DFID has supported capacity building of government, CSOs and private sector in the development of the Kenya National Climate Change Action Plan in 2012-13.

Notes:
1. In 2011, the UK Government established the £3.87 billion International Climate Fund to help reduce poverty and tackle climate change in developing countries. The ICF aims to help the poorest people adapt to the effects of climate change on their lives and livelihoods and to support countries to develop in ways that avoid or reduce harmful greenhouse gas emissions. Many of the ICF programmes actively support some form of capacity building (to a greater or lesser extent either directly or indirectly). Some specific examples are detailed on this submission.

Annex 3: Global Climate Observing System (GCOS) Implementation plan

UK Report on national activities with respect to the GCOS Implementation Plan

Prepared for submission to the
United Nations Framework Convention
on Climate Change (UNFCCC)

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Joint Nature Conservancy Committee
Marine Science Co-ordination Committee
Met Office
National Centre for Atmospheric Science
National Centre for Earth Observation
National Oceanography Centre
National Physical Laboratory
Natural England
Natural Resources Wales (formally Countryside Commission for Wales)
Northern Ireland Environment Agency
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Annex 3 Contents

Annex 3: GCOS Implementation plan

1. Introduction

This report provides an interim assessment of UK contributions towards the realisation of the GCOS Implementation Plan. It is intended for the UNFCCC Secretariat as an input to their overall GCOS assessment. The report uses the reporting structure set out by the UNFCCC Secretariat in its Draft decision 11/CP.13 'Reporting on global observing systems for climate'[1].

The process for producing the report has been to update the previous report, submitted as part of the 5th National Communication (Whitelaw et al., 2008), drawing heavily on new information collected from a UK Environmental Observation Framework (UKEOF) funded project: Coordinating Climate Science and Risk Assessment Observations (UKEOF, 2013[2]) and from the results of a recent consultation by UKEOF on behalf of DECC on the GCOS Implementation Plan (UKEOF, 2011[3]). In some cases, clarification was also sought from representatives involved directly with climate-related observation activities and associated programmes.

The section on common issues (Chapter 2) reuses text from websites and other documents to summarise UK inputs.

The report includes systematic observing systems operated by or on behalf of UK public sector organisations that are relevant to the GCOS Implementation Plan. Observations made by international organisations to which the UK contributes, such as the European Space Agency (ESA) and the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT), are presented under the auspices of the host countries — in these two particular examples, France and Germany respectively. Similarly, the reanalysis work of the European Centre for Medium-Range Weather Forecasts (ECMWF) is included in this report because the ECMWF is based in the UK.

The structure of the report follows that requested by the UNFCCC Secretariat. In outline, this is as follows:

- Common issues
- Atmospheric **Essential Climate Variables** (ECVs)
- Oceanic ECVs
- Terrestrial ECVs
- Additional information

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1 Subsidiary Body for Scientific and Technological Advice, Twenty-seventh session, Bali, 3–11 December 2007, FCCC/SBSTA/2007/L.14/Add.1,

2 UKEOF (2013) Coordinating climate science and risk assessment observations project final report.Available online: www.ukeof.org.uk.

3 UKEOF (2011). Summary of Consultation Responses to the GCOS Implementation Plan (IP-10). Available online: www.ukeof.org.uk.

2. Common issues

2.1 Planning

2.1.1 Overview

Climate research and procurement of climate-related observations are highly devolved activities in the UK. They are sponsored by various government departments in support of a range of responsibilities and policy requirements. In addition, some research is increasingly being funded from a wider stakeholder base in both public and private sectors, particularly in the area of climate impacts and adaptation. Although the UK does not therefore have set national plans for climate research and observations, and at present there are no plans to produce such plans, it regularly reviews such activities through the Living With Environmental Change (LWEC) Partnership. LWEC has a programme called the Environmental Observations Forum (EOF), founded in 2008 specifically to support better communication and sharing of information across the observations community. The preparation of the reports: Coordinating Climate Science and Risk Assessment Observations and Consultation Responses to the GCOS Implementation Plan have assisted in the task of gaining a national overview of activities.

2.1.2 Responsible departments

Responsibility for reporting to the UNFCCC lies with DECC, which has the lead on climate change policy and provides funds for climate research and observations to advise the UK's policy and its impacts and response strategies. The Department for Environment, Food and Rural Affairs (Defra) is responsible for domestic adaptation to climate change and provides funds for environmental observations, including some climate observations. The Department for Business, Innovation & Skills (BIS) funds work on new technologies and provides funding for the Research Councils. These Councils are responsible for maintaining the science base and operate at a distance from Government, though they participate in the LWEC and UKEOF coordination processes described below. The Research Council with the greatest direct interest in climate observations is the Natural Environment Research Council (NERC). NERC is responsible for basic research on climate prediction and processes and for some monitoring activities. The Met Office, as the national meteorological agency, also has a strong involvement in climate research (undertaken at its Hadley Centre) and observation.

Systematic observations in the UK and its overseas territories are made by a number of national agencies and organisations. The Met Office is the lead agency for making and collecting meteorological and atmospheric observations. Observations are also made by others, including the NERC research centres and other national capability Delivery Partners. These include the following:

NERC research centres

- British Antarctic Survey
- British Geological Survey
- Centre for Ecology & Hydrology
- National Centre for Atmospheric Science
- National Centre for Earth Observation
- National Oceanography Centre

Delivery Partners

- Plymouth Marine Laboratory
- Scottish Association for Marine Science
- Sea Mammal Research Unit

Collection of oceanographic (and marine) observations is widely distributed throughout the UK, with many government departments and laboratories, universities and commercial companies involved.

Terrestrial observations are made or coordinated by NERC, the Environment Agency (EA), Natural Resources Wales (NRW), the Scottish Environment Protection Agency (SEPA), the Northern Ireland Environment Agency (NIEA), the Forestry Commission and others. The UK also contributes to space-based observations through the European agencies: the European Space Agency and the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT).

2.1.3 Coordination processes

Living With Environmental Change (LWEC) partnership:

The Living With Environmental Change (LWEC) partnership[4] recognises the value of high quality environmental observational data and, through the activities of its UK Environmental Observation Framework[5] (UKEOF) is developing more strategic and co-ordinated approaches to the collection, management and sharing of observational data, both nationally and internationally. UKEOF was launched in response to the long term issues that surround environmental monitoring, and is a self-contained core activity of LWEC, funded by the major sponsors of environmental observations in the UK. UKEOF has recently set up a group of experts to oversee coordination of UK GCOS activities, the "Coordinating Climate Observations Group" (CCOG), which works with the UKEOF Management Group, LWEC, the GCOS Secretariat and other relevant stakeholders to ensure better coordination of GCOS activities within the UK.

The LWEC strategy[6] (LWEC, 2011) guides the design, delivery and uptake of research to understand how and why the environment is changing, to predict changes and to better understand what the impacts might be.

The Climate Challenge Strategic Framework[7] (LWEC, 2013) sets out the policy, business, societal and international context within which the LWEC partnership has established priorities for research and other activities. It identifies "development of observational programmes" as one of the eight highest priority areas to be addressed over the next five years.

Marine Science Co-ordination Committee (MSCC):

In the marine sector, the **Marine Science Co-ordination Committee (MSCC)** is a partnership of the main Government Departments, the Devolved Administrations of Scotland, Northern Ireland and Wales, the Environment Agencies and research bodies involved in funding and carrying out marine science in the UK.

The MSCC has two main responsibilities: to deliver the UK Marine Science Strategy; and to improve UK marine science co-ordination. The MSCC published the first UK Marine Science Strategy[8] in February 2010. It is a 15 year Strategy and was developed with significant input from the UK marine science community. It sets the general direction of travel for future marine science across the UK for the period 2010 to 2025.

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4 www.lwec.org.uk/about

5 http://www.ukeof.org.uk/

6 www.lwec.org.uk/sites/default/files/LWEC%20Strategy%202008~2013.pdf

7 http://www.lwec.org.uk/sites/default/files/LWEC%20Climate%20Challenge%20Strategic%20Framework%20-%2004%20March%202013.pdf

8 http://www.defra.gov.uk/mscc/files/uk-marine-science-strategy-.pdf

The delivery of long-term monitoring programmes was a key issue identified by stakeholders during the preparation of the Strategy. The aim is to make the process for selecting long-term observation systems for funding more transparent and providing secure, longer-term and cross-cutting funding for priority datasets.

The Marine Science Co-ordination Committee is working with the UK Environmental Observation Framework (UKEOF) and the UK Marine Monitoring and Assessment Strategy (UKMMAS) to address these issues.

2.1.4 International involvement

The UK participates in a number of international programmes and in particular with activities at European level. Such activities include the following:

- **ESA:** The UK contributes to a number of ESA programmes. In the past these have included the ERS and Envisat satellite programmes, and continuity from these will be provided by the joint EC-ESA Copernicus Programme Sentinel Missions. The UK is also involved in the ongoing ESA Earth Explorer Programme, which is developing new forms of observation of value to climate studies such as Cryosat, EarthCare and ADM Aeolus. The UK is the second largest contributor to the ESA Climate Change Initiative programme and leads ECV production activities in sea surface temperature and ocean colour. The Met Office also leads the user group for the programme.
- **EUMETSAT:** The UK contributes to EUMETSAT's polar orbiting METOP and METOP Second Generation (METOP-SG) series of satellites and the geostationary series (METEOSAT, MSG, MTG). The Met Office contributes to EUMETSAT's Climate Monitoring Satellite Application Facility (CMSAF). The CMSAF generates and archives datasets for specific climate application areas, derived primarily from EUMETSAT satellite data and also from US meteorological missions.
- **EUMETNET Composite Observing System (EUCOS):** The Met Office contributes to the EUCOS network, which aims to establish and operate a European observing network under the auspices of the European Meteorological Network (EUMETNET) to deliver increased efficiency, leading to better-quality numerical and general forecasts, initially on a European scale. EUCOS includes a terrestrial segment (surface and upper-air observing) and a surface marine programme, both of which contribute to GCOS.
- **Copernicus:** Copernicus, previously known as GMES, is a joint initiative of the European Commission (EC) and the ESA to which the UK contributes. In addition to the Sentinel satellite activity, Copernicus also involves in-situ measurements and the provision of services. The Met Office contributes to the European Reanalysis and Observations for Monitoring (EURO4M) project, an activity combining observations from satellites, ground-based stations and results from comprehensive model-based regional reanalyses. Products take the form of high-resolution datasets enabling observed high-impact weather and extreme events to be put into historical context.
- **ECMWF:** The UK is a partner in the European Centre for Medium Range Weather Forecasting (see section 2.5). The principal objectives of the Centre are:
  - development of numerical methods for medium-range weather forecasting;
  - regular preparation of medium-range weather forecasts for distribution to the meteorological services of the Member States;
  - scientific and technical research directed at the improvement of these forecasts;
  - collection and storage of appropriate meteorological data.

In addition, the ECMWF undertakes important reanalysis work, which is highly relevant to the GCOS Implementation Plan.

- **GEO:** The UK is a member of the international GEO programme as a national delegation and also through participation in a number of the GEO committees.
- **AGAGE:** The UK is involved in the international AGAGE programme through its activities at Mace Head. The Advanced Global Atmospheric Gases Experiment (AGAGE) and its predecessors (the Atmospheric Life Experiment, ALE, and the Global Atmospheric Gases Experiment, GAGE) have been measuring the composition of the global atmosphere continuously since 1978. AGAGE is distinguished by its capability to measure over the globe at high frequency almost all of the important species in the Montreal Protocol (e.g. CFCs and HCFCs) to protect the ozone layer and almost all of the significant non-CO_2 gases in the Kyoto Protocol (e.g. CF_4, SF_6, HFCs, methane, and nitrous oxide) to mitigate climate change.
- **ILTER:** The International Long Term Ecological Research (ILTER) is a 'network of networks', a global network of research sites located in a wide array of ecosystems that can help understand environmental change across the globe. The UK contribution is the Environmental Change Network (ECN) that gathers information about the pressures on and responses to environmental change in physical, chemical and biological systems. The Centre for Ecology & Hydrology (CEH) is taking the initial lead, in collaboration with ILTER, to develop a Global Network of Ecosystem Observatories as part of the Global Biodiversity Observation Network (GEO BON). GEO BON is also developing a set of Essential Biodiversity Variables which should complement the Essential Climate Variables that have already been developed for GCOS. ECN is working towards achievement of a global network of ecosystem observatories where co-located measurements of biological, hydrological, geochemical and climate measurements are undertaken and data made available through linked systems to contribute to global scale assessments of the effects of climate change impacts on ecosystems and ecosystem services.
- **FLUXNET:** FLUXNET coordinates regional and global analysis of observations from micrometeorological tower sites. The flux tower sites use eddy covariance methods to measure the exchanges of carbon dioxide (CO_2), water vapor, and energy between terrestrial ecosystems and the atmosphere. The UK has 14 contributory sites.
- **SOCAT:** The Surface Ocean Carbon Atlas (SOCAT) project is collating surface fCO_2 (fugacity of carbon dioxide, which is the partial pressure of CO_2 (pCO_2) corrected for non-ideal behaviour of the gas) from researchers across the globe. UK researchers at the University of East Anglia and the NOC are heavily involved in this project, both in quality control and submission of their data holdings. In the future the project will produce two products, a quality controlled global surface ocean fCO_2 data set following agreed procedures and regional review and gridded monthly surface water fCO_2 means.
- **OceanSITES:** OceanSITES is a worldwide system of long-term, deepwater reference stations measuring dozens of variables and monitoring the full depth of the ocean, from air-sea interactions down to 5,000 meters. The growing network now consists of about 30 surface and 30 subsurface arrays. Satellite telemetry enables near real-time access to OceanSITES data by scientists and the public. The network complements satellite imagery and other in-situ observation data (like Argo floats) by extending the dimensions of time and depth. The UK contributes four sites (PAP Observatory, RAPID-MOC, moorings in the Drake Passage and in the Antarctic). The NOC in

Southampton is coordinating the Framework 7 programme EuroSITES, which is the European contribution to the OceanSITES network.

- **GACS:** The Global Alliance of CPR Surveys (GACS) brings together the expertise of approximately 50 plankton specialists, scientists, technicians and administrators from 12 laboratories around the world, towing a common and consistent sampling tool, the CPR, from about 50 vessels. The Sir Alister Hardy Foundation for Ocean Science (SAHFOS) undertakes Continuous Plankton Recorder (CPR) Surveys across the Atlantic. Partnerships with other organisations have extended these surveys into the Pacific and also in the Southern Ocean (via Australia CPR and also through BAS who operate a CPR on the James Clark Ross on behalf of SAHFOS).

- **GO-SHIP:** The Global Ocean Ship-based Hydrographic Investigations Program (GO-SHIP) brings together scientists with interests in physical oceanography, the carbon cycle, marine biogeochemistry and ecosystems, and other users and collectors of ocean interior data to develop a sustained global network of hydrographic sections as part of the Global Ocean / Climate Observing System. GO-SHIP reference sections are coast-to-coast (or ice) repeat sections following WOCE station spacing with full-depth sampling of core variables. The UK has contributed through surveys using the ships RRS Discovery, RRS James Cook and BAS's RRS James Clark Ross.

- **RAPID-WATCH:** The RAPID-WATCH research programme is a strategic partnership between NERC and the Met Office Hadley Centre. The programme will record the strength and structure of the Atlantic Meridional Overturning Circulation (MOC) over a ten year period. These observations will be used to determine and interpret recent changes in the Atlantic MOC, to improve assessment of the risk of rapid climate change due to MOC change, and to investigate the potential for predictions of the MOC and its impacts on climate. The UK partnership funding has, through international partnership, leveraged contributions from US, German and Canadian partners and major in-kind contributions of ship-time from the US and Canadian partners. Significant co-funding has also been obtained from related EC FrameworkProgramme.

- **ARGO:** The international Argo project to establish a global network of profiling floats was initiated in 2000. The UK's contribution to Argo is being funded by the Department of Energy and Climate Change (DECC) and the Natural Environment Research Council (NERC), and is undertaken by a partnership involving the Met Office, the National Oceanography Centre (NOC), the British Oceanographic Data Centre (BODC) and the UK Hydrographic Office (UKHO). The UK Argo programme is managed and co-ordinated by the Met Office, with specialist scientific advice provided by NOC Southampton, while BODC operate the UK Argo Data Centre and the Southern Ocean Argo Regional Centre. The UK presently has around 130 active floats contributing to the Argo float array which consists of approximately 3,000 floats in total. We also have a significant role in the Euro-Argo Project[9] which aims to develop the European infrastructure to the level where the European partners have the capacity to procure and deploy ~250 floats per year, such a European contribution would support approximately 1/4 of the global array and provide an additional 50 floats per year for enhanced coverage in the European and marginal seas.

- **ISTI:** The International Surface Temperature Initiative[10] (ISTI) was formally launched at a workshop held at the Met Office in 2010, following a Met Office proposal to the

[9] http://www.euro-argo.eu/

[10] http://www.surfacetemperatures.org/

2010 session of the WMO Commission on Climatology. The ISTI aims to build an internationally agreed databank on surface temperature with the required metadata and traceability. The UK has a number of representatives on the Steering Committee, from the Met Office and elsewhere.

2.2 Implementation

Met Office:

The Met Office operates surface, upper air and marine observing networks that contribute to GCOS. These are mostly funded through the Public Weather Service (PWS), whose remit is to provide a coherent range of weather information and weather-related warnings to the UK public, on the basis that the GCOS commitments align well with PWS objectives. The PWS also provides UK climate and weather statistics.

The Met Office has recently taken on the responsibility for providing the role of the GCOS Implementation Manager, through funding from both DECC and its own Voluntary Cooperation Programme (VCP). The role, that of an international network manager, considers all aspects of the global observing systems in meeting the Climate requirements. It links the funding from the GCOS sponsors to priority areas in developing countries, both in terms of the uniqueness of measurement (i.e. location, content) and the financial challenges for the host organisation in operating the equipment. GCOS does not own any of the observing equipment but through the GCM (GCOS Cooperation Mechanism) it aims to support National services and institutes in the design, installation and operational management of their systems.

NERC marine centres:

A significant portion of the UK's open ocean observations capability lies within the NERC marine centres and are funded through research budgets. The Marine Science Co-ordination Committee (MSCC) has identified the delivery of sustained long-term monitoring programmes as a key issue during the preparation of the UK Marine Science Strategy. The MSCC is working with the UK Environmental Observation Framework (UKEOF) to address this issue which includes support for various long-term monitoring activities, a number of which are relevant to GCOS.

2.3 Quality control

2.3.1 Efforts to ensure ECV-observing activities adhere to the GCOS climate monitoring principles

UKEOF *Coordinating Climate Science and Risk Assessment Observations project:*

In 2013 the UKEOF commissioned the Coordinating Climate Science and Risk Assessment Observations project to improve the understanding of the relevance of UK climate-related observation activities to the GCOS ECVs. It identified those UK observations that contribute to GCOS and assessed where there are gaps in knowledge about UK observational data supporting the ECVs. One of the key aims was to raise awareness of relevant standards and practices (e.g. GCOS Climate Monitoring Principles, or GCMPs) amongst monitoring leads. The feedback received from the consultation will provide the opportunity to provide further information and guidance about standards and practices.

Met Office:

The Met Office undertakes comprehensive quality control of its GCOS stations by running a number of checks on the data held in its climate database. These include range, internal consistency and spatial checks on the observations. Faults identified are flagged for further investigation to resolve the problem promptly.

The Met Office operates a set of Change Advisory Boards (CABs) to consider and give approval to changes to its observing networks prior to implementation. Requested changes are thoroughly checked and assessed from both a technical and GCOS monitoring principles perspective. This is defined as part of the change control process within ITIL, a UK Government initiative.

The Met Office is implementing a new document management system, scheduled to be in place in 2014. This will ensure that operating procedures and observing practices are maintained in a coordinated and consistent manner. It will also retain old versions of documentation in an archive so that this metadata are safely stored and available for future reference.

The Met Office employs dedicated teams to inspect land and marine observing sites to ensure consistency of exposure according to WMO No. 8 guidelines. Details of local conditions, instruments and exposure (Metadata) are recorded using in-house developed software and archived. Since 2012 this has included assessing exposure using the CIMO siting classification for land observing sites.

The Met Office took a leading role in the planning, management and report writing for the WMO Intercomparison of Radiosonde Systems conducted in Yangjiang, China, July 2010. The primary aim of this intercomparison was improving the quality and cost-effectiveness of upper air observing systems by providing recommendations on system performances, improvements of instruments and methods of observation and suitable working references to WMO Members and instrument manufacturers. The final report is still in active use, both for numerous procurement activities to ensure measurement quality and in defining the priority improvements for the next generation systems.

British Rainfall Standard:

In 2012 the British Standards Institution (BSI) published a new national standard for the Acquisition and Management of Meteorological Precipitation Data from a Raingauge Network - BS 7843 (2012). It consists of 4 parts:

1. Guide for the design, development and review of a raingauge network
2. Code of practice for the design and manufacture of storage and automatic collecting rain gauges
3. Code of practice for operating raingauges and managing precipitation data
4. Guide for the estimation of areal rainfall

The standard gives guidance on those practices that minimise measurement uncertainty such as implementing change, collection of metadata, quality control and the operation of long-term monitoring sites. Members of the technical panel included representatives from the Met Office, Centre for Ecology and Hydrology (CEH), the Environment Agency (EA) and Scottish Environment Protection Agency (SEPA).

2.3.2 Difficulties encountered in protecting the integrity of long-term climate data records and steps being taken or required to address those difficulties

Government Chief Scientific Advisor's Environmental Observations Committee:

The aim of the Committee, set up in 2013, is to help ensure that the UK's crucial long-term environmental observational data needs can continue to be met for science, society and the green economy.

The Committee considers at a high level the UK Government's needs and priorities for scientific observations to inform and support environmental research, operational needs and policy-making. The Committee will seek to ensure that appropriate funding mechanisms are in place for priority programmes and that a coherent and robust environmental monitoring infrastructure exists to meet national needs.

Central England Temperature:

The Met Office has earmarked a small set of observing stations to ensure the consistent maintenance of the 350-year Central England Temperature record (see section 2.5.1).

Automation of ordinary climate stations:

Over the last 4 years the Met Office has secured the future of over 80 of its ordinary climate stations through automation with its established Met Monitoring System (MMS). A list of stations was prioritised based on length of observing record and risk/impact of closure. Changes in the local conditions were minimised by using the existing enclosure and Stevenson Screen without any significant new infrastructure.

Corrections to the global record of sea-surface temperature:

The Met Office Hadley Centre continues to develop corrections to the global record of sea surface temperature since 1850 to account for biases resulting from historical and ongoing changes in the composition of the data base, particularly relating to measurement platforms, methods and country of origin[11]. Uncertainties in these corrections are also quantified and made available together with uncertainties relating to under-sampling. The dataset was considerably enhanced when much of the undigitized ship logbook data held in the UK was digitized via the Recovery of Logbooks and International Marine Data (RECLAIM) project. DEFRA provided funding for the project between 2007 and 2011.

Improving CLIMAT data exchange:

The Met Office has occasional contacts with National Meteorological Services (NMSs) supplying CLIMAT observations with a view to improving data exchange. They also liaise regularly with the GCOS Monitoring Centres at Deutscher Wetterdienst (DWD) and the Japan Meteorological Agency (JMA).

Measurements of sea-surface temperature from satellites:

Since the demise of the satellite ENVISAT and with it the AATSR (Advanced Along-Track Scanning Radiometer), the UK hopes to continue to fund ship-borne radiometer measurements of sea-surface temperature to fill and bridge the gap in the satellite measurements until after data become available from the SLSTR (Sea and Land Surface Temperature Radiometer) to be flown under the Copernicus programme.

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[11] Kennedy J.J., Rayner, N.A., Smith, R.O., Saunby, M. and Parker, D.E. (2011a). Reassessing biases and other uncertainties in sea-surface temperature observations since 1850 part 1: measurement and sampling errors. J. Geophys. Res., 116, D14103, doi:10.1029/2010JD015218.

Kennedy J.J., Rayner, N.A., Smith, R.O., Saunby, M. and Parker, D.E. (2011b). Reassessing biases and other uncertainties in sea-surface temperature observations since 1850 part 2: biases and homogenisation. J. Geophys. Res., 116, D14104, doi:10.1029/2010JD015220.

2.4 International data exchange and data analysis

2.4.1 National policy or guidance that has been promulgated relevant to the international exchange of ECV data

The EU Directive known as INSPIRE (Infrastructure for Spatial information in the European Union) was transposed into UK law in December 2009. The INSPIRE directive aims to create an EU spatial data infrastructure. This will enable the sharing of environmental spatial information among public sector organisations and better facilitate public access to spatial information across Europe.

Data specifications for the EU INSPIRE directive are currently under review. The UK contribution involves many organisations that take part in the thematic working groups (it should however be noted that although this includes UK expertise, some of the funding for these activities is via the European Framework Programme). The Centre for Environmental Data Archival[12] (CEDA) and the UK Met Office have representatives on the Thematic Working Group on Atmospheric conditions and Meteorological Geographical Features. Both organisations also contribute to the MetOcean Domain Working Group of the World Meteorological Organisation (WMO) which aims to align the metadata/data models used in those communities with those being developed by INSPIRE.

The European Commission INSPIRE website[13] has news of developments on INSPIRE and an archive of EC INSPIRE documents.

2.4.2 Policy-level barriers to international exchange of climate data and their provision to international data centres (IDCs)

The UK has a policy of seeking some cost recovery from public investments, and some detailed observational data concerning the UK are only freely available under conditions that restrict use to supporting openly-published research.

2.5 Data centres

2.5.1 Met Office Hadley Centre

Datasets:

The Met Office Hadley Centre receives, quality controls, and archives large amounts of observed climate data. These are used for monitoring the climate, in studies of the causes of climate change, and in climate modelling.

National monitoring
Indicators of historical and present changes in climate include Central England Temperature (HadCET) and UK Precipitation (HadUKP). The HadCET mean temperature series is available at monthly resolution back to 1659, and at daily resolution back to 1772, and to date is the longest available instrumental record of temperature in the world. It is representative of a roughly triangular area of the UK enclosed by Bristol, Lancashire and London. The HadUKP (England & Wales) series is available at monthly resolution from 1766. Shorter series are available for other areas and resolutions. By using fewer, longer station records these series are designed to be more homogeneous over time.

[12] http://ceda.ac.uk

[13] http://inspire.jrc.ec.europa.eu/index.cfm

Additional resources for monitoring the climate in the UK are available from the MOHC National Climate Information Centre (NCIC). It routinely creates monthly series of 5 km gridded data and associated areal series using all available data. Recent work to digitise historical paper records has extended series back to 1910 for temperature & precipitation, and 1929 for sunshine duration.

Global monitoring
The Met Office Hadley Centre monitors the global average temperature on land and over the sea, and the sea surface temperature in the tropical Pacific, which is an indicator of variations associated with El Niño. Key global gridded datasets include monthly blended land surface air temperature and sea surface temperature (HadCRUT prepared in collaboration with the Climatic Research Unit (CRU) of the University of East Anglia); sea surface temperature with sea ice (HadISST); stand-alone sea surface temperature (HadSST); a new night marine air temperature data set (HadNMAT) developed in collaboration with the National Oceanography Centre, Southampton; and sea level pressure (HadSLP). Recent additions include is a global subsurface ocean analysis of temperature (HadGOA), and, with NOAA (USA), worldwide gridded land daily temperatures (HadGHCND). Many of these data sets and analyses are provided with quantified uncertainties. These and other data holdings are (or, for HadMAT, will be) fully described on the Hadley Centre Observations website[14]. Data currently on this site are due to be streamlined and made available through the British Atmospheric Data Centre under the European Union (EU) Framework Programme 7 (FP7) CLIP-C 3-year project which begins in December 2013.

Contribution to satellite Climate Data Record development
The Met Office Hadley Centre contributes to the ESA Climate Change Initiative SST project: leading the user requirements gathering process and interactions with climate users, product specification, user tool specification and climate assessment of the resultant data sets including: use in model evaluation; comparison with other SST data sets and analyses; and the amalgamation and reporting of feedback from trial users.

Co-ordination of international research network on surface temperature
The Met Office Hadley Centre co-leads, with the University of Reading and the University of Leicester, an international NERC-funded research network on surface temperature, the EarthTemp Network. This aims to bring together experts in the measurement of surface temperature both in situ and from satellites to better monitor surface temperature over the whole of the Earth.

International Surface Temperature Initiative
The Met Office Hadley Centre contributes to the development of traceable land air temperature data sets by the International Surface Temperature Initiative through leadership of the homogenisation benchmarking working group, amongst other things.

WMO OPACE Task Team on National Climate Monitoring Products
The Met Office Hadley Centre co-chairs the WMO OPACE Task Team on National Climate Monitoring Products which has proposed a common set of climate monitoring products that all nations around the world could produce in order to facilitate their participation in global climate monitoring activities.

Reanalysis work:

EU-funded ERA-CLIM project developing next generation reanalysis at ECMWF
The Met Office Hadley Centre develops data sets and analyses for boundary forcing of and assimilation into ERA-CLIM and future coupled reanalyses under ERA-CLIM2. These include: an ensemble of driving global SST and sea ice analyses (HadISST2); an integrated data base

[14] http://www.metoffice.gov.uk/hadobs/

of surface and sub-surface ocean temperature and salinity; a sub-surface ocean temperature and salinity data base (EN4); advice on the use of early satellite data; homogenised upper tropospheric humidity data from microwave satellite instruments; as well as inputs from ACRE, described below.

Atmospheric Circulation Reconstructions over the Earth (ACRE)
The Met Office Hadley Centre leads the international Atmospheric Circulation Reconstructions over the Earth (ACRE) initiative, which is an end-to-end project that facilitates both the historical global weather observational data needs of surface-observations-only climate quality reanalyses, and the seamless feeding of 3D weather products produced by these reanalyses into climate applications and impacts models. This activity is funded primarily by the Queensland Climate Change Centre of Excellence, but the project is run at the Met Office Hadley Centre. ACRE achieves this outcome by:

- linking international meteorological organisations and data rescue infrastructure to facilitate the recovery, extension, quality control and consolidation of global historical terrestrial and marine instrumental surface data covering the last 250 years;
- making these observations available to new pioneering surface-observations-only reanalyses;
- ensuring that reanalysis products can be tailored/downscaled to seamlessly flow into various climate applications and production models.

European 20th Century Reanalysis ERA-20C
We plan to contribute in-situ surface data to the European 20th Century Reanalysis ERA-20C.

UERRA
The Met Office Hadley Centre is also a major participant in the EU FP7 project Uncertainties in Ensembles of Regional Re-Analyses (UERRA) due to run from January 2014 until December 2017. We will produce a Europe-area reanalysis at 12 km resolution from 1979 to present, together with estimates of uncertainty derived from an ensemble of runs.

Distribution of model data:

Met Office Hadley Centre model data are distributed through the Climate Impacts LINK Project hosted by the British Atmospheric Data Centre. LINK[15] provides climate simulations from the Met Office Hadley Centre to the UK and international academic community.

2.5.2 Global Collecting Centre for Marine Climatological Data (GCC)

Under the Joint WMO/IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM), intergovernmental body of experts, which provides the international co-ordination, regulation and management of marine meteorological services, the Met Office runs one of two Global Collecting Centres. The GCC[16] is run as part of the WMO Marine Meteorology Programme.

The aim of the Global Collecting Centre is to ensure that marine data are received from contributing members around the world and processed to an agreed standard. The data are then distributed on a quarterly basis to eight members, each with their own area ofresponsibility.

[15] http://badc.nerc.ac.uk/view/badc.nerc.ac.uk__ATOM__dataent_linkdata

[16] http://www.metoffice.gov.uk/weather/marine/observations/gathering_data/gcc.html

2.5.3 Permanent Service for Mean Sea Level (PSML)

Established in 1933, the Permanent Service for Mean Sea Level (PSMSL) is responsible for the collection, publication, analysis and interpretation of sea level data from the global network of tide gauges. It is based at the National Oceanography Centre (NOC), Liverpool, and is supported by NERC and the Intergovernmental Oceanographic Commission (IOC). The PSMSL operates under the auspices of the International Council for Science (ICSU) and is working towards membership of the new ICSU World Data System.

Aside from its central role of operation of the global sea level data bank, the PSMSL provides advice to tide gauge operators and analysts. It occupies a central management role in the development of the Global Sea Level Observing System (GLOSS) and hosts important international study groups and meetings on relevant themes.

Datasets:

In April 2013 the total PSMSL data holdings amounted to over 707,402 station-months from 2174 stations. Most of the data originated from Europe and North America together with significant data sets from Japan and Australia. There are gaps in data receipts from parts of SE Asia, central and South America: these are presently being targeted to try to improve data flow. Africa continues to receive special attention through ODINAfrica and IOTWS, although data flow has improved considerably over the last decade. Close links have been maintained with the University of Hawaii Sea Level Center and other international sea level data centres. The data set and ancillary information are provided free of charge and are made available to the international scientific community through the PSMSL website[17]. The metadata includes descriptions of benchmarks and their locations, types of instrumentation and frequency of data collection (where available) as well as notes on other issues that it is considered users should be aware of (e.g. earthquakes that are known to have occurred in the vicinity or subsidence due to local groundwater extraction). Free access to data by users is central to the PSMSL's mission.

Other activities:

PSMSL staff have continued to be active participants in the IOC Group of Experts on the Global Sea Level Observing System (GLOSS) and GGOS meetings, co-convened sea level sessions at the EGU and contributed to IOC coordination group tsunami warning system meetings. PSMSL has contributed to the IPCC Fifth Assessment Report with Dr Svetlana Jevrejeva a lead author for Working Group I and other PSMSL staff also contributing.

The PSMSL attempts to stimulate the development of tide gauge networks with other countries at national, regional and global level. The most important component of this work is its planning, and part-management of, the GLOSS programme. It provides, through GLOSS and via other routes, advice and training to national sea level authorities and individual sea level scientists and technologists. It organises major international meetings on the themes of sea level changes and tides. It also supplies software packages for tidal data analysis and quality control and helps with the provision of training information and manuals. It maintains full participation with altimeter and space gravity working groups in view of the importance of those techniques to sea level research.

[17] http://www.psmsl.org/

2.5.4 British Oceanographic Data Centre (BODC)

NERC's British Oceanographic Data Centre (BODC) is a national facility for storing and distributing data concerning the marine environment. It is based at the NOC, Liverpool. Data holdings include biological, chemical, physical and geophysical oceanographic data, including measurements of nearly 22,000 different variables.

Datasets:

Data can be retrieved directly from the BODC website[18]. Data currently available include:

- All data (including CTD profiles, current meter and wave data) held in our National Oceanographic Database
- Argo floats
- CTD and underway data (Atlantic Meridional Transect)
- Gridded bathymetry data (General Bathymetric Chart of the Oceans)
- UK Tide Gauge Network
- Historical UK tide gauge data — scanned charts and ledgers
- International sea level data (Global Sea Level Observing System/World Ocean Circulation Experiment/Climate Variability and Predictability)
- Numerical model data — access to all numerical model data sets
- OPeNDAP/DODS server
- Historical bottom pressure recorder data

2.5.5 British Atmospheric Data Centre (BADC)

The British Atmospheric Data Centre (BADC) is NERC's designated data centre for the atmospheric sciences. The role of the (BADC) is to assist UK researchers to locate, access and interpret atmospheric data and to ensure the long-term integrity of atmospheric data produced by NERC projects.

Datasets:

The data held at the BADC are of two types:

- Datasets produced by NERC-funded projects: these datasets are of high priority since the BADC may be the only long-term archive of the data.
- Third party datasets that are required by a large section of the UK atmospheric research community and are most efficiently made available through one location (e.g. Met Office and ECMWF datasets).

There is also considerable interest from the international research community in BADC data holdings, in particular the Met Office data. The BADC makes available the Met Office Hadley Centre data as described in the previous section on LINK.

Data is available from the BADC website.[19]

[18] https://www.bodc.ac.uk/data/online_delivery/

[19] http://badc.nerc.ac.uk/data/

2.5.6 Polar Data Centre (PDC)

The Polar Data Centre (PDC) coordinates the management of data collected in the polar regions by the Natural Environment Research Council (NERC) and other UK funded scientists. The PDC is based within the British Antarctic Survey (BAS). It is the UK's National Antarctic Data Centre in the SCAR Standing Committee on Antarctic Data Management (SCADM). BAS, based in Cambridge maintain extensive climate related databases which support many international initiatives including the WCRP SPARC (World Climate Research Programme - Stratosphere-troposphere Processes And their Role in Climate) activity.

2.5.7 Environmental Information Data Centre (EIDC)

The Environmental Information Data Centre (EIDC) is the NERC data centre for the terrestrial and freshwater sciences. It is an umbrella body for a number of the data activities within the Centre for Ecology & Hydrology (CEH), including the National River Flow Archive (NRFA).

National River Flow Archive (NRFA):

The NRFA is mandated by UK government (Defra) and the devolved administrations of Northern Ireland, Scotland and Wales to maintain a comprehensive data retrieval service and provide information on water resources nationally.

The NRFA is the UK's focal point for hydrometric data, providing stewardship of, and access to, over 50,000 years' daily and monthly flow data for some 1400 gauging stations nationally. Across the UK, 1236 gauging stations are currently operational and providing data to the national archive (November 2013). It is maintained though routine collation, quality control, and archiving of river flow data from partner organisations. Within the UK the majority of river flow monitoring is conducted by four hydrometric measuring authorities, namely, the Environment Agency (EA) in England, Natural Resources Wales, the Scottish Environment Protection Agency (SEPA), and, in Northern Ireland, the Rivers Agency. The NRFA is delivered through close collaboration with these measuring authorities and the organisations work together to keep developments under review in the fields of network design, instrumentation and information technology.

As well as river flow data, the NRFA provides comprehensive user guidance information on issues such as data quality and factors affecting runoff, as well as catchment rainfall estimates and access to a variety of spatial data sets derived by CEH and the British Geological Survey (BGS) (e.g. rivers, landform, land cover, geology and hydrogeology). NRFA data are supplied for free to all users except for large or complex requests where a handling charge may be applied to cover the cost of supply.

Efforts are made to improve data quality through rigorous QA/QC programmes conducted by both the NRFA and measuring authorities. Data provided to the NRFA are validated, on an annual basis, through a range of techniques, including plausibility checks and expert judgment. Data provision is covered by a Service Level Agreement which aims to monitor and drive improvements in the timeliness of data provision, completeness and data quality. In addition, efforts are made to improve long-term data quality through a programme of liaison between the NRFA and measuring authorities to examine the quality of data capture (in particular, examining the credibility of hydrological extremes), the homogeneity of long-term records, and accuracy of user-guidance metadata.

The NRFA liaises with the measuring authorities to evaluate and optimise the hydrometric monitoring network. Since 2008, all the major operators of UK hydrometric monitoring programmes have conducted detailed reviews of their current gauging station networks, including assessments of the strategic utility of networks. The quality of UK hydrometric data is

advanced by the active Hydrometry Technical Committee operated by the national standards body, the British Standards Institution. Standards are maintained covering a variety of monitoring techniques and data management practices. The UK also currently chairs the Hydrometry Technical Committee of the European Committee for Standardisation and is an active contributor to the corresponding ISO Committee.

The NRFA plays a key role in hydrological research and technological and infrastructure development in the UK: its data have been used extensively by scientists, planners, engineers and students for countless water-related studies and projects. As part of its work to detect long-term climate variability in river flow records, the NRFA established and promotes the UK Benchmark Network. This sub-set of UK gauging stations monitor near-natural catchments, making them suitable for climate applications, and provides a core capability for hydrological trend detection and appraisal. The Benchmark Network has been exploited in a wide range of national studies of river flow trends and has been utilised in the UK Climate Change Indicator programme. Since 2008, the NRFA has been involved in initiatives with international collaborators, to bring together hydrological reference networks from across North America and Europe in large-scale studies of changing runoff patterns.

The NRFA services many of the UK's international commitments and obligations on hydrometric data by submitting river flow data and summary information to such organisations as:

- the WMO Global Runoff Data Centre (GRDC);
- the FRIEND European Water Archive (FRIEND – Flow Regimes from International Experimental and Network Data – is a component of the International Hydrological Programme (IHP) of UNESCO);
- the European Environment Agency (EEA);
- Eurostat (the Statistical Office of the European Communities);
- the Organisation for Economic Cooperation and Development (OECD); and
- the OSPAR and PARCOM conventions.

The National River Flow Archive (NRFA) presently supplies the Global Runoff Data Centre (GRDC) with data for 217 gauging stations across the UK. Data are supplied after validation. The vast majority of these data have a complete historical record. All the data the NRFA supply is subject to GRDC T&Cs and is thus freely available to GCOS and other UN programmes. Through the GRDC, river flow records for 7 UK gauging stations are currently included in the Global Terrestrial Network for River Discharge (GTN-R). The NRFA continues to work closely with the GRDC to further improve the availability of UK river flow data to GCOS.

2.5.8 European Centre for Medium-Range Weather Forecasts (ECMWF)

The ECMWF is the European Centre for Medium-Range Weather Forecasts based in the UK. Although its core mission is weather forecasting, it performs a great deal of work relevant to climate change monitoring and prediction, which is described in this section. It should of course be noted that ECMWF is a European Organisation supported by 34 states, but is reported under the UK submission because the centre is based in Reading, UK.

General climate contributions:

ECMWF's core mission is to develop its global weather forecasting system, run it operationally and distribute the results to its Member States. It is not to carry out climate simulations. However, through its core activity, ECMWF is contributing significantly to climate change studies

The first major contribution is with reanalyses. Initially a by-product of the assimilation system developed for global weather forecasting, it was aimed at:

- Studying the evolution of the observing system and evaluating the impact on the quality of the forecast.
- Testing forecasting techniques over a long period and developing calibrations.

However the quality and ease of use of the global, gridded data sets generate by reanalysis has attracted a growing interest from the climate community, as evidenced by the growing use of reanalysis data in the annual BAMS Special Supplements on the State of the Climate, and the many references to the latest ECMWF reanalysis, ERA-Interim, in the IPCC Fifth Assessment Report (AR5) published in 2013. Recent work on homogenization of the observations and improved bias corrections for satellite instruments has increased the credibility of climate trends deduced from reanalyses. Additional effort in the sonde homogeneity area is needed to be able to extend reliable trend analysis from reanalyses to years prior to 1979. Further improvements in reanalyses are expected in the coming years, thanks to the continuous improvement of the assimilation techniques, in particular those associated with atmospheric chemistry, oceans and continental surfaces.

A second important contribution from ECMWF is in the modelling area, related to the concept of seamless systems unifying weather and climate predictions. These systems benefit from important synergies between numerical weather prediction (NWP) and climate prediction. The first synergy is that many of the key feedbacks which lead to uncertainty in climate predictions are associated with processes such as clouds, convection or boundary-layer turbulence, whose intrinsic timescales lie within the domain of NWP. Another one is that, due to obvious time constraints (the need to deliver a forecast before the event), NWP has developed code optimisation and supercomputing tools that can also benefit climate prediction: this, in particular, is key to increasing the resolution of climate predictions. This contribution has been fully recognised by the international scientific community; as a result ECMWF was requested by the World Climate Research Programme (WCRP) and the World Weather Research Programme (WWRP) to host the "World Modelling Summit for Climate Prediction" in 2008, which aimed at identifying and developing such synergies. This is not a one-way road and NWP is also benefiting from developments in climate prediction, in particular in addressing model errors. With this in mind, several of ECMWF's Member States have developed the EC-EARTH initiative, which has resulted in a coupled Earth system model based on ECMWF's Integrated Forecast System (IFS). The EC-EARTH model was used to compute climate simulations for the CMIP5 project in preparation for the IPCC AR5.

Thirdly, ECMWF's core activities contribute to the adaptation of our societies to climate change. The ECMWF strategy puts the early warning of severe weather at the heart of its principal goals. As severe weather events are likely to increase in frequency or magnitude with climate change, early warnings will become even more crucial for mitigating the consequences of these events. Recent examples when such warnings were available 7 to 10 days in advance (e.g. superstorm Sandy in October 2012 and the severe windstorm in Europe of October 2013) have shown that early warnings are crucial for enabling civil protection authorities to make appropriate and timely decisions.

ECMWF also has responsibility of routine monitoring of daily TEMP and CLIMAT TEMP reports for the GCOS Upper Air Network (GUAN) as part of the GUAN Analysis Centre after the Met Office Hadley Centre ceased monitoring of CLIMAT TEMP messages in May 2007 (the Met Office Hadley Centre still provides data to users and creates global and regional statistics for the Centre).

Reanalysis work:

Over the past decade, reanalyses of multi-decadal series of past observations have become an important and widely utilized resource for the study of atmospheric and oceanic processes and predictability. The first reanalysis at ECMWF was carried out in early 1980s for the First GARP Global Experiment (FGGE) year 1979, when ECMWF operations began. Two major ECMWF reanalyses have exploited the substantial advances made since then in the forecasting system and technical infrastructure. The first project, ERA-15 (1979-1993), was completed in 1995 and the second extended reanalysis project, ERA-40 (1957-2002), in 2002. Products of ERA-15 and ERA-40 have been used extensively by the Member States and the wider user community. They are also increasingly important to many core activities at ECMWF, particularly for validating long-term model simulations, for helping develop a seasonal forecasting capability and for establishing the climate of EPS (Ensemble Prediction System) forecasts needed for construction of forecaster-aids such as the Extreme Forecast Index.

ERA-Interim is ECMWF's most recent atmospheric reanalysis, covering the data-rich period from 1979 to present, with monthly product updates to support climate monitoring. The ERA-Interim system is based on a 2006 release of the IFS (Cy31r2). ERA-Interim data are available on the internet, for research as well as commercial applications. ECMWF is preparing to replace ERA-Interim with a new atmospheric reanalysis at a global resolution of 40km, based a current version of the IFS.

In recent years ECMWF has been able to expand its climate reanalysis activities with substantial support from the European Commission through its 7th Framework Programme. The ERA-CLIM project (2011-2013), has led to the development of a set of new reanalysis products spanning the 20th century (from 1900-2010), which are based on surface pressure and marine wind observations. The Met Office is a key partner in ERA-CLIM, with contributions in data rescue and provision of new, state-of-the-art global SST and sea-ice estimates for the 20th century. ECMWF reanalysis products for the 20th century will become available to users by mid-2014. The ERA-CLIM2 project (2014-2016) will extend these activities to the production of climate reanalyses based on a coupled atmosphere-ocean model. A substantial work package, to be lead by the Met Office, will be dedicated to research and development in coupled data assimilation.

2.6 Capacity building

2.6.1 GSN activities

A number of projects aimed at improving the operation of the GCOS Surface Network (GSN) have been initiated using funds provided through in-kind contributions from Germany (DWD), Japan (JMA), the Netherlands (KNMI) and the UK Met Office. Using priorities set by the GCOS/WCRP Atmospheric Observation Panel for Climate, the GCOS secretariat, working with the WWW and RCD Departments, has designed and is implementing projects to benefit 27 GSN stations, primarily in equatorial areas of Africa, South America and on oceanic islands. Specific improvements included replacement of instrumentation, installation of new automated equipment and training both in the operation and maintenance of the system.

Through the UK contribution to the WMO Voluntary Cooperation Programme (VCP), we also support the GCOS Surface Network (GSN) at some UK Overseas Territories. For example, we support the station at Pitcairn Island through the 'Pacific Fund' operated in partnership with Met Service.

The Met Office is leading a project to upgrade 11 GSN stations in Madagascar, with associated training and systems. This focuses on automating:

- collection of weather data;
- integration into a climate database; and,
- real-time transmission of the data to the WMO Information System.

The initial installation was carried out jointly by Met Office staff and technicians from the Madagascar's Meteorological Service (Direction de la Météorologie et de l'Hydrologie (DMH)). An issue with the choice of communication solution is still to be resolved before the remainder can be installed by DMH staff. A two-year data comparison has been designed by the Met Office in keeping with the GCOS principles. The Madagascar project was funded through the GCOS Cooperation Mechanism (GCM) through by the Met. Service of the Netherlands (KNMI)

Once completed, the project will allow DHM to deliver improved services such as early warning of extreme weather events to their customers, allowing users to take more informed action. In addition, the observations will add to the, currently very limited, climate database for this region, enabling a better understanding of the impacts of climate change.

2.6.2 GUAN activities

A number of projects aimed at improving the operation of the GCOS Upper Air Network (GUAN) have been initiated using funds provided through in-kind contributions from Germany (DWD), Japan (JMA), Switzerland (MeteoSwiss) and the UK Met Office. Using priorities set by the GCOS/WCRP Atmospheric Observation Panel for Climate, the GCOS secretariat, working with the WWW and RCD Departments, has designed and is implementing projects to benefit 6 GUAN stations, primarily in equatorial areas of Africa, South America and on oceanic islands. Specific improvements included new upper-air stations to bridge gaps in network coverage, replacement of hydrogen generators when old units had become inoperable, and radiosondes for stations whose operation had ceased because they could no longer afford them.

Apart from these activities involving the GCOS' donor initiatives, the UK supports some overseas sites directly through the VCP. Over a long period, we have supported GUAN stations at St Helena, Gough Island (in partnership with South African Weather Services), Seychelles and in the South Pacific (in partnership with New Zealand's MetService) at Funafuti in Tuvalu, Tarawa in Kiribati and Rarotonga in the Cook Islands. The UK continues to support workshops to assist in the regional planning and sustainability of the network, and upgrades to technology where appropriate. Additional support is also provided to other GUAN stations where funds allow – for example consumables were supplied to the GUAN station at Gan, Maldives, via GCOS, in 2013.

2.6.3 Cape Verde Atmospheric Observatory

The National Centre for Atmospheric Science (NCAS), in conjunction with the Max-Planck-Institut für Biogeochemie, Jena, Germany (MPIB Jena), and the Leibniz-Institut für Troposphärenforschung, Leipzig, Germany (IfT), opened a major new WMO GAW station on Sao Vicente, Cape Verde in 2006. The observatory is currently supported financially by the UK and Germany and operated by the local National Meteorological and Hydrological Service, the Instituto Nacional de Meteorologia e Geofísica (INMG). The observatory contributes to a number of GAW networks and has been a key means to build people capacity associated with the atmospheric composition research in the West African region.

2.7 Acquisition and synthesis of palaeoclimate data

Palaeoclimate data relating to a range of climate variables are being acquired and synthesised by a number of groups in the UK. This list is very general, and it is likely that many of the studies are of little relevance to GCOS. Some will be, but it would take more co-ordination to determine the exact relevance to the ECVs designated within GCOS.

- The Palaeoceanography and Palaeoclimate Research Group at the National Oceanography Centre in Southampton. Current research topics include:
  - Quaternary sea-level changes
  - Interannual to decadal ocean/climate variability
  - Extreme Climates
  - Changes in the East Greenland Current and Deep Western Boundary Current
  - Cenozoic "Pacific Equatorial Age Transect"
  - Palaeogene climate change in high northern latitudes; DSDP, ODP and IODPprojects
- University of Aberdeen:
  - Research into climatic variability during the last Ice Age, including global synchroneity of late-glacial climatic shifts.
- British Antarctic Survey (NERC), Cambridge:
  - Research to understand the behaviour of the ice-atmosphere-ocean system in Antarctica in the past, and to use this knowledge to predict future behaviour. Work is also carried out in Greenland and Svalbard.
- Bangor University:
  - Studies of growth rings on long-lived clams to build up sea temperature records over long periods.
- University of Cambridge:
  - Cambridge Arctic Shelf Programme (CASP): Research into the Quaternary geology of the pan-Arctic and sub-Arctic areas, East Greenland, the North Atlantic margins, Svalbard, Russia and other areas of the former Soviet Union. Relevant research has included reconstructions of the Arctic Ocean and ice conditions in the Barents Sea area.
  - 'Cambridge Quaternary' (which is comprised of staff and students from Archaeology, Earth Sciences, Geography, Plant Sciences and Zoology departments): High-resolution isotope records of the history of ice sheet fluctuations during the Quaternary; proxy climatic indicators (isotopes, lithology, faunal counts, magnetic susceptibility) to investigate the relationship between orbital forcing and climatic change; palaeoceanographic processes; ice-rafting events and salinity changes.
- Cardiff University:
  - Research into late-glacial and postglacial evolution in Ireland, Wales and England, and into permafrost and climate change in Europe.
- Climatic Research Unit at the University of East Anglia, Norwich, Norfolk:
  - Quantitative climate reconstructions, climate change detection and historical documentary climatology.

- University of Edinburgh:
  - Quaternary palaeoenvironments; modelling of ancient ice sheets.
- University of Glasgow:
  - Quaternary science and polar environments.
- Liverpool John Moores University:
  - Quaternary palaeoenvironments.
- University of London, Royal Holloway and Bedford New College:
  - Quaternary research, palaeohydrology.
- Environmental Change Research Centre at the University of London, University College:
  - Reconstruction of climate and nutrient histories for lakes in a number of areas, including the Arctic (Svalbard, Kola Peninsula), the Antarctic (South Orkney Islands, Vestfold Hills) and Southern Africa.
- University of Southampton:
  - Palaeohydrological and permafrost data studies, palaeoecology/palaeoclimate, numerical modelling of Quaternary ocean/ice sheet dynamics.
- University of St Andrews:
  - Reconstruction and understanding of climate for the last 1000-2000 years using dendrochronology.
- Swansea University:
  - Quantifying uncertainty in isotope dendroclimatology to understand and characterise the natural variability between individual trees to maximise the potential of the tree-ring isotopic signal for palaeoclimate research.

2.8 Guideline issues

Steps being taken to improve the availability of information:

The UKEOF project: Coordinating Climate Science and Risk Assessment Observations sought to improve understanding of the relevance of UK climate-related observation activities to the GCOS ECVs, identifying those UK observations that contribute to GCOS and assessing where there are gaps in knowledge about UK observational data supporting the ECVs. It also sought to improve knowledge of climaterelated uses of the observation data (beyond their primary purpose) and understand more about observation standards in use.

3. Atmospheric ECVs

3.1. Contributions to the GCOS Surface Networks

Met Office Land Networks:

The UK's contribution to the GSN comes from the national network (for the UK itself) of 29 stations within the UK's Regional Basic Climate Network (RBCN) and the 34 stations within the UK's Reference Climate Network. The 6 UK GSN stations run by the Met Office are Lerwick (3005), Stornoway (3026), Eskdalemuir (3167), Valley (3302), Waddington (3377), Camborne (3808). Additionally there are 2 overseas stations: St Helena (61901) and Ascension Island (61902). Lerwick, Stornoway, Eskdalemuir, Camborne are funded via the PWS. In 2009 VCP took over funding of St Helena. All are considered secure. All 8 of these UK Met Office run GSN stations operate to the specific GCOS standards and therefore supply their data to the IDCs – but only back as far as they have been digitized.

There are three additional GCOS Surface Network stations in UK Overseas Territories for which the UK is not directly responsible. These are Gough Island (68906), Bermuda (78016) and Pitcairn (91964). Gough Island is run by SAWS; Bermuda is run by serco for the Bermudan Government; and Pitcairn is serviced by NZWS.

The UK contributes to the Baseline Surface Radiation Network (BSRN) with two stations, at Lerwick and Camborne. These stations are supported by the PWS and both stations provide data to the World Radiation Monitoring Center (WRMC), although post July 2007 data is awaiting processing for submission. There are 89 UK stations measuring downwelling global radiation, in addition to the 2 BSRN stations. The 89 stations are partly compliant with the GCMPs.

British Antarctic Survey:

The British Antarctic Survey (BAS) runs 4 Overseas GCOS Surface Network stations: Halley (89022), Rothera (89062), Fossil Bluff (89065) and Grytviken, South Georgia (88903). All 4 stations operate to GCOS standards and historic data have been supplied to the IDCs, for their operational periods where the data have been digitized.

Met Office Marine Networks:

The Met Office contributes to the EUMETNET Surface Marine programme (ESURFMAR) (managed by Meteo-France), which deploys around 120 drifters per year in the North Atlantic, Nordic Seas and Mediterranean. At end September 2013, 130 drifters were operating in the frame of E-SURFMAR. This includes 95 E-SURFMAR funded Iridium SVP-Bs (including 12 in the Arctic and 11 HRSST-2 drifters with more accurate SST sensors), the remaining buoys were 1 one ICEB buoy in the Arctic and 33 Iridium drifters owned by NOAA upgraded with barometers by E-SURFMAR, and one Iridium drifter operated by Environment Canada.

In addition to deploying drifting buoys for E-SURFMAR, the Met Office also procures and deploys drifters in the South Atlantic/Southern Ocean in support of the global drifter array. Typically this is around 10 drifters each year, with 17 drifters active at end September 2013. In 2013, 30 drifters were deployed by the Scottish Association for Marine Science (SAMS) as part of the NERC FASTNET (Fluxes Across Sloping Topography of the North East Atlantic) project – at end September 2013, 26 of these drifters were in operation.

The Met Office currently manages around 270 Voluntary Observing Ships (VOS) making manual observations, of which around 185 meet climate (VOSClim) standards. The Met Office also operates the real time monitoring centre for VOSClim data. Over the last 3 years the Met Office has developed an Autonomous Marine Observing System (AMOS), which has now been

installed on 42 ships, mainly operating around the British Isles. All VOS data are exchanged on the Global Telecommunication System (GTS) and available to the International Comprehensive Ocean-Atmosphere Data Set (ICOADS)[20]. This includes the contribution from 2 ships operated by BAS.

Table 1a: National contributions to the surface-based atmospheric ECVs

Contributing networks specified in the GCOS implementation plan	ECVs	Number of stations or platforms currently operating	Number of stations or platforms operating in accordance with the GCMPs	Number of stations or platforms providing data to the international data centres	Number of stations or platforms with complete historical record available in international data centres
GCOS Surface Network (GSN)	Air temperature	6 + 2 (Met Office) 4 (BAS)	12	12	12
	Precipitation	11	11	11	11
Full World Weather Watch/Global Observing System (WWW / GOS) surface network	Air temperature, air pressure, wind speed and direction, water vapour	29	29	29	29
	Precipitation	29	29	29	29
Baseline Surface Radiation Network (BSRN)	Surface radiation	2	2	2	2
Solar radiation and radiation balance data	Surface radiation	86	partly	Some	Some
Ocean drifting buoys	Sea surface temperature, air pressure (and position-derived surface current)	17 (Met Office) 26 (SAMS)	N/A	17	17
Moored buoys	Air temperature, air pressure	None for GCOS	0	0	0
Voluntary Observing Ship Climate Project (VOSClim)	Air temperature, air pressure, wind speed and direction, water vapour	185 (+ 85 other selected VOS and 42 ship AWS)	185	312	312
Ocean Reference Mooring Network and sites on small isolated islands	Air temperature, wind speed and direction, air pressure	0	0	0	0
	Precipitation	0	0	0	0

Information about other sustained measurements of the surface-based atmospheric ECVs, supplementary to those activities implicit in table 1a is below.

Met Office Climate and Rainfall networks:

The entire UK land surface observing network currently comprises 239 ordinary climate stations (many of which have very long records) and 161 synoptic stations. There are an additional 2633 rainfall-only stations. These stations are all compliant with GCOS standards, but are more subject to site changes or closures than those in the GSN, RBCN and the UK's Reference Climate Network. Historic time series from a small number of the UK surface climate and rainfall stations are available in IDCs, but there has been no comprehensive activity to add all that are digitally available.

[20] http://icoads.noaa.gov/

Met Office coastal moored buoy network:

The Met Office presently operates 11 moored buoys mainly to the west of the UK and in Biscay, which contribute to the wider WWW / GOS surface network. These networks deliver data on many ECVs and there are time-series in excess of 20 years. The data are being used in marine climate studies (e.g. the Defra Charting Progress reports on the state of UK seas) and are submitted to the International Comprehensive Ocean-Atmosphere Data Set (ICOADS).

NCAS Facility for Ground based Atmospheric Monitoring: Long-term observatories:

The Chilbolton Facility for Atmospheric and Radio Research (CFARR) in southern England is funded by NERC and operated by the Rutherford Appleton Laboratory. Co-located surface meteorological measurements including solar irradiance (relevant to the surface radiation budget) are taken.

3.2 Contributions to the GCOS Upper-Air Networks

Met Office:

The Met Office Radiosonde Network is part of the Full WWW/GOS Upper Air Network and GCOS Upper-air Network (GUAN) and provides measurements of air temperature, water vapour and wind speed and direction. The data is widely used for climate measurement and model verification. The 2 sites in the UK are Lerwick (03005) and Camborne (03808). There are 2 GUAN stations overseas: St Helena (61901) and Mt. Pleasant (88889), and 2 GUAN stations in UK overseas territories: Gough Island (run by the South African Weather Service) (68906) and Bermuda (78016). Lerwick, Camborne and St Helena are PWS/VCP funded so secure.

The Shipborne radiosonde network is part of the Full WWW/GOS Upper Air Network and also monitors upper air wind speed and direction, air temperature and water vapour. The UK Met Office no longer operates any upper air ASAP ships itself. These have now been integrated mangerially and financially into the EUMETNET EASAP programme. The Met Office is a member nation of E-ASAP, to which it contributes financially based upon Gross National Income GNI).

The Global Positioning System (GPS) Water Vapour Programme provides vertical integrated water vapour data as part of the Ground-based GPS receiver network. Data from roughly 250 stations are processed by the UK (though this varies). Most sites are run by external bodies, so data and most site choice is third party. Most sites are chosen to be of a roughly equal spatial distribution, and some are chosen to be specifically near to radiosonde stations.

The Met Office operates 6 wind profilers (one is in conjunction with NERC) providing observations of the vertical and horizontal velocity upper air wind speed and direction (doppler winds) and is part of the EUCOS wind profiler network (E-PROFILE).

The Met Office manages 1000+ AMDAR (Aircraft Meteorological Data Relay) equipped aircraft within E-AMDAR Programme. Commercial aircraft obtain upper air temperature and wind speed and direction measures. Some aircraft in Europe have a water vapour sensor installed as part of the E-AMDAR Extended Humidity Trial. During 2013/14 the number of aircraft equipped will rise to nine. The E-AMDAR Programme also hopes to expand further (in the US, the reporting of water vapour from commercial aircraft has advanced further with a network of 60+ aircraft equipped). AMDAR is part of the Aircraft (ASDAR etc.) network and Full WWW/GOS Upper AirNetwork.

British Antarctic survey:

The British Antarctic Survey acquires measures of air temperature, air pressure, wind speed and direction and water vapour. The upper air programme at the Halley (89022) station is fully GCOS compliant and forms part of GUAN network. Rothera upper air programme is GCOS compliant in all respects except that it has flights on only 4 out of 7 days a week, it is not a GUAN station but still submits its data via GTS.

Table 1b: National contributions to the upper-air atmospheric ECVs

Contributing networks specified in the GCOS implementation plan	ECVs	Number of stations or platforms currently operating	Number of stations or platforms operating in accordance with the GCMPs	Number of stations or platforms providing data to the international data centres	Number of stations or platforms with complete historical record available in international data centres
GCOS Upper Air Network (GUAN)	Upper air temperature, upper air wind speed and direction, upper air water vapour.	2 + 2 (Met Office) + 1 (BAS)	5	5	5
Full WWW / GOS Upper Air Network	Upper air temperature, upper air wind speed and direction, upper air water vapour.	2 + 2 (Met Office) + 1 (BAS)	5	5	5

Information about other sustained measurements of the upper air ECVs, supplementary to those activities implicit in table 1b are below.

NCAS Facility for Ground based Atmospheric Monitoring - Long-term observatories:

The Chilbolton Facility for Atmospheric and Radio Research (CFARR) in southern England is funded by NERC and operated by the Rutherford Appleton Laboratory. The activity collects water vapour density measurements. Co-located surface meteorological measurements including solar irradiance (relevant to the surface radiation budget) are taken. Continuous monitoring of cloud profiles has allowed evaluation of model biases/errors to be identified. Monitoring began in 1998 and is important for understanding the mechanisms by which aerosol in the atmosphere leads to the formation of different cloud types, which is important for predicting climate change. This approach, pioneered at Chilbolton, is being implemented at other observatories around the world, notably US ARM sites.

The Mesosphere-Stratosphere-Troposphere Radar Facility at Aberystwyth is operated by the Rutherford Appleton Laboratory. The facility measures cloud properties (cloud base height), upper air wind speed and direction and water vapour (at various heights). Co-located surface meteorological measurements of solar irradiance are taken.

British Antarctic Survey:

The British Antarctic Survey routinely measures mesospheric temperatures at Rothera and Halley stations.

3.3 Contributions to the Global Atmospheric Watch

Cape Verde Atmospheric Observatory:

The Cape Verde Atmospheric Observatory[21] was established in 2006 and is part of a bilateral German-UK initiative to undertake long-term ground and ocean-based observations. The Observatory measures greenhouse gases, stratospheric ozone depleting gases, short lived

[21] http://www.ncas.ac.uk/index.php/en/cvao-home

air pollutants, biogenic emissions, aerosols and particulates, atmospheric radiation, and precipitation and is located in the tropical Eastern North Atlantic Ocean. It is one of four long-term observatories that are part of NERC's NCAS Facility for Ground based Atmospheric Monitoring programme.

The University of York is responsible for trace gas measurements at this site and operates as part of WMO/GAW GCOS Global Baseline Profile Ozone Network. Measurements of gaseous mercury are provided to GMOS a five year project (2010-2015), funded by the European Commission 7th Framework.[22]

The Observatory has been audited by WMO GAW for ozone, carbon monoxide, greenhouse gases and VOCs.

Long Term Atmospheric Trace Gas Monitoring at Mace Head, Ireland:

Atmospheric composition monitoring began at Mace Head in 1987 (with measurements of ozone) and now cover a wide range of parameters relevant to all of the atmospheric ECVs including measurements of ozone, CO, CO_2, CH_4 and other GHGs (including N_2O, SF_6, halocarbons and a range of ozone depleting substances) and aerosol optical depth. Mace Head is an EMEP supersite, part of AGAGE and the "UK DECC (Deriving Emissions linked to Climate Change) Network". The site operates as part of the GCOS-affiliated WMO/GAW Global Atmospheric N_2O, CO_2 and CH_4 Monitoring Networks (GHGs and their precursors), the WMO/GAW GCOS Global Baseline Profile Ozone Network and WMO/GAW Aerosol Network (AOD). Co-located surface meteorological measurements are taken as part of the GCOS Surface Network and Full WWW/GOS Surface Network.

Baseline Measurement of Stratospheric Ozone and UV:

Baseline Measurement of Stratospheric Ozone and UV is a Defra funded initiative that measures column ozone and takes place at two sites - Reading and Lerwick. The Lerwick site makes column ozone measurements with a Dobson Spectrophotometer. At both sites, spectrally resolved UV measurements are also made and can be used both independently and in conjunction with the ozone measurements during both long term trend and event analysis. The sites are part of the WMO/GAW GCOS Global Baseline Total Ozone Network and WMO/GAW GCOS Global Baseline Profile Ozone Network. Ozone measurements are also made at Manchester and Reading using Brewer spectrophotometers but the data records are much shorter.

Sun photometers:

Sun photometer measurements of the direct (collimated) solar radiation provide information to calculate the columnar aerosol optical depth (AOD). There are three activities that collect data using sun photometers for the assessment of aerosol optical depth, two of which submit data to AERONET: CFARR (at Chilbolton) and the Wytham Wood sun photometer, located at one of CEH's ECN sites. The sun photometer at the Plymouth Marine Laboratory (PML) site uses instrumentation that precludes its inclusion in AERONET (data are held locally).

Observations in cryospheric environments:

The British Antarctic Survey (BAS) began taking measurements of ozone at the Halley (since 1957) and Rothera stations through their Long-Term Monitoring and Survey (LTMS) programme.

Halley operates as part of the WMO/GAW GCOS Global Baseline Total Ozone Network. Since 1983, Halley station has contributed to the carbon cycle measurement programme of the NOAA collaborative sampling network through their Long-Term Monitoring and Survey (LTMS)

[22] http://www.gmos.eu/index.php/background

programme. Whole air samples are collected approximately weekly in glass flasks and returned to NOAA's Global Monitoring Division in the US for analysis of various gases including CO_2, CH_4, CO, H_2, SF_6 and N_2O. The monitoring forms part of the GCOS-affiliated WMO/GAW Global Atmospheric N_2O, CO_2 and CH_4 Monitoring Networks.

In May 2013, Halley was upgraded to a Global[23] station within the WMO Global Atmospheric Watch programme. There are only 29 stations worldwide that have been awarded this status, and Halley[24] is only the second from the UK (the other being the Cape Verde Atmospheric Observatory).

Table 1c: National contributions to the atmospheric composition

Contributing networks specified in the GCOS implementation plan	ECVs	Number of stations or platforms currently operating	Number of stations or platforms operating in accordance with the GCMPs	Number of stations or platforms providing data to the international data centres	Number of stations or platforms with complete historical record available in international data centres
World Meteorological Organisation / Global Atmosphere Watch (WMO / GAW) Global Atmospheric CO_2 & CH4 Monitoring Network	Carbon Dioxide	2 (Mace Head, Halley)	2	2	2
	Methane	3 (Mace Head, Cape Verde, Halley)	3	3	3
	Other greenhouse gases	3 (Mace Head, Cape Verde, Halley)	3	3	3
WMO / GAW ozone sonde network	Ozone	4 (Mace Head, Cape Verde, Reading, Lerwick)	4	4	4
WMO / GAW column ozone network	Ozone	3 (Reading, Lerwick, Halley)	3	3	3
WMO / GAW aerosol network	Aerosol Optical Depth	3 (Mace Head, Chilbolton, Wytham Wood)	3	3	3
	Other Aerosol Properties	2 (Mace Head, Cape Verde)	2	2	2

Information about other sustained measurements of the atmospheric composition ECVs, supplementary to those activities implicit in table 1c are below.

Weybourne Atmospheric Observatory:

Weybourne Atmospheric Observatory measures surface ozone, CO_2, CO, oxides of nitrogen, VOCs and GHGs. Co-located surface meteorological measurements (AWS) including surface radiation data (relevant to the surface radiation budget ECV) are taken.

UK DECC (Deriving Emissions linked to Climate Change) Network:

The "UK DECC Network" is a new network of UK measurement sites set up to complement the measurements that take place at Mace Head, Ireland. Gases measured are CO_2, CH_4, CO, N_2O, SF_6 and a full suite of ODS and GHG compounds. In 2011, the University of Bristol and the Met Office were awarded a contract to establish an expanded programme of atmospheric observations to deliver increased spatial and temporal resolution in emissions estimates. The methodology chosen to achieve this was to establish two new tall tower observation sites based in Ridge Hill (Herefordshire) and Tacolneston (Norfolk) and to adopt an existing station Angus(Scotland).

[23] http://www.wmo.int/pages/prog/arep/gaw/GAW_Global_st.html

[24] http://www.antarctica.ac.uk/living_and_working/research_stations/halley/

Defra funded networks monitoring air pollution: UKEAP:

A further two UK EMEP “supersites” in the UKEAP network monitor a comprehensive range of atmospheric composition parameters that are highly relevant to all of the GCOS atmospheric ECVs. The Auchencorth EMEP supersite facility in Scotland is run by CEH and has begun the processes required for inclusion in the GAW programme, so is listed by GAWSIS as “contributing (prospective)”. Measurements of particulate mercury at Auchencorth are provided to the GAW GMOS project. A wide range of measurements relevant to all of the atmospheric composition ECVs are monitored: ozone, aerosols properties (including particulates, trace gas fluxes, emerging chemicals of concern (ECOCs)), precursors (supporting the ozone and aerosols ECVs), CO_2 and CH_4 and other long-lived GHGs. In addition there are co-located meteorological measurements using AWS (includes radiation measurements, surface wetness, soil surface and below surface temperature, water vapour fluxes). There are significant amounts of co-located data from the past decade for Auchencorth Moss relevant to terrestrial ECVs. This includes soil, vegetation, PAR and land use (from UK and EU projects). There are also water measurements made at the stream that flows out of the site including flow, composition and GHG gas exchange information (held internally at CEH).

4. Oceanic ECVs

4.1 Measurements of surface oceanic ECVs

The Met Office routinely produce (and periodically enhance) many global ocean products (including SST, see section 2.5).

Met Office:

The Met Office marine meteorological observations from Voluntary Observing Ships (incl. VOS CLIM) provide measurements of sea surface temperature, sea ice and sea state (the latter two measurements being from manually observing VOS). Sub-surface observations are not made from any UK VOS.

The Drifting Buoys Programme provides sea surface temperature measurements to the Global Drifter Array, see section 3.1. Sea surface currents are derived from buoy positions.

Observations in cryospheric environments:

BAS ships observe sea-ice extent in an opportunistic manner through the VOS programme: it is observed as part of the 6-hourly meteorological synoptic observations disseminated via the WMO GTS/WWW system as part of BAS Antarctic operations.

Global Sea Level Observing System:

The Global Sea Level Observing System (GLOSS) Tide Gauges run by NOC, Liverpool, provides sea level and supporting measures of air pressure to the GLOSS Core Sea-Level Network. The UK contributes 3 from the UK itself (Lerwick, Newlyn and Stornoway) plus Gibraltar and 8 sites in the South Atlantic which are in different states of working or needing maintenance visits. Assistance is also provided for some stations situated in Africa.

The 3 UK stations are part of the UK Tide Gauge Network.

UK National Tide Gauge Network:

The National Tidal and Sea Level Facility (NTSLF) is the UK centre of excellence for sea level measurement, computer modeling of tides and storm surges, and the statistical estimation of extreme sea levels. The core of NTSLF is based at the NOC in Liverpool and includes partners in top research universities, coastal engineering consultancies and the Met Office. The NTSLF manages precision tide gauges at 44 sites around the UK. NTSLF is also responsible for monitoring sea level in the British Overseas Territories, and at strategic sites in the south Atlantic as part of our contribution to international climate research. Sophisticated telemetry systems make the data available in real time for operational coastal flood warning.

Table 3a: National contributions to the oceanic ECVs - surface

Contributing networks specified in the GCOS implementation plan	ECVs	Number of stations or platforms currently operating	Number of stations or platforms operating in accordance with the GCMPs	Number of stations or platforms providing data to the international data centres	Number of stations or platforms with complete historical record available in international data centres
Global surface drifting buoy array on 5x5 degree resolution	Sea surface temperature, sea level pressure, position-change based current	17 (Met Office) 26 (SAMS)	N/A	44	44
GLOSS Core Sea-level Network	Sea level	3 UK + 1 (Gibraltar) + 8 South Atlantic (NERC POL)	12	12	12
Voluntary observing ships (VOS)	All feasible surface ECVs	185 (VOSClim) + 85 (VOS)	185	270	270
Ship of Opportunity Programme	All feasible surface ECVs	0	0	0	0

4.2 Measurement of water column ECVs

Porcupine Abyssal Plain Observatory:

The Porcupine Abyssal Plain (PAP) Observatory is a sustained, multidisciplinary observatory in the North Atlantic coordinated by the National Oceanography Centre, Southampton. In 2010 the NOC and the Met Office collaborated to revamp the Porcupine Abyssal Plain Sustained Observatory (PAP-SO). The site now monitors atmospheric variables like wind speed and air pressure, in addition to the physical, biological and chemical properties of the ocean that were already being monitored. The PAP mooring is part of the international OceanSITES network and a GCOS reference mooring site. There are time-series in excess of 20 years and the observing meets the GCMPs.

Met Office Argo Programme:

The Met Office Argo Programme that contributes to the Argo Array Network takes measures of temperature and salinity in the water column. The UK presently has around 130 active floats contributing to the Argo float array. The UK Argo programme is managed by the Met Office and operated in partnership with NOC Southampton, BODC and UKHO.

Normally the uppermost temperature and salinity measurement from Argo floats is at around 4-5m depth, however a sub-set of the Argo array continue to sample temperatures closer to the surface. Typically temperature and salinity are measured to 2,000m depth although new float designs that can go deeper are currently being tested. As at May 2013 over 200 floats are also measuring dissolved oxygen. Deep ocean currents are derived from positions.

All UK Argo float data, irrespective of location, are processed by BODC and the data are submitted in real-time to the WMO GTS and to the Argo Global Data Assembly Centres (GDACs). All UK Argo float data are subjected to delayed-mode QC by BODC and submitted to the GDACs. At present about 40% of eligible data (for floats that have expired or been operating for longer than 18 months) have been submitted.

Carbon inventory surveys:

For carbon inventory surveys, there are 3 current survey-based programmes:

1. Swire-NOCS Ocean Monitoring System (SNOMS)[25] — VOS-based upper ocean CO_2 parameters, funded by the Swire Group Trust.
2. Carbon-OPS project[26] — CO_2 parameters from UK research ships. Collaborators include the Plymouth Marine Laboratory (PML), University of East Anglia (UEA) and the British Oceanographic Data Centre (BODC).
3. Atlantic Meridional Transect (AMT)[27] — biogeochemical surveys of N and S Atlantic. The programme is now in its fourth phase with funding from NERC's National Capability. The programme is hosted by the Plymouth Marine Laboratory (PML) in collaboration with the National Oceanography Centre.

All these activities provide data to international data centres (CDIAC for CO_2 data, also SOCAT); CLIVAR for hydrographic data.

Table 3b: National contributions to the oceanic ECVs – water column

Contributing networks specified in the GCOS implementation plan	ECVs	Number of stations or platforms currently operating	Number of stations or platforms operating in accordance with the GCMPs	Number of stations or platforms providing data to the international data centres	Number of stations or platforms with complete historical record available in international data centres
Global reference mooring network	All feasible surface and subsurface ECVs	1	1	1	1
Global tropical moored buoy network	All feasible surface and subsurface ECVs	0	0	0	0
Argo network	Temperature, salinity, current	~130	N/A	All	Some
Carbon inventory survey lines	Temperature, salinity, ocean tracers, biogeochemistry variables	3	3	3	3

Information about other sustained measurements of the oceanic surface and sub-surface ECVs, supplementary to those activities implicit in tables 3a and 3b are below.

British Antarctic Survey:

Oceanographic/Biological Monitoring - Rothera Oceanographic and Biological Time Series (BAS LTMS) known as RaTS is a manned time series sampling site (since 1997) providing a comprehensive range of measurements of relevance to many of the oceanic surface and subsurface ECVs. This includes measurements relevant to the phytoplankton, salinity of the column, temperature of the column, sea ice and nutrients ECVs monitored in compliance with the GCMPs. Oceanographic Monitoring - CTD stations (BAS LTMS) observes temperature of the water column and salinity of the water column for the Marguerite Trough. BAS holds other CTD datasets collected in consistent sampling areas over time, e.g. Drake Passage and Western Core Box, in addition to those collected in the Marguerite Trough.

25 http://noc.ac.uk/ocean-watch/open-ocean/snoms

26 www.bodc.ac.uk/carbon-ops

27 http://www.amt-uk.org/default.aspx

BAS operate a mooring site at Rothera as part of the OceanSITES network which supplies data to the Global Reference Mooring Network as part of research programmes rather than via sustained observation budgets.

BAS operates a continuous plankton recorder and PCO_2 equipment on the James Clark Ross - in conjunction with SAHFOS and Plymouth Marine Laboratory (PML).

NOC – Southampton and Liverpool:

The Atlantic Meridional Overturning Circulation Monitoring is funded by NERC's RAPID-WATCH programme and run by NOC Southampton and became operational in late March 2004. It comprises a monitoring array of 25 moorings and contributes measurements of sub-surface temperature, salinity and currents. It also measures pressure (relevant to deriving sea level).

Plymouth Marine Laboratory:

The Atlantic Meridional Transect (AMT) provides a wide array of measurements of relevance to ocean acidity, phytoplankton, ocean colour partial pressure CO_2, carbon, nutrients, oxygen, temperature of the column and salinity of the column ECVs. The Western Channel Observatory is a NERC funded oceanographic time-series and marine biodiversity reference site in the Western English Channel. In situ measurements are undertaken weekly at the coastal station and fortnightly at the open shelf station, and comprise parameters relevant to the temperature and salinity ECVs (water column), ocean colour, phytoplankton, carbon, nutrient and oxygen ECVs. The WCO has some of the longest time-series in the world for zooplankton and phytoplankton, and the hydrographic series dates from 1903. These long data series are complemented by hourly measurements made at moorings situated at both stations. PML also takes standard meteorological measurements at their site as part of the WCO.

Scottish Association for Marine Science (SAMS):

The Ellett line and extended Ellet line oceanographic section also provides a comprehensive range of measurements of relevance to many of the oceanic surface and subsurface ECVs. This includes measurements relevant to the nutrients, oxygen, salinity of the column, temperature of the column and subsurface current. Measurement standards are maintained through long-established 'best practice' amongst UK marine scientists. These are reported and logged with the data as meta data through the BODC. The Wyville Thomson Ridge Mooring monitors the horizontal and vertical velocity of the sea current, and temperature of the water column. This activity finished after 10 years in May 2013. The observational programme will be relocated and integrated into a sustained observing array (OSNAP) that is planned to begin in 2014. The data from both of these activites have been used for the EU Framework 7 programme: North Atlantic Climate Variability (NACLIM) for investigating and quantifying the predictability of North Atlantic/ European Climate.

Water Framework Directive Monitoring:

The Water Framework Directive Surveillance monitoring network includes measurements in coastal areas, covers Transitional and Coastal Waters. In England and Wales monitoring takes place up to 1 nautical mile from the shore and in Scotland this is extended to 3 nautical miles. Measurements relevant to a wide range of ECVs are monitored (nutrients, dissolved oxygen, salinity, temperature, phytoplankton, benthic invertebrates, macroalgae, seagrass and saltmarsh).

The UK has 3 other mooring sites which contribute to OceanSITES – the RAPID array, Angmagssalik Denmark Strait Overflow array (jointly maintained by Cefas & German partners) and The Wyville Thomson Overflow moorings run by the Scottish Association for Marine Science (SAMS). With the exception of the SAMS site, these sites are funded as part of research programmes rather than via sustained observation budgets.

Continuous Plankton Recorder:

The *Sir Alister Hardy Foundation for Ocean Science (SAHFOS)* is an international charity that operates the Continuous Plankton Recorder (CPR) survey. The CPR survey is the world's most geographically extensive and longest-running large-scale plankton biodiversity monitoring activity (it started in 1931). The survey determines the abundance and distribution of microscopic plants (phytoplankton) and animals (zooplankton) in our oceans and shelf seas. Using ships from about 20 shipping companies, it obtains samples at monthly intervals on about 30 routes across the oceans.

4.3 Satellite-based products over the ocean

This aspect is covered in section 6.1 of this report.

5. Terrestrial ECVs

River discharge:

The UK reports river discharge measurements from seven UK gauging stations to the GTN-R, which forms part of the GTN-H. Data are collected by the Environment Agency (EA) in England, Scottish Environment Protection Agency (SEPA), Natural Resources Wales (NRW), Rivers Agency of Northern Ireland and the Centre for Ecology & Hydrology and provided on a UK wide basis by the National River Flow Archive via the Global Runoff Data Centre (GRDC). These sites are at: Ballathie on the River Tay (Scotland); Blairstone on the River Clyde (Scotland); Colwick on the River Trent (England); Kingston on the River Thames (England); Movanagher on the Lower River Bann (Northern Ireland); Norham on the River Tweed (Scotland) and at Redbrook on the River Wye (Wales). All seven sites operate in accordance with GCMPs. The majority of sites have a complete historical record with the GRDC. The sites represent major freshwater outflows from the UK and as such are impacted by abstractions, discharges and impoundment. Other UK sites for which data is held on the GRDC may be of higher utility climate-monitoring assessments, for example those in the UK's Benchmark Network (see section 2.5.7), and the NRFA is working with the GRDC regarding their inclusion in the Global Climate Sensitive Stations Dataset. Data will continue to be provided to the GTN-R for all seven sites as part of the larger UK contribution of over 200 sites to the Global Runoff Data Centre.

Figure: UK gauging stations for which data from the National River Flow Archive (NRFA) are provided to the Global Runoff Data Centre (GRDC). Stations shown in red are also form part of the GTN-R. © NERC (CEH). Contains Ordnance Survey data © Crown Copyright and database right 2013.

Snow cover:

Of the stations in the Met Office land surface network, 68 synoptic sites have automatic snow depth sensors. Some ordinary climate stations also periodically report snow depth.

Table 5: National contributions to the terrestrial domain ECVs

Contributing networks specified in the GCOS implementation plan	ECVs	Number of stations or platforms currently operating	Number of stations or platforms operating in accordance with the GCMPs	Number of stations or platforms providing data to the international data centres	Number of stations or platforms with complete historical record available in international data centres
GCOS baseline river discharge network (GTN-R)	River discharge	7 (GCOS) 217 (GRDC)	7 217	7 217	7 217
GCOS Baseline Lake Level/ Area/Temperature Network (GTN-L)	Lake level/area/ temperature	0	0	0	0
WWW / GOS synoptic network	Snow cover	68	68	0	0
GCOS glacier monitoring network (GTN-G)	Glaciers mass balance and length, also ice sheet mass balance	0	0	0	0
GCOS permafrost monitoring network (GTN-P)	Permafrost Borehole temperatures and active layer thickness	0	0	0	0

Information about other sustained measurements of the terrestrial domain ECVs, supplementary to those activities implicit in table 5 are below.

Hydrometric monitoring:

Groundwater monitoring in the UK is mostly carried out by the regulatory agencies, the Environment Agency (EA), Natural Resources Wales (NRW), Scottish Environment Protection Agency (SEPA) and the Northern Ireland Environment Agency (NIEA). Groundwater levels are monitored at over 4000 sites nationally, with the majority of wells concentrated in England and Wales. The National Groundwater Level Archive (NGLA) is maintained by the British Geological Survey (BGS), part of the Natural Environment Research Council (NERC) and operated in close collaboration with the National River Flow Archive. The NGLA brings together water level data from across the UK for a set of boreholes chosen to provide a representative national network, with boreholes in all major aquifers, which can be used to assess seasonal resource variations and long term trends. Particular attention is paid to long term data, with a number of records from the 1800s; the longest time series held dates from 1838.

Water quality monitoring is carried out in the UK by the Environment Agency (EA), Natural Resources Wales (NRW), Scottish Environment Protection Agency (SEPA) and the Northern Ireland Environment Agency (NIEA) and other organisations in response to water management and regulatory activities. Particular focuses for water quality monitoring include the Water Framework Directive (WFD) Surveillance monitoring network and Upland Waters Monitoring Network. The WFD Surveillance monitoring network is a fixed monitoring network designed to measure long term environmental changes in rivers, lakes, transitional waters (estuaries) and coastal waters, with data collection of relevance to a range of terrestrial ECVs. The requirements for WFD surveillance monitoring of groundwater is built into a wider strategic monitoring network.

Glacier monitoring:

The British Antarctic Survey (BAS) monitors and maintains networks of GPS stations measuring the movement of key icestreams and glaciers. A network of land-based GPS stations is also maintained to assist in the determination of isostatic recovery of Antarctica. This work is a component of their long-term monitoring and survey programme (LTMS).

6. Additional information

6.1 Contribution to satellite ECVs

The UK's main contribution to satellite based ECVs is through participation in international programmes of EUMETSAT, ESA and the EU. The UK's financial contributions to EUMETSAT, ESA and the EU may result in UK building satellite missions or instruments but the UK does not currently have its own independent programme for building climate relevant instruments or missions. The UK contributes to the following European satellite programmes:

- EUMETSAT's polar orbiting METOP and METOP Second Generation (METOP-SG) series of satellites and the geostationary series (METEOSAT, MSG, MTG).
- The multi-agency JASON series of satellites.
- ESA/EU Copernicus Sentinel series of satellites which provide long term continuity of many measurements started under the ESA ERS-1, 2 and ENVISAT missions.
- ESA's Earth Observation Envelope Programme (EOEP).

EUMETSAT's polar orbiting and geostationary programmes, the JASON programme and the Copernicus Sentinels are all designed to provide long term continuity of measurements, a key requirement for climate ECVs. ESA's EOEP programme provides one-off scientific missions, which have potential to contribute to ECVs but long term continuity is not assured.

In the past, the UK also provided instruments to international programmes. DECC (from 2008 to the end of the ENVISAT mission in 2012; previously Defra and other predecessor departments) sponsored the Advanced Along Track Scanning Radiometer (AATSR) satellite instrument, which monitored sea surface temperature. It was launched in 2002 on ESA's ENVISAT satellite platform and continued to operate successfully until the end of the ENVISAT mission in 2012. The AATSR instrument extended the record of highly accurate sea surface temperature measurements obtained from its precursor instruments ATSR and ATSR-2, also funded and built in the UK, and launched in 1991 (ERS-1) and 1996 (ERS-2) respectively. While there has been a break in the series with the failure of ENVISAT, similar future European capabilities are planned with the expected launch of the Sea and Land Surface Temperature Radiometer (SLSTR) instrument on the Copernicus Sentinel 3 platform in 2014, extending the series of highly accurate SST to 2022.

The UK also funded, designed and built the first Geostationary Earth Radiation Budget (GERB) instrument which measures solar reflected radiance and total reflected/emitted radiance. In all, a series of four GERB instruments on successive EUMETSAT geostationary satellites are planned providing a 20 year time series from 2002 to 2022.

In addition to European satellite missions and instruments, the UK is involved in European programmes which develop ECVs, from satellite data, notably at present:

The UK Met Office contributes to EUMETSAT's Climate Monitoring Satellite Application Facility (CMSAF). The CM SAF generates and archives datasets for specific climate application areas, derived primarily from EUMETSAT satellite data and also from US meteorological missions.

The UK contributes to the ESA Climate Change Initiative (CCI). It is the second largest contributor to the programme and leads ECV production activities in sea-surface temperature and ocean colour. UK Met Office also leads the user group for the programme.

UK participation in the ESA CCI programme:

ECV	UK groups leading/participating
Aerosol	University of Oxford, Swansea University, Rutherford Appleton Laboratory
Cloud	University of Oxford, Rutherford Appleton Laboratory
Fire	University of Leicester
GHG	University of Leicester
Glaciers	Universities of Leeds, University of Bristol
Ice sheets	Universities of Leeds
Land cover	Met Office, Hadley Centre
Ocean colour	Plymouth Marine Laboratory (lead), University of East Anglia, Telespazio-Vega
Ozone	University of Cambridge, Rutherford Appleton Laboratory
Sea ice	UCL, University of Cambridge, CGI (formerly Logica)
Sea level	CGI (formerly Logica)
Soil moisture	-
Sea surface temperature	University of Edinburgh, Reading (lead), University of Leicester Met Office, Space Connexions
User group	Met Office (lead)

ESA sponsors other relevant research, e.g. through its DUE (Data User Element) programme[28] and the STSE (Support to Science Element) programme[29] which develop global data sets (e.g. the DUE GLOB series of projects). Although not officially designated "ECVs" many of the activities are relevant to ECV production. A summary of current and recent projects relevant to ECV production with UK participants is summarised below[30]/[31].

Other ESA sponsored projects relevant to ECV production with UK participation:

ESA project	Description	UK participation
GlobAerosol	Development of a satellite data processing system to generate a standard reference multi-year global aerosol product (GAP) over land and water.	Rutherford Appleton Laboratory, University of Oxford
GlobAlbedo	Developing and delivering a multi-annual global albedo dataset that has the potential to be sustained into the future using data from operational European satellites, such as the Copernicus Sentinels.	University College London, University of Swansea
GlobColour	Demonstrated the production of a merged data set from several different satellite data streams: MERIS, SeaWiFS and Aqua / MODIS. The objective was to combine these data streams in such a way that the output product is as far as possible independent of the input data source	University of Plymouth, School of Earth, Ocean and Environmental Sciences
GlobIce	To derive information data sets over sea ice, which will improve our understanding of the role of the Arctic in global climate.	University College London, Met Office, Planetary Visions
GlobVapour	To support user requirements for a long, homogenous time series of satellite borne global water vapour measurements.	Met Office
GlobWave	The objective of the GlobWave project is to improve the uptake of satellite-derived wind-wave and swell data by the scientific, operational and commercial user community.	CGI (formerly Logica), National Oceanography Centre, SatOC Ltd
OceanFlux GHG	To improve quantitative air-sea flux estimates of CO_2 and other greenhouse gases using EO data in synergy in the Atlantic Ocean.	North Highland College, Plymouth Marine Laboratory, National Oceanography Centre
Alanis-Methane	To investigate the potential of EO data to reduce current uncertainties in methane emissions from boreal lakes and wetlands through the synergistic use of EO-based products in a coupled land surface-atmosphere model.	Centre for Ecology and Hydrology

[28] http://due.esrin.esa.int/

[29] http://due.esrin.esa.int/stse/

[30] http://due.esrin.esa.int/duedirectory2010.pdf provides a complete list of all DUE projects.

[31] http://due.esrin.esa.int/stse/files/document/STSE_report_121016.pdf provides a complete list of all STSE projects

The UK is also active in the development of the EU's Copernicus climate service[32]. An operational service is still being defined. UK is participating in a range of FP7 projects aimed at developing climate services incorporating the use of satellite data.

Internationally, the UK participates in CEOS and GEO/GEOSS and leads the coordination of GHRSST (with UK funding from the Natural Environment Research Council (NERC)[33]. National activities also include:

- Development and use of ECVs within NERC's National Centre for Earth Observation[34], including activities which span most of the satellite related ECVs. There is close collaboration with the ESA CCI programme.
- Activities within other NERC Centres, e.g. CEH produce daily and monthly burnt area of the boreal forests based on MODIS-based circumpolar data (2001 onwards)[35]
- Funding for national infrastructure to develop and archive ECVs through NERC's (Climate and Environmental Monitoring from Space (CEMS)[36] facility located at Rutherford Appleton Laboratory and closely associated with the new Satellite Applications Catapult. CEMS is currently undergoing a major development with funding from NERC, via its "Big Data" initiative[37].

The UK Space Innovation and Growth Strategy highlight opportunities for development of climate and other services using satellite data. Recommendation 6 reads:

"Take a leadership role in climate-change monitoring, mitigation and agreement verification".[38]

In addition the UK, primarily through the National Physical Laboratory (NPL), has a leading role in standards and techniques for pre- and post-launch calibration and validation to ensure that satellite datasets are consistent and reliable. NPL leads a European Commission funded project to establish a "European Meteorology Centre for Earth Observation and Climate"[39]. This is one of a number of projects within NPL's Centre for Carbon Measurement, which also includes participating in work led by the World Meteorological Organisation to look at the role of Meteorology in Environmental Monitoring. Topics covered range from global monitoring of gases to satellite monitoring of land and ocean temperature.

[32] http://copernicus.eu/pages-principales/services/climate-change/

[33] https://www.ghrsst.org/contact/ghrsst-project-office-contacts/

[34] http://www.nceo.ac.uk/

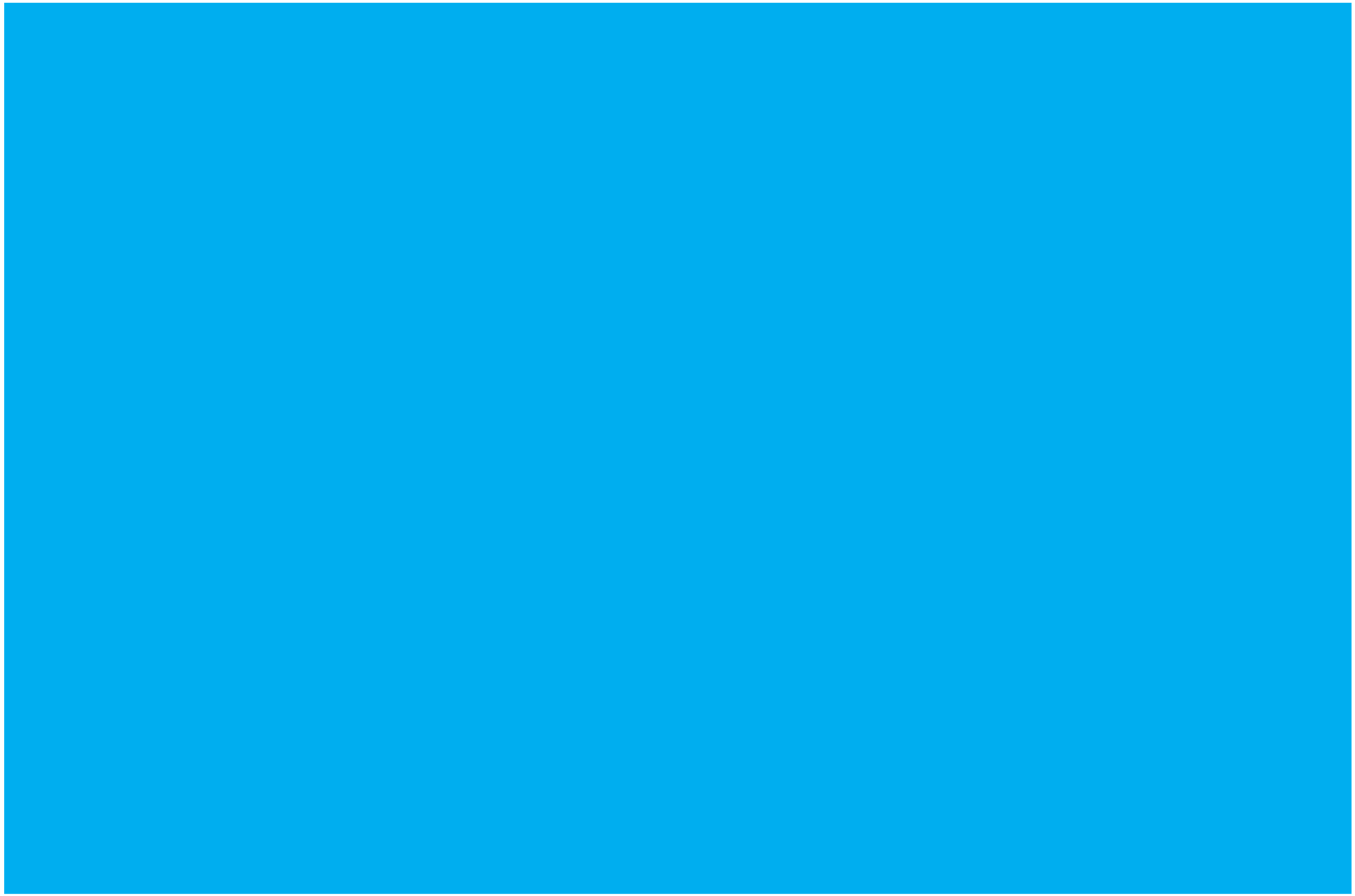
[35] http://www.ceh.ac.uk/staffwebpages/drfrancegerard.html

[36] http://www.stfc.ac.uk/e-Science/38663.aspx and http://sa.catapult.org.uk/cems/climate-and-environmental-monitoring-from-space/

[37] http://www.nerc.ac.uk/research/capability/environmental.asp

[38] "Space Innovation and Growth Strategy – Leadership in Climate Technologies and Services", Executive Summary

[39] http://www.emceoc.org/



Annex 4: UK GHG Inventory tables

Summary Table for National Greenhouse Gas Inventories - 1990
(Summary1.As1 to Summary1.As3 from CRF tables)

Greenhouse Gas Source and Sink Categories		Net CO_2 emissions/ removals	CH_4	N_2O	HFC		PFC		SF_6		NOx	CO	VOC	SO_2
					P	A	P	A	P	A				
		Gg			CO_2 equivalent (Gg)						Gg			
Total National Emissions and Removals		**593,536**	**4,721.78**	**220.31**	**11.88**	**11,385.62**	**73.47**	**1,401.60**	**0.10**	**0.04**	**2,879.37**	**9,128.38**	**2,699.80**	**3,724.49**
1. Energy	1A1. Energy Industries	235,521	9.68	6.67							865.86	135.52	8.66	2,891.04
	1A2. Manufacturing Industries and Construction	103,522	15.75	5.23							398.50	734.50	30.05	443.25
	1A3. Transport	114,363	30.57	4.02							1,319.28	6,433.22	954.97	91.98
	1A4. Other Sectors	108,050	73.21	3.13							213.74	1,164.70	89.96	201.02
	1A5. Other	5,285	0.15	0.16							38.96	13.37	2.21	6.17
	1B1. Solid Fuels	856	871.72	0.01							0.58	38.38	0.34	20.68
	1B2. Oil and Natural Gas	5,778	493.26	0.14							13.34	21.49	564.22	7.78
1. Energy Total		**573,375**	**1,494.34**	**19.35**							**2,850.25**	**8,541.18**	**1,650.41**	**3,661.92**
2. Industrial Processes	2A. Mineral Products	10,413	1.12									5.31	13.12	4.58
	2B. Chemical Industry	2,994	8.07	79.49							8.49	83.97	171.99	41.60
	2C. Metal Production	2,309	0.78	0.04				1,332.75		0.02	4.85	194.19	2.05	8.94
	2D. Other Production												77.25	

	2E.	Production of Halocarbons and SF6					11,373.73		10.90					
	2F.	Consumption of Halocarbons and SF6				11.88	11.89	73.47	57.95	0.10	0.03			
2 Industrial Processes Total			**15,716**	**9.97**	**79.52**	**11.88**	**11,385.62**	**73.47**	**1,401.60**	**0.10**	**0.04**	**13.33**	**283.47**	**264.41**	**55.12**
3. Solvent and Other Product Use	3.	Solvent and other Product Use												668.49	
3. Solvent and Other Product Use Total														**668.49**	
4. Agriculture	4A.	Enteric Fermentation		896.91											
	4B.	Manure Management		165.51	6.32										
	4D.	Agricultural Soils			107.90										
	4F.	Field Burning of Agricultural Residues		12.66	0.26							9.06	265.91	26.06	
	4G.	Other			0.29										
4. Agriculture Total				**1,075.08**	**114.76**							**9.06**	**265.91**	**26.06**	
5. Land Use, Land-Use Change and Forestry	5A.	Forest Land	(12,002)	0.20	0.18							0.01	4.66		
	5B.	Cropland	15,753	0.01	2.48							0.00	0.11		
	5C.	Grassland	(6,313)	0.62	0.05							0.88	15.20		
	5D.	Wetlands	482		0.01										
	5E.	Settlements	6,943	0.32	0.00							0.08	2.77		
	5F.	Other Land	NO												
	5G.	Other	(1,711)												
5. Land Use, Land-Use Change and Forestry Total			**3,152**	**1.15**	**2.73**							**0.97**	**22.74**		
6. Waste	6A.	Solid Waste Disposal on Land		2,054.57										85.96	
	6B.	Waste-water Handling		80.27	3.76										
	6C.	Waste Incineration	1,292	6.40	0.18							5.75	15.08	4.48	7.46
6. Waste Total			**1,292**	**2,141.24**	**3.94**							**5.75**	**15.08**	**90.44**	**7.46**
Aviation_Bunkers			15,675	0.30	0.50							75.25	13.10	5.54	3.00
Marine_Bunkers			8,788	0.14	0.22							193.08	20.42	6.40	98.50
International Bunkers Total			24,463	0.44	0.72							268.33	33.52	11.94	101.50

Summary Table for National Greenhouse Gas Inventories – 2011 (Summary1.As1 to Summary1.As3 from CRF tables)

Greenhouse Gas Source and Sink Categories		Net CO_2 emissions/ removals	CH_4	N_2O	HFC		PFC		SF_6		NOx	CO	VOC	SO_2
					P	A	P	A	P	A				
		Gg			CO_2 equivalent (Gg)						Gg			
Total National Emissions and Removals		**460,687**	**2,003.02**	**112.29**	**100,652.98**	**14,653.91**	**175.66**	**325.31**	**0.03**	**0.03**	**1,036.81**	**2,158.74**	**752.75**	**381.92**
1. Energy	1A1. Energy Industries	178,523	11.42	4.49							317.42	99.64	4.60	235.74
	1A2. Manufacturing Industries and Construction	67,517	10.95	3.09							173.87	627.60	22.04	69.04
	1A3. Transport	115,209	3.31	3.06							431.83	807.74	55.20	11.29
	1A4. Other Sectors	85,385	26.32	2.02							84.55	454.57	36.24	38.55
	1A5. Other	2,751	0.08	0.08							22.73	6.93	1.37	5.58
	1B1. Solid Fuels	258	95.06	0.01							0.34	8.80	0.39	7.62
	1B2. Oil and Natural Gas	4,103	243.05	0.20							2.13	9.81	141.43	0.55
1. Energy Total		**453,745**	**390.18**	**12.94**							**1,032.86**	**2,015.09**	**261.26**	**368.38**
2. Industrial Processes	2A. Mineral Products	6,640	0.25	NE								1.61	7.66	6.66
	2B. Chemical Industry	2,560	3.47	0.67							0.73	19.48	21.51	0.84
	2C. Metal Production	1,384	0.43	0.02		13.18		162.40		0.00	1.23	85.08	1.11	5.31
	2D. Other Production												83.66	
	2E. Production of Halocarbons and SF_6					72.60		87.36						
	2F. Consumption of Halocarbons and SF_6				100652.98	14,568.13	175.66	75.55	0.03	0.02				
2. Industrial Processes Total		**10,583**	**4.14**	**0.69**	**100,652.98**	**14,653.91**	**175.66**	**325.31**	**0.03**	**0.03**	**1.96**	**106.16**	**113.94**	**12.82**
3. Solvent and Other Product Use	3. Solvent and other Product Use	-											345.01	
3. Solvent and Other Product Use Total		**-**											**345.01**	
4. Agriculture	4A. Enteric Fermentation		732.22											
	4B. Manure Management		121.91	5.31										

	4D. Agricultural Soils			87.15				
	4F. Field Burning of Agricultural Residues							
	4G. Other			0.25				
4. Agriculture Total			**854.14**	**92.70**				
5. Land Use, Land-Use Change and Forestry	5A. Forest Land	(10,222)	0.33	0.20	0.02	7.62		
	5B. Cropland	11,454	0.01	1.67	0.01	0.18		
	5C. Grassland	(8,484)	0.67	0.03	0.64	12.29		
	5D. Wetlands	403	NE,NO	0.00				
	5E. Settlements	6,320	0.34	0.00	0.08	2.98		
	5F. Other Land	NO	NO	NO				
	5G. Other	(3,402)	NE	NE				
5. Land Use, Land-Use Change and Forestry Total		**(3,931)**	**1.36**	**1.91**	**0.75**	**23.07**		
6. Waste	6A. Solid Waste Disposal on Land		674.81				28.23	
	6B. Waste-water Handling		78.09	3.89				
	6C. Waste Incineration	290	0.29	0.16	1.24	14.41	4.31	0.72
6. Waste Total		**290**	**753.20**	**4.05**	**1.24**	**14.41**	**32.54**	**0.72**
Aviation_Bunkers		32,878	0.09	1.04	147.09	17.69	6.02	9.19
Marine_Bunkers		9,902	0.15	0.25	232.21	22.79	8.88	79.65
International Bunkers Total		42,780	0.25	1.29	379.29	40.48	14.89	88.84

Note: An error with the CRF reporter software means that emissions of HFCs in 2C are not shown in table Summary1.As1. These have been added by Ricardo-AEA in order to maintain consistency with reported national emissions totals.

Summary Report for CO_2 equivalent – 1990
(Summary2 from CRF tables)

Greenhouse Gas Source and Sink Categories		CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Total
		CO_2 equivalent (Gg)						
Total National Emissions and Removals		593,535.72	99,157.42	68,295.64	11,385.62	1,401.60	1,029.95	774,805.94
1. Energy	1A1. Energy Industries	235,521.31	203.37	2,066.68				237,791.35
	1A2. Manufacturing Industries and Construction	103,521.52	330.73	1,622.84				105,475.09
	1A3. Transport	114,363.30	641.98	1,244.90				116,250.19
	1A4. Other Sectors	108,049.95	1,537.32	971.26				110,558.52
	1A5. Other	5,284.82	3.14	49.14				5,337.10
	1B1. Solid Fuels	856.42	18,306.20	2.08				19,164.70
	1B2. Oil and Natural Gas	5,777.92	10,358.46	42.40				16,178.78
1. Energy Total		**573,375.24**	**31,381.19**	**5,999.30**				**610,755.73**
2. Industrial Processes	2A. Mineral Products	10,412.92	23.60	NE				10,436.52
	2B. Chemical Industry	2,994.08	169.43	24,641.19				27,804.70
	2C. Metal Production	2,309.27	16.36	11.11		1,332.75	426.03	4,095.51
	2E. Production of Halocarbons and SF_6				11,373.73	10.90		11,384.63
	2F. Consumption of Halocarbons and SF_6				11.89	57.95	603.92	673.76
2. Industrial Processes Total		**15,716.28**	**209.38**	**24,652.30**	**11,385.62**	**1,401.60**	**1,029.95**	**54,395.13**
3. Solvent and Other Product Use	3. Solvent and other Product Use	-						-
3. Solvent and Other Product Use Total		**-**						**-**
4. Agriculture	4A. Enteric Fermentation		18,835.17					18,835.17
	4B. Manure Management		3,475.66	1,958.28				5,433.95
	4D. Agricultural Soils			33,449.62				33,449.62
	4F. Field Burning of Agricultural Residues		265.91	79.31				345.22
	4G. Other			88.62				88.62
4. Agriculture Total			**22,576.74**	**35,575.84**				**58,152.58**
5. Land Use, Land-Use Change and Forestry	5A. Forest Land	(12,002.08)	4.30	57.22				(11,940.56)

	5B. Cropland	15,752.87	0.14	769.95	16,522.97
	5C. Grassland	(6,312.65)	13.02	14.43	(6,285.19)
	5D. Wetlands	481.73		3.98	485.71
	5E. Settlements	6,942.64	6.64	0.67	6,949.96
	5F. Other Land				
	5G. Other	(1,710.68)			(1,710.68)
5. Land Use, Land-Use Change and Forestry Total		**3,151.84**	**24.11**	**846.26**	**4,022.20**
6. Waste	6A. Solid Waste Disposal on Land		43,145.94		43,145.94
	6B. Waste-water Handling		1,685.62	1,165.05	2,850.67
	6C. Waste Incineration	1,292.36	134.43	56.89	1,483.69
6. Waste Total		**1,292.36**	**44,965.99**	**1,221.94**	**47,480.30**
Aviation_Bunkers		15,674.66	6.31	154.28	15,835.25
Marine_Bunkers		8,788.31	2.90	68.43	8,859.64
International Bunkers Total		24,462.97	9.21	222.71	24,694.89

Summary Report for CO_2 equivalent - 2011
(Summary2 from CRF tables)

Greenhouse Gas Source and Sink Categories		CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Total
		CO_2 equivalent (Gg)						
Total National Emissions and Removals		**460,687.46**	**42,063.39**	**34,810.93**	**14,653.91**	**325.31**	**607.48**	**553,148.47**
1. Energy	1A1. Energy Industries	178,522.96	239.72	1,391.65				180,154.34
	1A2. Manufacturing Industries and Construction	67,516.75	229.98	958.83				68,705.56
	1A3. Transport	115,208.50	69.52	947.74				116,225.76
	1A4. Other Sectors	85,385.12	552.63	625.48				86,563.23
	1A5. Other	2,750.97	1.60	25.41				2,777.99
	1B1. Solid Fuels	258.25	1,996.33	1.69				2,256.27
	1B2. Oil and Natural Gas	4,102.68	5,104.09	60.72				9,267.49
1. Energy Total		**453,745.24**	**8,193.87**	**4,011.52**				**465,950.63**
2. Industrial Processes	2A. Mineral Products	6,640.02	5.19					6,645.21
	2B. Chemical Industry	2,559.68	72.84	206.77				2,839.30
	2C. Metal Production	1,383.72	8.94	6.14	13.18	162.40	74.46	1,648.84
	2E. Production of Halocarbons and SF_6				72.60	87.36		159.96
	2F. Consumption of Halocarbons and SF_6				14,568.13	75.55	533.02	15,176.69
2. Industrial Processes Total		**10,583.42**	**86.97**	**212.91**	**14,653.91**	**325.31**	**607.48**	**26,470.00**
3. Solvent and Other Product Use	3. Solvent and other Product Use	-						-
3. Solvent and Other Product Use Total		**-**						**-**
4. Agriculture	4A. Enteric Fermentation		15,376.70					15,376.70
	4B. Manure Management		2,560.21	1,645.49				4,205.70
	4D. Agricultural Soils			27,015.70				27,015.70
	4F. Field Burning of Agricultural Residues							
	4G. Other			76.45				76.45
4. Agriculture Total			**17,936.91**	**28,737.64**				**46,674.55**

5. Land Use, Land-Use Change and Forestry	5A. Forest Land	(10,221.62)	7.03	63.33	(10,151.26)
	5B. Cropland	11,454.22	0.29	518.49	11,973.00
	5C. Grassland	(8,484.39)	14.03	10.07	(8,460.28)
	5D. Wetlands	402.68		0.51	403.18
	5E. Settlements	6,319.92	7.14	0.72	6,327.78
	5F. Other Land				
	5G. Other	(3,401.78)			(3,401.78)
5. Land Use, Land-Use Change and Forestry Total		**(3,930.98)**	**28.50**	**593.12**	**(3,309.36)**
6. Waste	6A. Solid Waste Disposal on Land		14,171.06		14,171.06
	6B. Waste-water Handling		1,639.92	1,205.97	2,845.89
	6C. Waste Incineration	289.77	6.16	49.76	345.70
6. Waste Total		**289.77**	**15,817.14**	**1,255.73**	**17,362.64**
Aviation_Bunkers		32,878.37	1.92	323.60	33,203.89
Marine_Bunkers		9,901.57	3.23	76.39	9,981.19
International Bunkers Total		**42,779.94**	**5.16**	**399.99**	**43,185.09**

Emission Trends - Carbon Dioxide	kt CO_2																							
Greenhouse Gas Source and Sink Categories			**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
		Gg																						
1. Energy	1A1.	Energy Industries	235,521.31	233,316.19	222,166.68	205,961.90	203,759.67	201,977.62	203,658.64	190,983.75	196,639.08	187,575.78	197,890.74	207,874.90	205,878.20	213,407.15	212,682.55	211,163.96	218,038.13	212,655.52	208,674.70	185,612.37	191,356.51	178,522.96
	1A2.	Manufacturing Industries and Construction	103,521.52	105,797.73	102,633.43	100,145.26	99,292.95	95,937.84	97,049.66	95,501.34	94,463.42	94,974.98	95,413.03	94,674.96	86,165.60	87,468.63	86,386.92	86,854.39	84,618.82	83,612.34	80,980.95	70,177.13	69,459.08	67,516.75
	1A3.	Transport	114,363.30	113,573.62	115,024.88	116,207.21	116,705.59	115,886.58	120,436.85	121,971.61	121,559.37	122,626.39	121,926.99	122,102.68	124,544.70	124,331.11	125,832.49	126,692.10	126,918.43	128,021.73	122,646.45	118,198.57	116,651.46	115,208.50
	1A4.	Other Sectors	108,049.95	119,448.91	116,437.76	119,982.54	115,256.25	111,180.78	124,484.74	115,374.25	116,806.68	116,819.29	116,259.19	119,306.15	111,948.96	113,284.08	115,061.36	110,818.76	105,833.68	100,876.26	102,911.61	95,259.29	107,964.60	85,385.12
	1A5.	Other	5,284.82	4,292.42	4,086.79	4,140.93	3,959.80	3,886.18	3,804.99	3,630.71	3,194.00	3,149.63	2,916.31	2,921.90	3,056.63	3,162.18	3,052.75	2,842.02	3,463.17	3,751.11	3,253.34	2,980.51	2,892.56	2,750.97
	1B1.	Solid Fuels	856.42	519.42	450.00	344.83	163.25	225.84	366.77	459.63	158.41	112.08	102.36	101.68	107.49	111.87	168.08	111.98	138.47	197.58	236.18	149.11	219.68	258.25
	1B2.	Oil and Natural Gas	5,777.92	5,713.55	6,137.34	6,560.01	6,959.38	8,428.80	8,911.79	6,989.33	6,918.67	5,975.66	5,683.82	5,908.47	5,596.70	5,305.59	5,238.24	5,851.50	4,950.90	5,084.43	4,302.16	4,490.32	4,424.01	4,102.68
1. Energy Total			**573,375.24**	**582,661.83**	**566,936.88**	**553,342.67**	**546,096.90**	**537,523.63**	**558,713.43**	**534,910.61**	**539,739.64**	**531,233.81**	**540,192.44**	**552,890.74**	**537,298.28**	**547,070.60**	**548,422.39**	**544,334.70**	**543,961.61**	**534,198.97**	**523,005.39**	**476,867.31**	**492,967.91**	**453,745.24**
2. Industrial Processes	2A.	Mineral Products	10,412.92	8,748.80	8,235.24	8,274.38	9,338.65	9,399.50	9,736.60	10,174.63	10,341.24	9,680.70	9,458.45	8,897.24	8,825.50	9,024.82	9,301.13	9,210.65	9,363.23	9,599.78	8,412.94	6,099.33	6,320.56	6,640.02
	2B.	Chemical Industry	2,994.08	3,030.02	3,087.88	3,130.99	3,168.69	3,174.78	3,183.31	2,716.88	2,944.38	2,945.49	3,110.62	3,108.82	3,231.47	3,092.01	3,030.81	3,054.30	2,751.58	3,085.00	2,893.47	2,667.11	2,922.15	2,559.68
	2C.	Metal Production	2,309.27	1,683.72	1,450.46	1,364.97	1,639.35	1,938.24	2,225.44	1,961.90	1,786.83	2,088.95	1,984.76	1,513.75	1,170.83	1,846.10	2,053.49	2,455.75	2,124.94	2,657.34	3,063.24	1,233.77	1,681.87	1,383.72
2. Industrial Processes Total			**15,716.28**	**13,462.53**	**12,773.58**	**12,770.34**	**14,146.69**	**14,512.52**	**15,145.35**	**14,853.41**	**15,072.45**	**14,715.14**	**14,553.83**	**13,519.82**	**13,227.80**	**13,962.93**	**14,385.43**	**14,720.69**	**14,239.75**	**15,342.13**	**14,369.66**	**10,000.21**	**10,924.58**	**10,583.42**
3. Solvent and Other Product Use	3.	Solvent and other Product Use	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3. Solvent and Other Product Use Total			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5. Land Use, Land-Use Change and Forestry	5A.	Forest Land	(12,002.08)	(12,348.43)	(13,256.49)	(13,552.66)	(14,059.95)	(12,898.38)	(13,169.91)	(12,792.50)	(12,995.57)	(13,415.70)	(13,555.61)	(14,002.21)	(14,727.39)	(15,345.92)	(15,916.67)	(15,161.43)	(14,693.20)	(13,768.87)	(13,226.74)	(12,395.92)	(10,448.93)	(10,221.62)
	5B.	Cropland	15,752.87	15,955.15	15,994.76	15,598.05	15,684.39	15,855.67	15,921.44	15,685.45	15,583.30	15,502.84	15,097.69	14,733.33	14,462.26	14,257.43	13,909.03	13,574.73	13,378.69	13,217.68	12,891.17	12,743.99	11,938.16	11,454.22
	5C.	Grassland	(6,312.65)	(6,276.10)	(6,420.00)	(6,793.75)	(6,861.94)	(6,855.88)	(7,082.34)	(7,089.43)	(7,448.59)	(7,626.19)	(7,799.43)	(7,965.96)	(8,059.31)	(7,969.15)	(8,214.70)	(8,323.84)	(8,695.67)	(8,794.63)	(8,868.32)	(8,878.16)	(8,587.69)	(8,484.39)
	5D	Wetlands	481.73	489.31	483.23	476.50	594.64	681.11	587.28	524.93	404.97	540.93	537.03	582.92	391.16	628.83	459.14	517.64	538.91	377.28	335.69	375.20	402.63	402.68
	5E.	Settlements	6,942.64	6,881.18	6,820.00	6,772.36	6,729.88	6,672.95	6,649.20	6,631.02	6,594.89	6,614.75	6,570.29	6,535.51	6,475.57	6,443.19	6,401.47	6,355.77	6,293.01	6,254.00	6,206.09	6,184.60	6,249.72	6,319.92
	5F.	Other Land	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	5G.	Other	(1,710.68)	(1,446.62)	(1,136.06)	(1,046.07)	(831.24)	(1,077.58)	(1,206.98)	(1,411.07)	(1,490.11)	(1,493.10)	(1,292.02)	(796.42)	(340.27)	(141.22)	204.48	(321.64)	(547.74)	(1,360.08)	(1,829.81)	(2,530.92)	(3,862.89)	(3,401.78)
5. Land Use, Land-Use Change and Forestry Total			**3,151.84**	**3,254.49**	**2,485.45**	**1,454.43**	**1,255.80**	**2,377.88**	**1,698.69**	**1,548.39**	**648.89**	**123.53**	**(442.05)**	**(912.83)**	**(1,797.97)**	**(2,126.85)**	**(3,157.23)**	**(3,358.76)**	**(3,725.99)**	**(4,074.62)**	**(4,491.92)**	**(4,501.21)**	**(4,309.00)**	**(3,930.98)**
6. Waste	6C.	Waste Incineration	1,292.36	1,301.71	1,272.64	1,192.22	1,022.26	894.04	892.14	534.59	538.32	495.34	502.36	526.68	526.77	477.17	450.63	396.72	324.74	348.81	303.90	293.49	297.89	289.77
6. Waste Total			**1,292.36**	**1,301.71**	**1,272.64**	**1,192.22**	**1,022.26**	**894.04**	**892.14**	**534.59**	**538.32**	**495.34**	**502.36**	**526.68**	**526.77**	**477.17**	**450.63**	**396.72**	**324.74**	**348.81**	**303.90**	**293.49**	**297.89**	**289.77**
Total CO_2 emissions including net CO_2 from LULUCF			**593,535.72**	**600,680.57**	**583,468.55**	**568,759.67**	**562,521.65**	**555,308.06**	**576,449.61**	**551,847.00**	**555,999.29**	**546,567.82**	**554,806.58**	**566,024.41**	**549,254.88**	**559,383.86**	**560,101.21**	**556,093.35**	**554,800.11**	**545,815.29**	**533,187.03**	**482,659.81**	**499,881.38**	**460,687.46**
Total CO_2 emissions excluding net CO_2 from LULUCF			**590,383.88**	**597,426.07**	**580,983.10**	**567,305.24**	**561,265.85**	**552,930.18**	**574,750.92**	**550,298.61**	**555,350.41**	**546,444.29**	**555,248.64**	**566,937.24**	**551,052.86**	**561,510.70**	**563,258.45**	**559,452.11**	**558,526.10**	**549,889.90**	**537,678.95**	**487,161.02**	**504,190.38**	**464,618.44**

Emission Trends - Methane **kt CH_4**

Greenhouse Gas Source and Sink Categories			1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
		Gg																						
1. Energy	1A1.	Energy Industries	9.68	9.63	9.58	9.70	10.82	11.15	11.69	11.51	12.35	13.15	12.59	13.26	13.98	13.33	13.59	13.22	11.53	12.27	12.04	12.34	12.57	11.42
	1A2.	Manufacturing Industries and Construction	15.75	15.58	14.88	14.89	15.55	15.83	16.34	16.88	16.38	16.10	15.64	14.56	13.60	14.79	14.07	13.79	13.97	13.68	12.81	10.90	10.88	10.95
	1A3.	Transport	30.57	30.20	29.07	27.35	25.42	23.51	21.90	20.09	18.41	16.81	14.62	12.76	11.41	10.18	9.14	8.28	7.55	6.75	5.91	4.38	3.75	3.31
	1A4.	Other Sectors	73.21	76.51	70.49	69.69	55.55	42.55	45.82	42.31	43.75	46.38	36.04	32.78	27.34	25.70	24.70	22.68	23.21	24.72	27.00	25.78	28.63	26.32
	1A5.	Other	0.15	0.12	0.11	0.12	0.11	0.11	0.11	0.10	0.09	0.09	0.08	0.08	0.09	0.09	0.08	0.08	0.10	0.11	0.09	0.08	0.08	0.08
	1B1.	Solid Fuels	871.72	896.33	888.88	827.76	549.60	601.19	556.29	533.14	454.19	375.86	323.37	286.98	282.17	232.39	208.70	154.81	140.85	111.75	111.00	106.98	99.56	95.06
	1B2.	Oil and Natural Gas	493.26	483.41	478.92	458.46	447.90	445.49	426.49	381.27	364.70	335.35	322.59	308.48	289.78	278.02	290.12	278.00	261.73	271.57	251.95	250.62	247.58	243.05
1. Energy Total			**1,494.34**	**1,511.77**	**1,491.93**	**1,407.96**	**1,104.95**	**1,139.84**	**1,078.63**	**1,005.30**	**909.88**	**803.73**	**724.94**	**668.90**	**638.34**	**574.49**	**560.40**	**490.85**	**458.94**	**440.85**	**420.81**	**411.08**	**403.06**	**390.18**
2. Industrial Processes	2A.	Mineral Products	1.12	0.91	0.82	0.69	0.77	0.77	0.72	0.71	0.71	0.59	0.59	0.58	0.59	0.62	0.61	0.51	0.83	0.88	0.43	0.26	0.27	0.25
	2B.	Chemical Industry	8.07	8.03	8.64	7.59	8.95	6.84	8.00	6.62	4.80	4.03	3.78	3.68	3.92	4.57	4.07	3.51	3.19	3.61	2.86	3.61	4.00	3.47
	2C.	Metal Production	0.78	0.53	0.46	0.44	0.56	0.70	0.79	0.69	0.63	0.73	0.68	0.42	0.29	0.59	0.66	0.84	0.66	0.87	0.97	0.31	0.56	0.43
2. Industrial Processes Total			**9.97**	**9.48**	**9.92**	**8.71**	**10.28**	**8.31**	**9.51**	**8.02**	**6.14**	**5.35**	**5.04**	**4.69**	**4.79**	**5.78**	**5.34**	**4.86**	**4.68**	**5.35**	**4.26**	**4.19**	**4.83**	**4.14**
4. Agriculture	4A.	Enteric Fermentation	896.91	884.46	884.68	883.28	888.59	880.03	890.07	877.04	878.29	878.19	847.22	799.21	785.75	789.48	794.49	784.39	779.52	764.63	747.34	733.78	736.07	732.22
	4B.	Manure Management	165.51	165.83	165.42	168.22	164.67	156.25	153.15	152.08	145.67	140.05	132.72	129.02	127.40	126.88	129.74	128.48	131.25	126.97	123.74	121.12	122.37	121.91
	4F.	Field Burning of Agricultural Residues	12.66	10.56	7.79	0.06	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4. Agriculture Total			**1,075.08**	**1,060.85**	**1,057.89**	**1,051.56**	**1,053.26**	**1,036.29**	**1,043.22**	**1,029.13**	**1,023.96**	**1,018.24**	**979.94**	**928.23**	**913.16**	**916.36**	**924.23**	**912.86**	**910.77**	**891.60**	**871.09**	**854.90**	**858.44**	**854.14**
5. Land Use, Land-Use Change and Forestry	5A.	Forest Land	0.20	0.35	0.09	0.15	0.12	0.95	0.49	0.64	0.35	0.06	0.19	0.26	0.22	0.19	0.24	0.41	0.37	0.41	0.40	0.40	0.23	0.33
	5B.	Cropland	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.01	0.01	0.01	0.02	0.02	0.02	0.01	0.01
	5C.	Grassland	0.62	0.62	0.62	0.62	0.63	0.63	0.63	0.67	0.63	0.63	0.86	0.53	0.75	2.07	0.85	1.02	0.84	1.17	0.79	0.77	0.61	0.67
	5E.	Settlements	0.32	0.30	0.28	0.27	0.28	0.25	0.28	0.31	0.31	0.40	0.41	0.43	0.40	0.41	0.41	0.39	0.35	0.34	0.30	0.32	0.32	0.34
5. Land Use, Land-Use Change and Forestry Total			**1.15**	**1.27**	**1.00**	**1.06**	**1.03**	**1.83**	**1.40**	**1.62**	**1.30**	**1.09**	**1.48**	**1.24**	**1.39**	**2.70**	**1.51**	**1.84**	**1.57**	**1.93**	**1.51**	**1.51**	**1.17**	**1.36**
6. Waste	6A.	Solid Waste Disposal on Land	2,054.57	2,012.64	1,950.92	1,889.20	1,839.87	1,788.77	1,736.46	1,612.89	1,513.45	1,385.97	1,299.04	1,135.21	1,035.30	904.54	833.83	811.39	796.35	778.09	756.23	731.21	703.24	674.81
	6B.	Waste-water Handling	80.27	80.27	80.09	80.11	80.19	80.48	80.36	80.52	80.70	83.00	85.25	86.50	85.43	84.44	87.56	87.40	88.60	89.67	89.79	78.66	77.36	78.09
	6C.	Waste Incineration	6.40	6.35	6.09	5.41	3.98	3.81	4.15	0.33	0.37	0.38	0.40	0.34	0.33	0.33	0.32	0.32	0.31	0.31	0.29	0.29	0.30	0.29
6. Waste Total			**2,141.24**	**2,099.26**	**2,037.10**	**1,974.72**	**1,924.03**	**1,873.06**	**1,820.97**	**1,693.74**	**1,594.52**	**1,469.35**	**1,384.69**	**1,222.04**	**1,121.07**	**989.31**	**921.71**	**899.11**	**885.25**	**868.07**	**846.30**	**810.17**	**780.90**	**753.20**
Total CO_2 emissions including net CO_2 from LULUCF			**4,721.78**	**4,682.63**	**4,597.83**	**4,444.01**	**4,093.56**	**4,059.33**	**3,953.73**	**3,737.80**	**3,535.80**	**3,297.75**	**3,096.09**	**2,825.10**	**2,678.75**	**2,488.64**	**2,413.19**	**2,309.53**	**2,261.22**	**2,207.81**	**2,143.97**	**2,081.84**	**2,048.40**	**2,003.02**
Total CO_2 emissions excluding net CO_2 from LULUCF			**4,720.63**	**4,681.35**	**4,596.83**	**4,442.95**	**4,092.53**	**4,057.49**	**3,952.33**	**3,736.18**	**3,534.50**	**3,296.66**	**3,094.61**	**2,823.86**	**2,677.36**	**2,485.94**	**2,411.68**	**2,307.69**	**2,259.65**	**2,205.88**	**2,142.46**	**2,080.33**	**2,047.23**	**2,001.66**

Emission Trends - Nitrous Oxide	kt N_2O																						
Greenhouse Gas Sources and Sinks		**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
	Gg																						
1. Energy	1A1. Energy Industries	6.67	6.65	6.38	5.64	5.61	5.55	5.36	4.90	5.09	4.63	5.00	5.25	5.34	5.38	5.17	5.29	5.39	4.98	4.82	4.38	4.41	4.49
	1A2. Manufacturing Industries and Construction	5.23	5.13	5.17	4.93	4.97	4.83	4.71	4.57	4.45	4.45	4.37	4.37	4.34	4.24	4.20	4.37	4.13	4.27	3.99	3.32	3.30	3.09
	1A3. Transport	4.02	3.99	4.03	4.31	4.87	5.64	5.09	5.04	5.01	4.95	4.84	4.58	4.39	4.16	4.01	3.84	3.72	3.62	3.12	2.95	2.96	3.06
	1A4. Other Sectors	3.13	3.21	3.09	3.14	2.99	2.77	2.84	2.79	2.69	2.66	2.50	2.47	2.35	2.29	2.18	2.15	2.02	1.96	1.97	1.99	2.05	2.02
	1A5. Other	0.16	0.13	0.12	0.12	0.12	0.12	0.11	0.11	0.10	0.09	0.09	0.09	0.09	0.09	0.09	0.08	0.10	0.11	0.10	0.09	0.09	0.08
	1B1. Solid Fuels	0.01	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	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	1B2. Oil and Natural Gas	0.14	0.14	0.15	0.16	0.16	0.20	0.20	0.18	0.17	0.17	0.15	0.15	0.14	0.13	0.13	0.15	0.12	0.13	0.11	0.12	0.15	0.20
1. Energy Total		**19.35**	**19.26**	**18.93**	**18.32**	**18.71**	**19.11**	**18.32**	**17.58**	**17.51**	**16.95**	**16.95**	**16.92**	**16.65**	**16.30**	**15.80**	**15.88**	**15.49**	**15.06**	**14.11**	**12.84**	**12.95**	**12.94**
2. Industrial Processes	2B. Chemical Industry	79.49	79.99	65.04	52.42	53.02	47.95	47.65	48.26	49.16	17.28	17.87	15.52	8.96	9.38	12.08	9.50	7.63	8.88	7.78	3.80	4.25	0.67
	2C. Metal Production	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.03	0.03	0.02	0.03	0.03	0.02	0.02	0.02
2. Industrial Processes Total		**79.52**	**80.02**	**65.07**	**52.44**	**53.05**	**47.99**	**47.69**	**48.29**	**49.19**	**17.31**	**17.90**	**15.54**	**8.98**	**9.41**	**12.11**	**9.53**	**7.66**	**8.91**	**7.81**	**3.81**	**4.27**	**0.69**
4. Agriculture	4B. Manure Management	6.32	6.51	6.50	6.53	6.57	6.71	6.91	7.16	7.09	6.79	6.74	6.55	6.22	6.28	6.27	6.00	5.90	5.75	5.59	5.43	5.37	5.31
	4D. Agricultural Soils	107.90	107.96	107.60	105.98	106.48	106.24	106.37	107.42	105.87	104.64	101.09	95.16	96.68	95.28	95.16	94.97	90.53	87.68	86.73	85.58	86.95	87.15
	4F. Field Burning of Agricultural Residues	0.26	0.21	0.16	0.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	4G. Other	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.28	0.28	0.30	0.30	0.26	0.26	0.25	0.26	0.27	0.27	0.25	0.25	0.25
4. Agriculture Total		**114.76**	**114.97**	**114.55**	**112.80**	**113.34**	**113.24**	**113.57**	**114.87**	**113.25**	**111.71**	**108.11**	**102.02**	**103.20**	**101.81**	**101.68**	**101.21**	**96.69**	**93.70**	**92.58**	**91.27**	**92.57**	**92.70**
5. Land Use, Land-Use Change and Forestry	5A. Forest Land	0.18	0.19	0.18	0.18	0.18	0.23	0.20	0.21	0.20	0.18	0.19	0.20	0.20	0.20	0.20	0.21	0.21	0.21	0.21	0.21	0.20	0.20
	5B. Cropland	2.48	2.49	2.49	2.50	2.50	2.51	2.51	2.52	2.52	2.53	2.44	2.37	2.29	2.23	2.16	2.10	2.04	1.98	1.93	1.88	1.77	1.67
5C. Grassland		0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.02	0.03	0.13	0.03	0.04	0.05	0.07	0.03	0.02	0.02	0.03
5D. Wetlands		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5E. Settlements	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	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5. Land Use, Land-Use Change and Forestry Total		**2.73**	**2.75**	**2.74**	**2.74**	**2.74**	**2.80**	**2.77**	**2.79**	**2.78**	**2.77**	**2.70**	**2.59**	**2.52**	**2.56**	**2.39**	**2.35**	**2.30**	**2.26**	**2.17**	**2.11**	**2.00**	**1.91**
6. Waste	6B. Waste-water Handling	3.76	3.73	3.86	3.83	3.85	3.88	4.00	3.90	3.95	3.91	4.11	4.00	4.02	3.81	3.76	3.83	3.80	3.79	3.76	3.83	3.90	3.89
	6C. Waste Incineration	0.18	0.18	0.18	0.18	0.15	0.15	0.16	0.10	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.18	0.18	0.18	0.15	0.16	0.17	0.16
6. Waste Total		**3.94**	**3.91**	**4.04**	**4.01**	**3.99**	**4.03**	**4.17**	**4.00**	**4.13**	**4.10**	**4.30**	**4.19**	**4.22**	**3.99**	**3.95**	**4.01**	**3.98**	**3.97**	**3.92**	**3.99**	**4.07**	**4.05**
Total CO_2 emissions including net CO_2 from LULUCF		**220.31**	**220.90**	**205.32**	**190.31**	**191.84**	**187.17**	**186.52**	**187.53**	**186.87**	**152.83**	**149.96**	**141.26**	**135.57**	**134.08**	**135.92**	**132.99**	**126.12**	**123.90**	**120.59**	**114.03**	**115.86**	**112.29**
Total CO_2 emissions excluding net CO_2 from LULUCF		**217.58**	**218.15**	**202.59**	**187.57**	**189.10**	**184.37**	**183.75**	**184.75**	**184.09**	**150.06**	**147.26**	**138.67**	**133.05**	**131.52**	**133.53**	**130.64**	**123.82**	**121.64**	**118.42**	**111.92**	**113.87**	**110.38**

Emission Trends - HFCs	$KtCO_2$ equivalent																						
Greenhouse Gas Source and Sink Categories		**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
	Gg CO_2 equivalent																						
Total National Emissions and Removals		**11,386**	**11,862**	**12,347**	**13,020**	**13,937**	**15,328**	**16,566**	**18,996**	**16,903**	**10,262**	**9,342**	**10,267**	**10,733**	**11,930**	**11,209**	**12,110**	**12,794**	**13,102**	**13,687**	**14,033**	**14,388**	**14,654**
2. Industrial Processes	2C. Metal Production	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2	2	26	13	14	13
	2E. Production of Halocarbons and SF_6	11,374	11,842	12,310	12,780	13,265	13,981	14,321	15,622	12,117	4,882	2,620	2,387	2,034	1,981	445	442	387	176	126	94	82	73
	2F. Consumption of Halocarbons and SF_6	12	20	37	240	672	1,347	2,245	3,373	4,786	5,380	6,723	7,879	8,698	9,948	10,763	11,666	12,404	12,924	13,535	13,926	14,293	14,568
2. Industrial Processes Total		**11,386**	**11,862**	**12,347**	**13,020**	**13,937**	**15,328**	**16,566**	**18,996**	**16,903**	**10,262**	**9,342**	**10,267**	**10,733**	**11,930**	**11,209**	**12,110**	**12,794**	**13,102**	**13,687**	**14,033**	**14,388.34**	**14,653.91**

Emission Trends - PFCs **$KtCO_2$ equivalent**

Greenhouse Gas Source and Sink Categories			1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
			$Gg\ CO_2$ equivalent																					
Total National Emissions and Removals			**1,402**	**1171**	**573**	**490**	**486**	**462**	**480**	**398**	**387**	**366**	**461**	**385**	**319**	**276**	**340**	**298**	**302**	**219**	**204**	**145**	**221**	**325**
2. Industrial Processes	2C.	Metal Production	1,333	1,096	490	381	345	286	282	220	208	188	253	218	150	112	153	99	127	84	116	61	113	162
	2E.	Production of Halocarbons and SF_6	11	11	11	27	49	71	77	38	42	19	23	54	57	56 108	90 97	110 88	90 85	55 80	12 76	11 72	39 69	87 76
	2F.	Consumption of Halocarbons and SF_6	58	64	72	81	92	105	120	139	137	159	184	113	111									
2. Industrial Processes Total			**1,402**	**1,171**	**573**	**490**	**486**	**462**	**480**	**398**	**387**	**366**	**461**	**385**	**319**	**276**	**340**	**298**	**302**	**219**	**204**	**145**	**220.62**	**325.31**

Emission Trends - SF_6 **$KtCO_2$ equivalent**

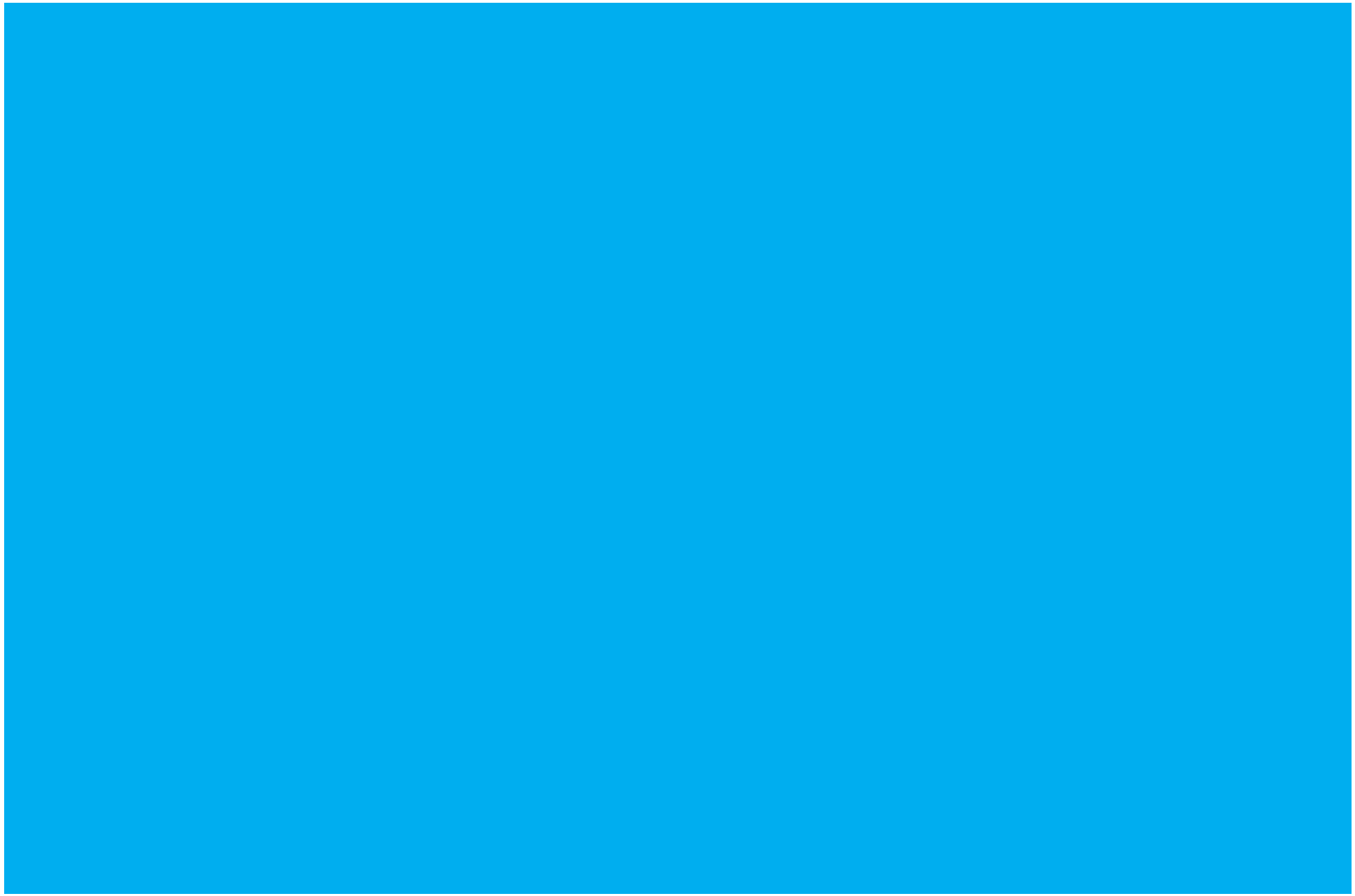
Greenhouse Gas Source and Sink Categories			1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
			$Gg\ CO_2$ equivalent																					
Total National Emissions and Removals			**1,030**	**1,078**	**1,124**	**1,167**	**1,183**	**1239**	**1267**	**1,226**	**1,263**	**1,426**	**1798**	**1,425**	**1,509**	**1,324**	**1129**	**1,110**	**875**	**793**	**712**	**662**	**690**	**607**
2. Industrial Processes	2C.	Metal Production	426	426	426	426	426	426	426	428	471	687	1093	756	847	672	388	254	180	148	88	78	130	74
	2F.	Consumption of Halocarbons and SF_6	604	652	698	741	757	813	841	797	791	739	705	669	662	652	741	856	695	645	623	584	559	533
2. Industrial Processes Total			**1,030**	**1,078**	**1,124**	**1,167**	**1,183**	**1,239**	**1267**	**1,226**	**1,263**	**1,426**	**1,798**	**1,425**	**1,509**	**1,324**	**1,129**	**1,110**	**875**	**793**	**712**	**662**	**690**	**607**

Summary by Gas **$MtCO_2$ equivalent**

	Greenhouse Gas	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
		$MtCO_2$ eq																					
	Carbon	593.54	600.68	583.47	568.76	562.52	555.31	576.45	551.85	556.00	546.57	554.81	566.02	549.25	559.38	560.10	556.09	554.80	545.82	533.19	482.66	499.88	460.69
	CH_4	99.16	98.34	96.55	93.32	85.96	85.25	83.03	78.49	74.25	69.25	65.02	59.33	56.25	52.26	50.68	48.50	47.49	46.36	45.02	43.72	43.02	42.06
	N_2O	68.30	68.48	63.65	59.00	59.47	58.02	57.82	58.14	57.93	47.38	46.49	43.79	42.03	41.56	42.14	41.23	39.10	38.41	37.38	35.35	35.92	34.81
	HFC	11.39	11.86	12.35	13.02	13.94	15.33	16.57	19.00	16.90	10.26	9.34	10.27	10.73	11.93	11.21	12.11	12.79	13.10	13.69	14.03	14.39	14.65
	PFC	1.40	1.17	0.57	0.49	0.49	0.46	0.48	0.40	0.39	0.37	0.46	0.38	0.32	0.28	0.34	0.30	0.30	0.22	0.20	0.15	0.22	0.33
	SF_6	1.03	1.08	1.12	1.17	1.18	1.24	1.27	1.23	1.26	1.43	1.80	1.43	1.51	1.32	1.13	1.11	0.87	0.79	0.71	0.66	0.69	0.61
Total National Emissions and Removals		**774.81**	**781.61**	**757.72**	**735.76**	**723.56**	**715.60**	**735.61**	**709.10**	**706.73**	**675.25**	**677.91**	**681.22**	**660.10**	**666.74**	**665.59**	**659.34**	**655.35**	**644.70**	**630.19**	**576.57**	**594.11**	**553.15**

Summary by Source **$MtCO_2$ equivalent**

	Categories	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
		$MtCO_2$ eq																					
1.	Energy	610.76	620.38	604.13	588.59	575.10	567.38	587.04	561.47	564.28	553.37	560.67	572.18	555.87	564.19	565.09	559.57	558.40	548.13	536.22	489.48	505.45	465.95
2.	Industrial Processes	54.40	52.58	47.20	43.89	46.42	46.59	48.44	50.61	49.00	32.25	31.81	30.51	28.67	30.53	30.93	31.30	30.68	32.33	31.48	26.11	27.65	26.47
3.	Solvent and Other Product Use	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	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.	Agriculture	58.15	57.92	57.73	57.05	57.25	56.87	57.12	57.22	56.61	56.01	54.09	51.12	51.17	50.81	50.93	50.55	49.10	47.77	46.99	46.25	46.73	46.67
5.	Land Use, Land-Use Change and Forestry	4.02	4.13	3.35	2.33	2.13	3.28	2.59	2.45	1.54	1.00	0.42	-0.08	-0.99	-1.28	-2.38	-2.59	-2.98	-3.33	-3.79	-3.82	-3.67	-3.31
6.	Waste	47.48	46.60	45.30	43.90	42.67	41.48	40.42	37.34	35.30	32.62	30.91	27.49	25.38	22.49	21.03	20.52	20.15	19.81	19.29	18.54	17.96	17.36
Total National Emissions and Removals		**774.81**	**781.61**	**757.72**	**735.76**	**723.56**	**715.60**	**735.61**	**709.10**	**706.73**	**675.25**	**677.91**	**681.22**	**660.10**	**666.74**	**665.59**	**659.34**	**655.35**	**644.70**	**630.19**	**576.57**	**594.11**	**553.15**

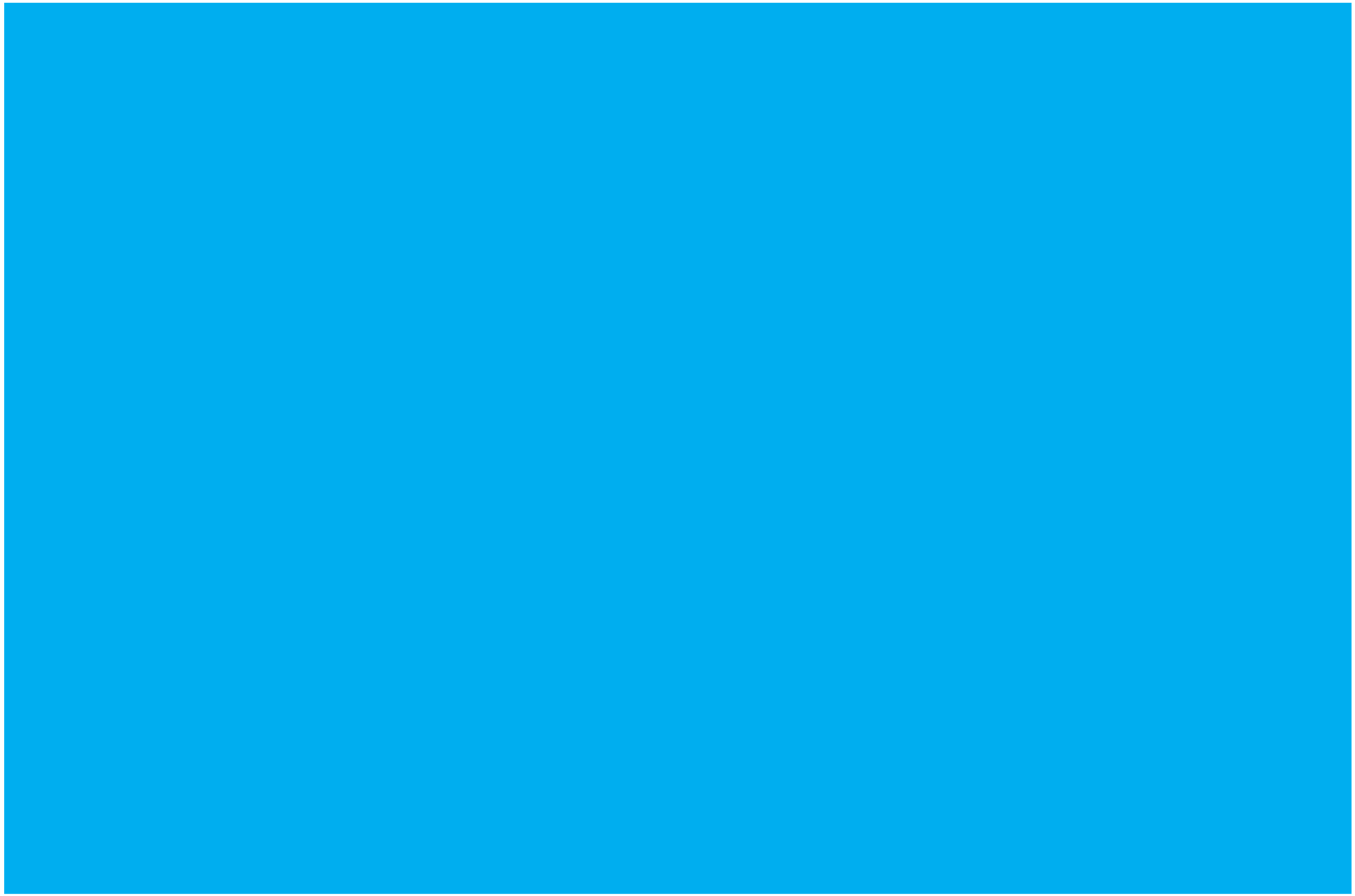


Annex 5: Mapping between categories used in this National Communication and IPCC (inventory) categories

IPCC (Inventory)				National Communications	Methane	F-Gases
1. Energy	A. Fuel combustion (sectoral approach)	1. Energy industries		Energy Supply	Fuel combustion	Not used
		2. Manufacturing industries and construction		Business (Industry)		
			a. Sinter coke	Industrial Processes		
		3. Transport		Transport		
		4. Other sectors	a. Commercial/ Institutional	Business (Commercial services)		
				Public (Public services)		
			b. Residential	Residential		
			c. Agriculture/ Forestry/Fishing	Agriculture		
		5. Other		Not used	Not used	
	B. Fugitive emissions from fuels	1. Solid fuels		Energy Supply	Coal mining	
		2. Oil and natural gas			Natural gas distribution	
					Offshore oil and gas	
2. Industrial processes	A. Mineral products	1. Cement		Industrial Processes	Not used	
		2. Lime				
		3. Limestone & Dolomite use in power stations		Energy Supply		
		4. Soda Ash		Industrial Processes		
		7. Fletton Bricks				
	B. Chemical industry	1-3. and other 5.				
		5. Carbon in pesticides		Agriculture		
		5. Carbon in detergents		Residential		
		5. Petroleum waxes		Residential		
		5. Energy recovery		Business		

	C. Metal production	1. Iron & Steel		Industrial Processes		
		3. Aluminium production				PFCs – Aluminium production
		4. Magnesium production				HFCs – Magnesium Cover Gas
						SF_6 – Magnesium Cover Gas
	D. Other production			Not used		Not used
	E. Production of halocarbons and SF_6			Business (Industry)		HFC-23 from HCFC-22 manufacture and fugitive losses from HFC manufacture
	F. Consumption of halocarbons and SF_6	1. Refrigeration/ Air conditioning		Business		HFCs – Refrigeration/air conditioning
		2. Foams				HFCs – Foams (excluding OCF)
		3. Firefighting				HFCs – Firefighting
		4. Aerosols/ Metered dose inhalers				HFCs – General aerosols and OCF
				Residential		HFCs – Metered dose inhalers
		5. Solvents		Business		HFCs – Precision cleaning
		6. Semiconductor manufacture				PFCs – Electronics
						SF_6 – Electronics
		7. Electrical equipment				SF_6 – Electrical Insulation
		8. Other				PFCs – Other uses
						SF_6 – Other uses
	G. Other			Not used		Not used
3. Solvent and other product use				Industrial Processes		
4. Agriculture	A. Enteric fermentation			Agriculture	Agriculture	
	B. Manure management					
	C. Rice cultivation					
	D. Agricultural soils					
	E. Prescribed burning of savannas					
	F. Field burning of agricultural residues					
	G. Other					

5. Land use, land-use change and forestry	A. Forest land			LULUCF	Other	
	B. Cropland					
	C. Grassland					
	D. Wetlands					
	E. Settlements					
	F. Other land					
	G. Other					
6. Waste	A. Solid waste disposal on land			Waste	Waste disposal on land	
	B. Wastewater handling				Wastewater treatment	
	C. Waste incineration				Other	
	D. Other			Not used	Not used	
7. Other (as specified in the summary 1.A in the latest submitted CRF)				Not used	Not used	



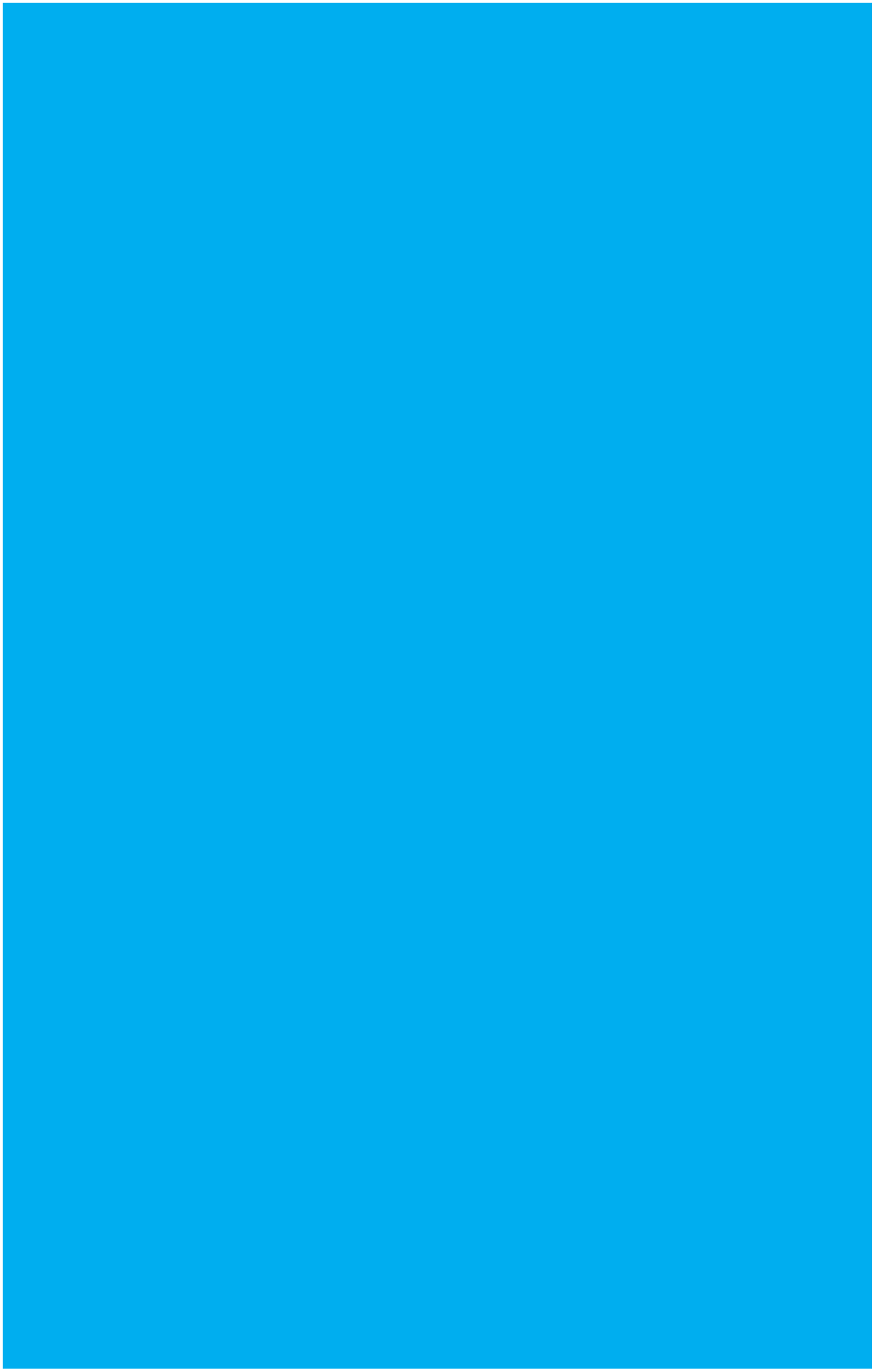
Annex 6: Reconciliation of UNFCCC and KP reporting bases

$MtCO_2e$	Fixed Base Year [c]	1990	1995	2000	2005	2010	2011	2015	2020	2025	2030
A: UNFCCC reporting basis (Total GHG sources minus total sinks)	782.47	774.81	715.60	677.91	659.34	594.11	553.15	528.88	438.47	420.96	399.23
B: Total LULUCF sources and sinks	2.93	4.02	3.28	0.42	-2.59	-3.67	-3.31	-1.49	-0.43	0.93	2.16
C: Total without any LULUCF (A minus B)	779.54	770.78	712.32	677.49	661.93	597.78	556.46	530.37	438.90	420.02	397.07
D: Article 3.3 LULUCF (all three gases) [a, d]		0.31	0.03	-0.84	-1.52	-2.42	-2.51	-2.36	-3.07	-3.89	-4.57
E: Article 3.4 Forest Management [a]		-1.40	-1.40	-1.40	-1.40	-1.40	-1.40	NE	NE	NE	NE
F: Article 3.7 Deforestation estimate 1990 [b]	0.37										
Kyoto Protocol reporting basis (Total of C:F above)	779.90	769.70	710.95	675.25	659.02	593.96	552.55	NE	NE	NE	NE

The geographical coverage of this table includes the UK and all Crown Dependencies and Overseas Territories that have signed up to the UK's instruments of ratification to the UNFCCC and the Kyoto Protocol.

Estimates may not sum due to rounding

[a] Articles 3.3 and 3.4 LULUCF not added to base year
[b] Articles 3.7 estimate only added to base year
[c] Fixed base year is base year calculated from the 2004 inventory, from which the UK's assigned amount is calculated.
[d] Article 3.4 emissions are capped. The values presented above refer to the annual cap for the first commitment period (2008-2012). Values between 2015 and 2030 will be estimated once a final approach to Article 3.4 has been agreed for each respective commitment period.



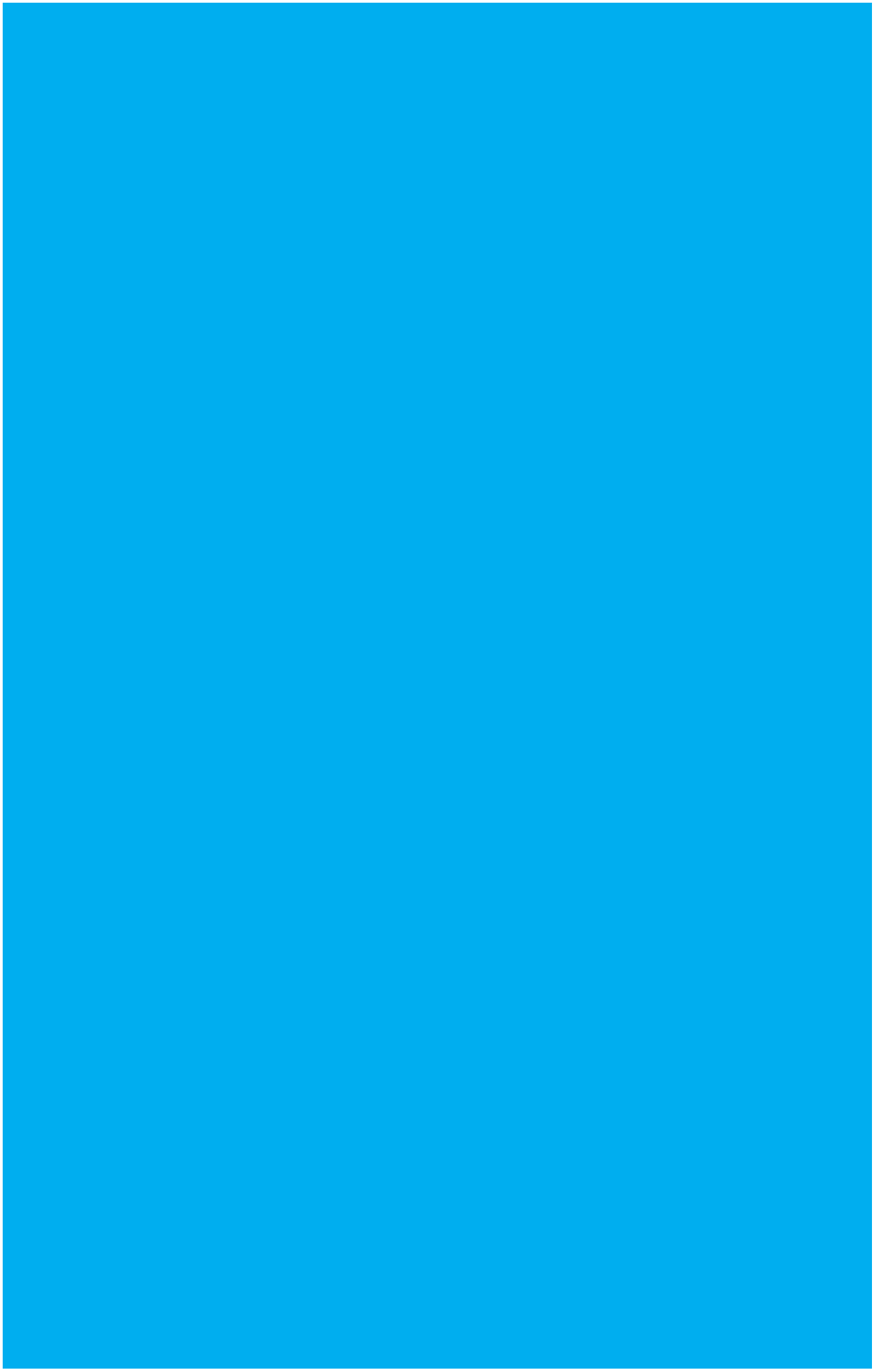
Annex 7: Bilateral and regional contributions related to the implementation of the convention

– Financial Contributions to the Global Environment Facility

	£ million			US$ million		
	2010	2011	2012	2010	2011	2012
Global Environment Facility (GEF)	66.5m	73.5m	52.5m	102.862	113.58	84.803

Notes

1. Figures indicate total contribution to the Global Environment Facility, and not just the climate-specific elements.
2. Exchange rate for 2010 is £1 = US$1.5468 (as at 31 12 2010).
3. Exchange rate for 2011 is £1 = USD1.5453 (as at 31 12 2011).
4. Exchange rate for 2012 is £1 = USD1.6153 (as at 31 12 2012).



Annex 8: Reporting under Article 7, Paragaph 2

National Systems in accordance with Article 5, paragraph 1	
30. Each Party included in Annex I shall provide a description of how it is performing the general and specific functions defined in the guidelines for national systems under Article 5, paragraph 1. The description shall contain the following elements:	
(a) The name and contact information for the national entity and its designated representative with overall responsibility for the national inventory of the Party	6NC Chapter 2 Section 2.3 and National Inventory Report (NIR)
(b) The roles and responsibilities of various agencies and entities in relation to the inventory development process, as well as the institutional, legal and procedural arrangements made to prepare the inventory	6NC Chapter 2 Section 2.3 and NIR
(c) A description of the process for collecting activity data, for selecting emission factors and methods, and for the development of emission estimates	6NC Chapter 2 Section 2.3 and NIR
(d) A description of the process and the results of key source identification and, where relevant, archiving of test data	6NC Chapter 2 Section 2.3 and NIR
(e) A description of the process for the recalculation of previously submitted inventory data	6NC Chapter 2 Section 2.3 and NIR
(f) A description of the quality assurance and quality control plan, its implementation and the quality objectives established, and information on internal and external evaluation and review processes and their results in accordance with the guidelines for national systems	6NC Chapter 2 Section 2.12 and NIR
(g) A description of the procedures for the official consideration and approval of the inventory.	6NC Chapter 2 Section 2.3 and NIR
31. Where the Party included in Annex I has not performed all functions, the Party shall provide an explanation of which functions were not performed or were only partially performed and information on the action planned or taken to perform these functions in the future.	6NC Chapter 2 Section 2.3 and NIR

National Registries	
32. Each Party included in Annex I shall provide a description of how its national registry performs the functions defined in the annex to decision 13/CMP.1 and the annex to decision 5/CMP.1,11 and complies with the requirements of the technical standards for data exchange between registry systems as adopted by the COP/MOP. The description shall include the following information:	
(a) The name and contact information of the registry administrator designated by the Party to maintain the national registry	6NC Chapter 2 Section 2.3 and Standard Independent Assessment Report (SIAR)
(b) The names of the other Parties with which the Party cooperates by maintaining their national registries in a consolidated system	6NC Chapter 2 Section 2.3 and SIAR
(c) A description of the database structure and capacity of the national registry	6NC Chapter 2 Section 2.3 and SIAR
(d) A description of how the national registry conforms to the technical standards for data exchange 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, paragraph 1)	6NC Chapter 2 Section 2.3 and SIAR

(e) A description of the procedures employed in the national registry to minimize discrepancies in the issuance, transfer, acquisition, cancellation and retirement of ERUs, CERs, tCERs, lCERs, AAUs and/or RMUs, and replacement of tCERS and lCERs, 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	6NC Chapter 2 Section 2.3 and SIAR
(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	6NC Chapter 2 Section 2.3 and SIAR
(g) A list of the information publicly accessible by means of the user interface to the national registry	6NC Chapter 2 Section 2.3 and SIAR
(h) The Internet address of the interface to its national registry	6NC Chapter 2 Section 2.3 and SIAR
(i) A description of measures taken to safeguard, maintain and recover data in order to ensure the integrity of data storage and the recovery of registry services in the event of a disaster.	6NC Chapter 2 Section 2.3 and SIAR
(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.	6NC Chapter 2 Section 2.3 and SIAR

Supplementarity relating to the mechanisms pursuant to Articles 6, 12 and 17	
33. Each Party included in Annex I shall provide information on how its use of the mechanisms is supplemental to domestic action, and how its domestic action thus constitutes a significant element of the effort made to meet its quantified limitation and reduction commitments under Article 3, paragraph 1, in accordance with the provisions of decision 5/CP.6.	6NC Chapter 3

Policies and measures in accordance with Article 2	
34. In providing information under part II, section V, of the guidelines for the preparation of national communications by Parties included in Annex I to the Convention (FCCC/CP/1999/7), each Party included in Annex I shall specifically address policies and measures implemented and/or further elaborated as well as cooperation with other such Parties in achieving its quantified emission limitation and reduction commitment under Article 3, in order to promote sustainable development. Such reporting shall take into account any relevant decision by the COP and the COP/MOP resulting from the process for further consideration of the issue of policies and measures (decision 13/CP.7).	6NC Chapter 4 and 6
35. With respect to aviation and marine bunker fuels, each Party included in Annex I shall, in pursuit of Article 2, paragraph 2, of the Kyoto Protocol, identify the steps it has taken to promote and/or implement any decisions by the International Civil Aviation Organization and the International Maritime Organization in order to limit or reduce emissions of greenhouse gases not controlled by the Montreal Protocol from aviation and marine bunker fuels.	6NC Chapter 3
36. Each Party included in Annex I shall also provide information not reported elsewhere under these guidelines on how it strives to implement policies and measures under Article 2 of the Kyoto Protocol in such a way as to minimize adverse effects, including the adverse effects of climate change, effects on international trade, and social, environmental and economic impacts on other Parties, especially developing country Parties and in particular those identified in Article 4, paragraphs 8 and 9,of the Convention, taking into account Article 3 of the Convention.	6NC Chapter 3

Domestic and regional programmes and/or legislative arrangements and enforcement and administrative procedures	
37. Each Party included in Annex I shall report any relevant information on its domestic and regional legislative arrangements and enforcement and administrative procedures, established pursuant to the implementation of the Kyoto Protocol, according to its national circumstances.	6NC Chapter 1 and 3
(a) A description of any domestic and regional legislative arrangements and enforcement and administrative procedures the Party has in place to meet its commitments under the Kyoto Protocol, including the legal authority for such programmes, how they are implemented, and procedures for addressing cases of non-compliance under domestic law.	6NC Chapter 3
(b) A description of any provisions to make information on these legislative arrangements and enforcement and administrative procedures (e.g. rules on enforcement and administrative procedures, action taken) publicly accessible	6NC Chapter 3
(c) A description of any institutional arrangements and decision-making procedures that it has in place to coordinate activities relating to participation in the mechanisms under Articles 6, 12 and 17, including the participation of legal entities.	6NC Chapter 3
38. Each Party included in Annex I shall provide a description of any national legislative arrangements and administrative procedures that seek to ensure that the implementation of activities under Article 3, paragraph 3, and any elected activities under Article 3, paragraph 4, also contribute to the conservation of biodiversity and sustainable use of natural resources.	6NC Chapter 3

Information under Article 10	
39. Each Party included in Annex I shall report its activities, actions and programmes undertaken in fulfilment of its commitments under Article 10.	6NC Chapter 6
40. Each Party included in Annex I shall report on the steps it has taken to promote, facilitate and finance the transfer of technology to developing countries and to build their capacity, taking into account Article 4, paragraphs 3, 5 and 7, of the Convention, in order to facilitate the implementation of Article 10 of the Kyoto Protocol.	6NC Chapter 6

Financial resources	
41. Each Party included in Annex II shall provide information on the implementation of Article 11 of the Kyoto Protocol, in particular information on what new and additional financial resources have been provided, in what way these resources are new and additional, and how that Party has taken into account the need for adequacy and predictability in the flow of these resources.	6NC Chapter 5
42. Each Party included in Annex II shall provide information on its contribution to the entity or entities entrusted with the operation of the financial mechanism.	6NC Chapter 5
43. Any Party included in Annex I that has provided funding for the adaptation fund established in accordance with decision 10/CP.7 shall report on its financial contributions to this fund. In doing so, the Party shall take into account the information reported in accordance with paragraph 6 of decision 10/CP.7.	6NC Chapter 5

Glossary

AATSR	Advanced Along Track Scanning Radiometer
AgMIP	Agricultural Model Inter-comparison Project
AHRC	Arts and Humanities Research Council
AIMES	Analysis, Integration and Modelling of the Earth System
AMDAR	Aircraft Meteorological Data Relay
ASAP	Adaptation for Smallholder Agriculture Programme
ASC	Adaptation Sub-Committee (part of the CCC)
ASHPs	Air Source Heat Pumps
ATSR	Along Track Scanning Radiometer
AVOID	Avoiding Dangerous Climate Change
BADC	British Atmospheric Data Centre
BAS	British Antarctic Survey
BBL	Barrel (unit of volume for crude oil and petroleum products)
BBSRC	Biotechnology and Biological Sciences Research Council
BGS	British Geological Survey
BIS	Department for Business, Innovation and Skills
BREEAM	Building Research Establishment Energy Assessors
CarDio	carbon diagnostic tool
CARES	Community And Renewable Energy Scheme
CARIAA	Collaborative Adaptation Research Initiative in Africa and Asia
CCA	Climate Change Agreements
CCAA	Climate Change Adaptation in Africa
CCC	Committee on Climate Change
CCCEP	Centre for Climate Change Economics and Policy
CCI	Climate Change Initiative
CCL	Climate Change Levy
CCOG	Coordinating Climate Observations Group
CCRA	Climate Change Risk Assessment
CCS	Carbon Capture and Storage
CCW	Climate Change Commission for Wales
CDKN	Climate and Development Knowledge Network
CDM	Clean Development Mechanism
CDs	Crown Dependencies
CEH	Centre for Ecology and Hydrology
CEMS	Climate and Environmental Monitoring from Space

CERT	carbon emissions reduction target
CET	Central England Temperature
CFARR	Chilbolton Facility for Atmospheric and Radio Research
CfDs	Contracts for Difference
CfE	Curriculum for Excellence
CFR	Central Feed-in Tariff Register
CH4	Methane
CHP	Combined Heat and Power
CIFs	Climate Investment Funds
CLG	Department for Communities and Local Government
CO	Carbon Monoxide
CO2	Carbon dioxide
COP	Conference of the Parties
CP3	Climate Public Private Partnership programme
CPF	carbon price floor
CPS	carbon price support
CRF	Common Reporting Format
CTC	Climate Technology Centre
CTC-N	CTC-Network
CTF	Clean Technology Fund
DA	Devolved Administration
DA	Devolved Administrations
DCLG	Department for Communities and Local Government
DECC	Department of Energy & Climate Change
Defra	Department for Environment, Food and Rural Affairs
DETINI	Department for Enterprise, Trade and Investment
DFID	Department for International Development
DfT	Department for Transport
DNOs	distribution network operators
DOE	Department of the Environment (Northern Ireland)
EA	Environment Agency
EA's	Environment Agency's
EAS	Energy Assistance Scheme
EC	European Commission
ECO	Energy Company Obligation
ECVs	Essential Climate Variables
EEDO	Energy Efficiency Deployment Office
EO	Earth Observation
EPCs	Energy Performance Certificate
EPS	Emissions Performance Standard
EPSRC	Engineering and Physical Sciences Research Council
ESA	European Space Agency
ESC	Ecological Site Classification
ESD	Effort Sharing Decision
ESM	Earth System Modelling
ESOS	Energy Saving Opportunity Scheme
ESPA	Ecosystem Services for Poverty Alleviation
ESRC	Economic and Social Research Council
ESRC	Economic and Social Research Council's
ETI	Energy Technologies Institute

EU	European Union
EU ETS	European Emissions Trading System
EUAAs	European Union Aviation Allowances
EUAs	European Union Allowances
EUMM	EU Monitoring Mechanism
EWI	external wall insulation
FCO	Foreign & Commonwealth Office
FFBC	Farming For A Better Climate
FGMC	Forest Governance, Markets and Climate
FIP	Forest Investment Programme
FITs	Feed-in Tariffs
FLEGT	Forest Law Enforcement, Governance and Trade
FQD	Fuel Quality Directive
GCC	Global Collecting Centres
GCOS	Global Climate Observing System
GCP	Global Carbon Project
GDP	Gross Domestic Product
GHG	Greenhouse gas
GHGAP	Greenhouse Gas Action Plan
GLOSS	Global Sea Level Observing System
GRA	Global Research Alliance
GRDC	Global Runoff Data Centre
GSN	GCOS Surface Network
GTN-R	Global Terrestrial Network for River Discharge
GVA	Gross Value Added
GWP	global warming potential
HEFCE	Higher Education Funding Council for England
HEFCW	Higher Education Funding Council Wales
HFC	Hydrofluorocarbons
HFCF	hydrochlorofluorocarbons
HFCs	Hydrofluorocarbons
HIE	Highlands and Islands Enterprise
HMG	Her Majesty's Government
HMT	Her Majesty's Treasury
IAGP	Integrated Assessment of Geoengineering Proposals
ICAO	International Civil Aviation Organization
ICF	International Climate Fund
ICOADS	International Comprehensive Ocean-Atmosphere Data Set
ICSU	International Council for Science
IDC	International Data Centre
IGAC	International Global Atmospheric Chemistry
ILUC	indirect land use change
IPCC	Intergovernmental Panel on Climate Change
IPHE	International Partnership for Hydrogen and Fuel Cells in the Economy
IPPC	Integrated Pollution Prevention Control
ISIU	BIS International Science and Innovation Unit
JCCF	Junior Climate Challenge Fund
JPI FACCE	Joint Programming Initiative on Food Security and Climate Change
JWCRP	Joint Weather and Climate Research Programme
kWh	Kilowatt-hour

LATS	Landfill Allowance Trading Scheme
LCBP	Low Carbon Buildings programme
LCF	Low Carbon Fuels
LCICG	Low Carbon Innovation Coordination Group
LEPs	Local Enterprise Partnerships
LGA	Local Government Association
LPG	liquefied petroleum gas
LSE	London School of Economics and Political Science
LULUCF	Land use, land-use change and forestry
LWEC	Living With Environmental Change
MCS	Microgeneration Certification Scheme
MDB	Multilateral Development Bank
MEPS	minimum energy performance standards
MIDAS	motorway incident detection system
MOHC	Met Office Hadley Centre
MRC	Medical Research Council
MSCC	Marine Science Coordination Committee
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MtCO2-eq	Million tonnes of carbon dioxide equivalent
MTOE	Million tonnes of oil equivalent
MWH	Megawatt-hour
N2O	Nitrous oxide
NAP	National Adaptation Programme
NCA	National Character Area
NCIC	National Climate Information Centre
NDRC	National Development and Reform Commission
NE	Natural England
NERC	Natural Environment Research Council
NEWP	Natural Environment White Paper
NGLA	National Groundwater Level Archive
NHBC	National House Building Council
NHS	National Health Service
NIA	Nature Improvement Area
NIAP	Northern Ireland Adaptation Programme
NICs	National Insurance Contributions
NIEA	Northern Ireland Environment Agency
NIR	National Inventory Report
NIRDP	Northern Ireland Rural Development Programme
NISC	Inventory Steering Committee
NISEP	Northern Ireland Sustainable Energy Programme
NMVOC	Non-Methane Volatile Organic Compounds
NOAA	National Oceanic and Atmospheric Administration
NOx	Nitrogen Oxides
nrg4SD	Network of Regional Governments for Sustainable Development
NRW	Natural Resources Wales
NTSLF	National Tidal and Sea Level Facility
OBR	Office for Budget Responsibility
OECD	Organisation for Economic Co-operation and Development
Ofwat	Office of Water Services
OLEV	Office for Low Emission Vehicles

OTs	Overseas Territories
PAP	Porcupine Abyssal Plain
PASSAGE	Prosperity and Sustainability in the Green Economy
PAYE	Pay As You Earn
PFCs	Perfluorocarbons
PHE	Public Health England
PI	Performance Indicator
PIPs	Plugged-in Places
PISCES	Policy Innovation Systems for Clean Energy Security
PMR	Partnership for Market Readiness
PPCR	Pilot Programme for Climate Resilience
PRECIS	Providing Regional Climates for Impacts Studies
PRN	Packaging Recovery Note
PSE	Personal and Social Education
PSV	public service vehicles
PV	Photovoltaics
QA	Quality Assurance
QC	Quality Control
QCF	Qualification Credit Framework
REACT	Renewable Energy and Adapting to Climate Technologies
RBCN	Regional Basic Climate Network
RCE Network	Regional Centres of Expertise
RCEP	The Research Councils Energy Programme
RD&D	research, development and demonstration
RED	Renewable Energy Directive
REDD	Reducing Emissions from Deforestation and Forest Degradation
RFTCs	Renewable Transport Fuel Certificates
RFTO	Renewable Transport Fuels Obligation
RGF	Revolving Green Fund
RHI	Renewable Heat Incentive
RHPP	Renewable Heat Premium Payment
RO	Renewables Obligation
ROCs	Renewables Obligation Certificates
RPI	Retail Price Index
RTFO	Renewable Transport Fuel Obligation
SAP	Standard Assessment Procedure
SAPs	Sectoral Adaptation Plans
SAWG	South Asia Water Governance Programme
SAWS	South African Weather Service
SCCAN	Scottish Communities Climate Action Network
SCCF	Special Climate Change Fund
SE	Scottish Enterprise
SEAD	Super Efficient Appliance Deployment Initiative
SEPA	Scottish Environment Protection Agency
SF6	Sulphur hexafluoride
SLRG	Sustainable Lifestyles Research Group
SMEs	Small and Medium Sized Enterprises
SO2	Sulphur dioxide
SPLiCE	Sustainable Pathways for Low Carbon Energy Research Programme
SPRG	Sustainable Practices Research Group

SR	Spending Review
SRDP	Scotland Rural Development Programme
SREP	Scaling Up Renewable Energy Programme
SRUC	Scotland's Rural College
SSC	Sector Skills Councils
STFC	Science and Technology Facilities Council
SWIMS	Severe Weather Impacts Monitoring System
TINAs	Technology Innovation Needs Assessments
TSB	Technology Strategy Board
TWh	Terawatt-hours
UK	United Kingdom
UK-GEM	UK Global Environmental Model
UKCDS	UK Collaborative on Development Sciences
UKCP09	UK Climate Projections (2009)
UKEOF	UK Environmental Observation Framework
UKERC	UK Energy Research Centre
UKFS	UK Forestry Standard
ULEV	ultra low emissions vehicles
UNFCCC	United Nations Framework Convention on Climate Change
UPGro	Unlocking the Potential for Groundwater in Africa
VAT	Value Added Tax
VED	Vehicle Excise Duty
VOS	Voluntary Observing Ships
WBQ	Welsh Baccalaureate Qualification
WFD	Water Framework Directive
WHQS	Welsh Housing Quality Standard

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