Department for
Business, Energy
& Industrial Strategy

7th National Communication

December 2017

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Contents

Foreword by Minister of State for Climate Change and Industry

Climate change is one of the most urgent and pressing challenges we face today, and the UK is committed to tackling it.

The UK was the first country to introduce legally binding emission reduction targets through the Climate Change Act, and we played our part in securing the agreement of 195 countries to sign up to the historic Paris Climate Agreement. It is an unprecedented multilateral partnership demonstrating a real commitment and collective responsibility for our planet.

We are already making progress on the Paris Agreement, as evidenced by our strong domestic performance. The UK has been among the most successful countries in the developed world in growing our economy while reducing emissions, and the recently published Clean Growth Strategy sets out ambitious policies and proposals to meet our carbon reduction targets while seizing the opportunities of clean growth.

The global shift to clean growth is one of the most foreseeable and significant global economic trends. Our Clean Growth Grand Challenge aims to make the UK a world leader in the development, manufacture and use of clean technologies, systems and services that cost less than the high carbon alternatives.

Our most recent analysis shows that the UK's performance against our carbon reduction targets has improved, and I am proud to set out in this National Communication the strong progress that the UK has already made.

We are also committed to helping developing countries meet their objectives. The UK is among the largest contributors of climate finance, committing to provide at least £5.8 billion from 2016 to 2020, to help developing countries mitigate and adapt to the impacts of climate change, reduce deforestation and support cleaner economic growth.

Our climate finance is helping developing countries reduce their emissions and deal with the impacts of climate change by building their capacity to take action themselves and by catalysing large scale public and private finance investments.

So far, our climate finance has helped 34 million people cope with the effects of climate change; supported 12 million people to access clean energy; reduced or avoided 9.2 million tons of CO_2 and leveraged £2.2bn of public finance and £500m of private finance.

Achieving the clean growth we need will require everyone to play their part – governments, businesses and civil society working together. The prize will be driving and capturing the benefits and opportunities of the world's low carbon future – this document sets out our progress towards that goal.

Claire Perry MP

Executive Summary

The UK was one of the first countries to recognise and act on the economic and security threats of climate change. The Climate Change Act, passed in 2008, committed the UK to reducing greenhouse gas emissions by at least 80 per cent by 2050 when compared to 1990 levels, through a process of setting five year caps on greenhouse gas emissions termed 'Carbon Budgets'. This approach has now been used as a model for action across the world, and is mirrored by the United Nations' Paris Agreement.

The UK has been among the most successful countries in the developed world in growing its economy while reducing emissions. Since 1990, the UK Government has cut emissions by 42 per cent[1] while our economy has grown by two thirds[2]. This means that we have reduced emissions faster than any other G7 nation, while leading the G7 group of countries in growth in national income over this period[3].

This progress has meant that the UK has outperformed the target emissions reductions of its domestically set first carbon budget (2008 to 2012) by one per cent and projects that it will outperform against our second and third budgets, covering the years 2013 to 2022, by about four per cent and six per cent respectively[4]. In doing so, we also expect to over-achieve our international commitments under the Kyoto Protocol. The UK economy is expected to grow by 12 per cent over that time[5], representing a significant achievement.

The UK has made progress across every sector of our economy. This progress has been aided by the falling costs of many low carbon technologies, resulting in new high value jobs, industries and companies. This progress has altered the way that we see many of the trade-offs between investing in low carbon technologies that help secure our future but that might incur costs today. It is clear that actions to cut emissions can be a win-win: cutting consumer bills, driving economic growth, creating high value jobs and helping to improve quality of life.

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1 BEIS (2017) BEIS UK emissions statistics 1990-2016 https://www.gov.uk/government/statistics/provisional-uk-greenhouse-gas-emissions-national-statistics-2016

2 ONS (2016) Quarterly National Accounts Statistical bulletins (Series ABMI. Seasonally adjusted chained volume measures) https://www.ons.gov.uk/economy/grossdomesticproductgdp/timeseries/abmi

3 Figures on per capita basis. OECD (retrieved September 2017) http://stats.oecd.org/index.aspx?DataSetCode=PDB_LV; World Resources Institute (2017) CAIT Climate Data Explorer http://cait.wri.org

4 Figures available in Energy and Emission Projection report due to be published in January 2018

5 OBR (March 2017) Economic and Fiscal Outlook http://budgetresponsibility.org.uk/efo/economic-fiscal-outlook-march-2017/; OBR (January 2017) FiscalSustainability Report http://budgetresponsibility.org.uk/fsr/fiscal-sustainability-report-january-2017/

The UK has also been leading the way internationally. We played an important role in securing the historic Paris Agreement in 2015 and we are fully committed to its implementation. We are also supporting other countries in implementing their commitments through our International Climate Fund: from 2011/12 to 2015/16 we provided £3.87bn and we have pledged to spend a further £5.8bn in climate finance through to 2020/21.

The devolved administrations of Scotland, Wales and Northern Ireland contribute to the UK's overall climate objectives as outlined throughout this report. For example, Scotland has its own domestic climate change legislation and statutory emissions reduction targets. Sustained progress has been made towards these targets, with the last two annual targets (for 2014 and 2015) having been met and emissions reductions well on track to exceed the interim 2020 target of a 42% reduction from baseline levels. The package of policies and proposals to meet Scotland's future targets is set out in statutory Climate Change Plans. In response to the UNFCCC Paris Agreement, the Scottish Government has proposed new domestic legislation to raise the level of its emissions reduction targets[6]. Since 2010 Wales has been achieving its non-statutory target for 3% year-on-year emissions reduction in devolved policy areas. To contribute to this target, the Welsh Government has reduced emissions from its administrative estate by 45% since 2010/11. The Environment (Wales) Act 2016 provides Wales with its own climate change legislation and statutory framework. In 2018 the Welsh Government will set interim targets to 2050 and its first two carbon budgets. A plan for meeting the first budget will follow in 2019.

This report covers the UK's Seventh National Communication and Third 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

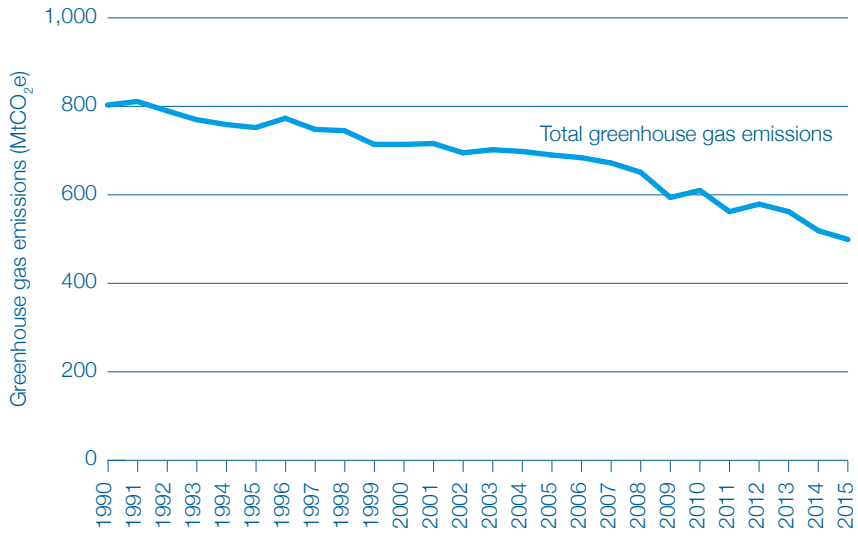
- The UK population in 2016 was 65.6 million, with nearly 84% of the population resident in England. The UK population is predicted to rise to over 70 million by 2030.
- The UK covers over 24 million hectares. In 2016 around 71% of this is used for agricultural use.
- In March 2017 the Office for Budget Responsibility forecast GDP growth of 2.0% in 2017, 1.6% in 2018, and then 1.7% in 2019, 1.9% in 2020 and 2.0% in 2021.
- Eight of the ten warmest years recorded for the UK have been since 2002, with all top ten warmest years occurring since 1990.
- Climate projections indicate that all areas of the UK will get warmer during the 21st century, more so in summer than in winter.

[6] Information on action in Scotland available at www.gov.scot/climatechange

Chapter 2: Greenhouse gas emissions inventory

- In 2015, UK greenhouse gas (GHG) emissions on a UNFCCC basis were 499.4 million tonnes of carbon dioxide equivalent ($MtCO_2e$) – 37.8% lower than 1990 levels.[7]
- Between 1990 and 2015 carbon dioxide emissions including LULUCF fell by 32.0%. Methane emissions fell by 61.1% and nitrous oxide emissions fell by 54.8%.
- Between 1990 and 2015, hydrofluorocarbons emissions increased by 10.9%, perfluorocarbons emissions fell by 80.2%, and sulphur hexafluoride emissions fell by 64.2%.
- The reduction in GHG emissions since 1990 has been due to a reduction in many sectors. These include; restructuring in the energy supply industry (concerted move away from coal and oil generation towards use of gas and renewables), energy efficiency, pollution control measures in the industrial processes sector and other policies that reduced emissions of non-carbon dioxide GHGs, most notably the increase in landfill methane capture and oxidation.

Figure 1: Total emissions of GHGs, 1990–2015, $MtCO_2e$



Source: 2015 UK GHG Inventory

Chapter 3: Policies and Measures

- In 2016, 47 per cent of UK electricity came from low carbon sources, around double the level in 2010[8], and the UK now has the largest installed offshore wind capacity in the world. Homes and commercial buildings in the UK have become more efficient in the way they use energy which helps to reduce emissions and also cut energy bills, for example average household energy consumption has fallen by 17 per cent since 1990.[9]

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7 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).

8 BEIS (2017): Digest of UK Energy Statistics 2017 https://www.gov.uk/government/statistics/energy-chapter-1-digest-of-united-kingdom-energy-statistics-dukes

9 BEIS (2017) Energy Consumption in the UK https://www.gov.uk/government/statistics/energy-consumption-in-the-uk Change in average consumption per household 1990-2016

- Automotive engine technology has helped drive down emissions per kilometre driven by up to 16 per cent and driving a new car bought in 2015 will save car owners up to £200 on their annual fuel bill, compared to a car bought new in 2000.[10] England also recycles nearly four times more than it did in 2000.[11]
- This progress has been aided by the falling costs of many low carbon technologies: renewable power sources like solar and wind are comparable in cost to coal and gas in many countries[12]; energy efficient light bulbs are over 80 per cent cheaper today than in 2010[13]; and the cost of electric vehicle battery packs has tumbled by over 70 per cent in this time.[14]
- This progress has meant that the UK has outperformed the target emissions reductions of its domestically set first carbon budget (2008 to 2012) by one per cent and projects that it will outperform against our second and third budgets, covering the years 2013 to 2022, by about four per cent and six per cent respectively.[15]

Chapter 4: Projections

- In 2015, emissions of the basket[16] of six greenhouse gases (GHGs) covered by the Kyoto Protocol are estimated to be 499 million tonnes of carbon dioxide equivalent ($MtCO_2e$), 38% lower than the 1990 level of 802 $MtCO_2e$. Emissions of the basket are projected to fall to 414 $MtCO_2e$ (48% below the 1990 level) by 2020 and 382 $MtCO_2e$ by 2030 (52% below the 1990 level).
- Emissions of carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) are projected to be 44%, 65% and 57% respectively, below 1990 levels by 2020. Emissions of the fluorinated GHGs (Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs) and sulphur hexafluoride (SF6)) are collectively projected to be 33% below their 1990 level in 2020.
- Since the 6th National Communication, the UK has implemented further policies to help meet its EU effort sharing, renewable energy and energy efficiency targets, and the targets for the Carbon Budgets[17] set under the 2008 Climate Change Act.[18] The UK met the first carbon budget with headroom of 36 $MtCO_2e$, and is projected to meet the second and third carbon budgets with headroom of 125 and 143 $MtCO_2e$, respectively. There are projected shortfalls against the fourth and fifth carbon budgets of 94 $MtCO_2e$ and 196 $MtCO_2e$, respectively. As policies and proposals in the

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10 Annual average household saving from driving a car purchased new in 2015 (the latest year for which data is available) compared to driving a car purchased new in 2000. Fuel savings valued using 2015 prices. DfT (2017) National Travel Survey; DfT (2017) Vehicles Statistics; ICCT (2015) From Laboratory to Road; BEIS (2016) Green Book supplementary appraisal guidance

11 Defra (2016) ENV18 – Local authority collected waste: annual results tables: https://www.gov.uk/government/statistical-data-sets/env18-local-authority-collected-waste-annual-results-tables

12 New Climate Economy (2014) Better Growth, Better Climate http://newclimateeconomy.report/

13 International Energy Agency (2016) Energy Efficiency Market Report https://www.iea.org/eemr16/files/medium-term-energy-efficiency-2016_WEB.PDF

14 Bloomberg New Energy Finance (2016) 2016 lithium-ion battery price survey https://www.bnef.com/core/insights/15597

15 Figures available in Energy and Emission Projection report due to be published in January 2018

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

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

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

Clean Growth Strategy[19] are developed more fully, their impacts will be included as appropriate in future projections.

Chapter 5: Vulnerability assessment, Climate Change impact and adaptation measures

- **Government Action** – Since the publication of the 6th National Communication (2013), the UK has successfully passed a number of further significant milestones, including the publication of the country's second Climate Change Risk Assessment (2017) and two statutory assessments of progress (2015 and 2017) on the first National Adaptation Programme.
- **UK Climate Projections** – The UK's climate projections were released in summer 2009 (UKCP09) and relate to current and future climate change up to 2100. They were used in both the first and second UK Climate Change Risk Assessments published in January 2012 and 2017. We have been working towards updating these projections in 2018 (UKCP18). Work builds upon the current set of projections to provide the most up-to date assessment of how the climate of the UK may change over the 21st century. UKCP18 will update the probabilistic projections over land and provide a set of high-resolution spatially-coherent future climate projections for the globe at 60km scale and for the UK at 12km scale. Projections will be further downscaled to a level previously only used for short-term meteorological modelling allowing realistic simulation of high impact events such as localised heavy rainfall in summer. The marine projections will also be updated for sea-level rise and storm surge.
- **UK Climate Change Risk Assessment** – The Climate Change Act 2008 requires a Climate Change Risk Assessment (CCRA) to be completed every five years. The first UK CCRA was published in January 2012 and identified over 700 risks to the UK from a changing climate. The second CCRA was published in January 2017 and outlines the UK and Devolved Governments' views on the key climate change risks and opportunities that the UK faces. Six priority risk areas have been identified where further action is needed in the next five years.
- **The National Adaptation Programme** –The first National Adaptation Programme (NAP) was published in July 2013 covering England and non-devolved climate adaptation matters, as required by the Climate Change Act 2008. Assessments of progress in implementing the NAP, also required every two years by the Climate Change Act, were completed in June 2015 and 2017 by the independent Adaptation Sub-Committee of the Committee on Climate Change. The 2017 assessment concluded that actions in the NAP have largely been completed, identifying where progress is being made or where further efforts are needed to reduce vulnerability.

Chapter 6: Financial Assistance and Support for technologies

- Building on the provision of £3.87 billion in **International Climate Finance (ICF)** between 2011/12-2015/16, the UK has committed to further scale up climate finance by providing at least £5.8 billion between 2016/17-2020/21 The UK's ICF helps developing countries mitigate and adapt to the impacts of climate change, reduce deforestation and pursue clean economic growth. The ICF is focussed on transformational change, reflecting the scale of the challenge of climate change. This

[19] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/651916/BEIS_The_Clean_Growth_online_12.10.17.pdf

includes unlocking the potential of the private sector, with UK ICF funding mobilising £500m in private finance to date.

- Since 2011, the UK has used its ICF to install more than 400 megawatts of clean energy capacity and to reduce or avoid 9.2m tonnes of CO_2. These impacts will continue to grow as new and ambitious programmes like the £177.5m Sustainable Infrastructure Programme are delivered. The UK continues to apply and share lessons learned from its ICF extensive monitoring & evaluation framework, improving effectiveness and enhancing transparency.
- Recognising that adaptation is a priority for many developing countries, the UK aims to spend half of its climate finance on adaptation, and achieved this aim in 2016. Since 2013, the UK has provided over £1.2 billion to support more than 34 million people adapt to the impacts of climate change.
- The UK is committed to an effective international climate finance architecture, and has been one of the largest contributors to major multilateral climate funds like the Green Climate Fund (£720 million) and the Clean Technology Fund (£701 million). We have also supported multi-lateral development bank ambition as they scale up their activities towards their 2020 climate finance pledges.
- We have supported international knowledge generating organisations such as the Intergovernmental Panel on Climate Change and Mission Innovation, amongst others.
- Through its ICF and other international action, the UK is continuing to scale up support towards the shared developed country goal of jointly mobilising $100 billion per year in climate finance from a range of sources by 2020/21. Beyond this, the UK is focussed on helping developing countries put in place the conditions to align finance flows with low greenhouse gas and climate resilient development, including by creating the right conditions to unlock green investment for Nationally Determined Contributions (NDCs) and by phasing out the most polluting activities.

Chapter 7: Research and Systematic Observations

The UK is committing to research on both climate science and observations, and mitigation and adaptation actions. Selected highlights include:

- Funding two major research programmes on a global temperature rise of 1.5°C to contribute to the body of evidence to be assessed by the IPCC in its Special Report on Global Warming of 1.5°C.
- Publication of the second UK Climate Change Risk Assessment, setting out the priority risks and opportunities for the UK posed by climate change.
- Continued work under the world-leading Met Office Hadley Centre Climate Programme, with the work plan for 2018-2021 now in place. This plan will help the UK meet the needs of the post-Paris science agenda.
- Continued UK support for the IPCC, through government funding and through the contributions of the UK's world-leading research community.
- Major collaborative projects with international partners, such as the Climate Science for Service Partnership China and the Ganga Delta – Bay of Bengal Interactions programme with India.
- UK involvement in the Sentinel programme, which has included provision of the satellite platform for the Sentinel-5 Precursor mission. This was successfully launched

in October 2017, bridging the data gap between Envisat and Sentinel-5 providing measurements of greenhouse gas concentration in the atmosphere.

- Significant investment in UK funding for science and innovation: £2.5 billion of public funding is expected to be invested in research, development and demonstration of low-carbon energy, transport, agriculture and waste between 2015 and 2021.
- Pioneering programme of work on Greenhouse Gas Removal Technologies and their implications.
- Work with European partners on the development of MicroCarb, a satellite monitoring system for CO_2 sources and sinks across the whole earth.
- The continued development of the UK DECC (Deriving Emissions linked to Climate Change) Network of tall towers. This provides top down verification of the UK's emission inventory.

Chapter 8: Education, training and public awareness

- Climate Change, and broader sustainability issues, feature in the educational curricula of the UK and its devolved administrations.
- Since the Sixth National Communication, the UK has continued to develop the 2050s Global calculator, as well as supporting 10 countries in developing their own calculators. All 10 calculators have now been launched, along with Global calculator.
- The launch of the Government's Clean Growth Strategy included a dedicated Green Britain week to focus on climate and air quality issues across the UK.

Chapter 1 – National Circumstances

1.1 Key developments

- The UK population in 2016 was 65.6 million, which was 8.4 million more (15%) than in mid-1990. The UK population is predicted to rise to over 74 million by 2039.
- The UK covers over 24 million hectares. In 2016 around 71% of this is used for agricultural use.
- The area of woodland in the UK at 31 March 2017 is 3.2 million hectares. Of this total, 1.4 million hectares (45%) is in Scotland, 1.3 million hectares (41%) is in England, 0.3 million hectares (10%) is in Wales and 0.1 million hectares (4%) is in Northern Ireland.
- Eight of the ten warmest years recorded for the UK have been since 2002, with all top ten warmest years occurring since 1990. By 2080, UK daily minimum temperatures are set to rise by up to 4ºC or more, depending on the region and the future emissions.
- In March the Office for Budget Responsibility forecast GDP growth of 2.0% in 2017, 1.6% in 2018, and then 1.7% in 2019, 1.9% in 2020 and 2.0% in 2021.
- Total energy production in the UK has fallen between 2000 and 2014; driven by a sharp decrease in primary oil, gas and coal production. Since 2014 total energy production has increased due to increases in primary oil and gas production from new fields commencing production.
- In 2016, 42% of total production came from primary oil, 32% from natural gas, 16% from primary electricity (nuclear, wind, natural flow hydro and imports), 2% from coal and 9% from other renewables (bioenergy and waste).
- The UK's long term strategy to reduce transport emissions includes the Renewable Transport Fuels Obligation (RFTO), which requires 9.75% of transport fuel sold in the UK to come from renewable sources by 2020.
- In 2015 households in the UK produced 26.7 million tonnes of waste, a reduction of 1% since 2010. In 2015, 44.3% of waste from households was recycled in the UK; this is an increase from the rate of 43.9% achieved in 2014. Local Authorities recycled, composted or reused 9.8 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 2014 there were around 28 million dwellings in the UK, of which 23.4 million were in England.
- In June 2016, the total number of cattle and calves in the UK saw a 1% increase, to around 10 million. The total number of pigs in the UK increased by 2.7% between June 2015 and June 2016, to just below 4.9 million. The total number of sheep and lambs in the UK increased by 1.8% between June 2015 and June 2016, to just below 34 million.

1.2 Introduction

This chapter presents a brief description of the UK's national circumstances and how changes in national circumstances affect GHG emissions over time.

The UK has international targets for reducing greenhouse gas (GHG) emissions. The first commitment period of the Kyoto Protocol required that UK GHG emissions were reduced by 12.5% below base year levels over the 2008-12 period, which the UK met. Under the second commitment period (2013-2020), the EU and the Member States, Iceland and Norway have a collective target to reduce its emissions by 20 per cent relative to base year levels. The UK has now ratified the Doha Amendment, but it has not yet come into force. This report therefore does not include information on the UK's progress against its second commitment period.

Information on legal entities authorised to participate in mechanisms under Articles 6, 12 and 17 of the Kyoto Protocol can be found on the UK Emissions Registry website in the Kyoto Protocol Public Reports.[20] Further information on institutional measures are outlined in section 2.3 of this report.

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, Energy and Industrial Strategy (BEIS), the Department for Transport (DfT), the Department for Communities and Local Government (DCLG), the Department for International Development (DfID), the Department for the Environment, Food and Rural Affairs (Defra), Her Majesty's Treasury (HMT).

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[21]
- Welsh Government[22]
- Northern Ireland Executive[23]

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[20] https://ets-registry.webgate.ec.europa.eu/euregistry/GB/public/reports/publicReports.xhtml

[21] http://home.scotland.gov.uk

[22] http://wales.gov.uk/

[23] http://www.northernireland.gov.uk/

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[24], 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.

HMG is split into 25 ministerial departments and 21 non-ministerial departments. Each department focuses on a different aspect of government policy, including:

- The Department for Business, Energy and Industrial Strategy 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[25], who produce the official population estimates for the UK and its constituent countries.

The total population of the UK was estimated to be 65.6 million in mid-2016, which was 8.4 million more (15% more) than in mid-1990. 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 40.0 in 2016. The population aged greater than 64 years increased from 15.7% in 1990 to 18% in 2016. The male to female ratio of the UK population has remained steady between 1990 and 2016 at approximately 49% to 51%.

Table 1: Mid-year population estimates, UK, 1990-2016

	Total population (thousands)	Male population (thousands)	Female population (thousands)	Median Age (years)	Percentage of population aged less 16 years	Percentage of population aged 16 to 64	Percentage of population aged more than 64 years
1990	57,237	27,819	29,419	35.8	20.2%	64.0%	15.7%
2000	58,886	28,690	30,196	37.6	20.3%	63.9%	15.8%
2010	62,759	30,805	31,954	39.5	18.8%	64.8%	16.4%
2015	65,110	32,074	33,036	40.0	18.8%	63.3%	17.8%
2016	65,648	32,378	33,270	40.0	18.9%	63.1%	18.0%

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

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

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

The UK is expected to see a continued growth in population, as shown in Table 2. The population is projected to increase to 74.3 million by 2039 an increase equivalent to an average annual rate of growth of 0.5% between 2016 and 2039.[26]

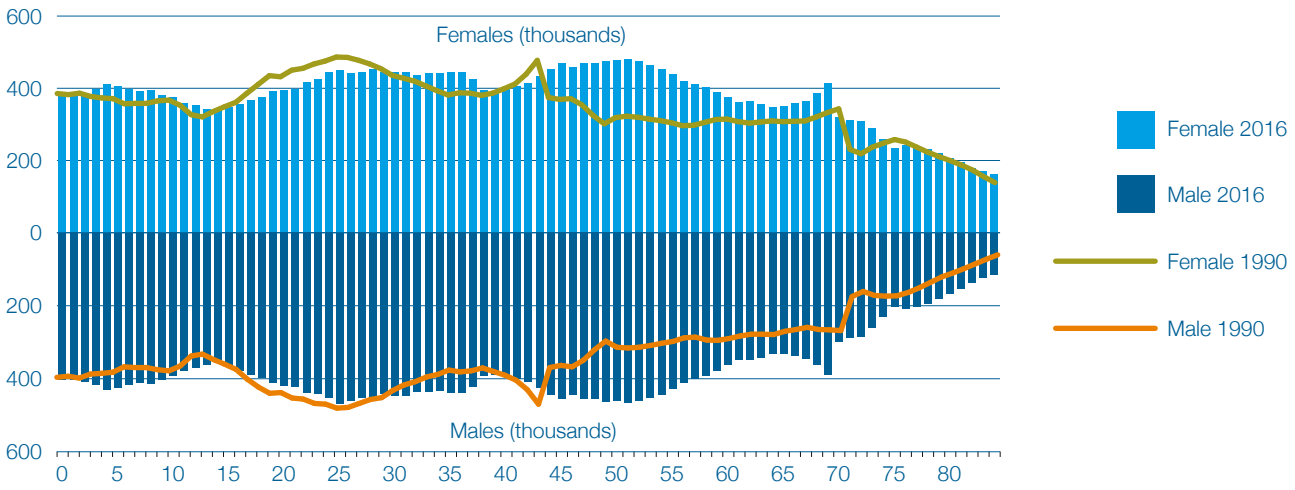
If past trends continue, the UK population will continue to grow, reaching 74.3 million by 2039. Assumed net migration accounts for 51% of the projected increase over the next 25 years, with natural increase (more births than deaths) accounting for the remaining 49% of growth

Table 2: Population projections in the UK by country, 2014 to 2039

						Millions
	2014	2019	2024	2029	2034	2039
United Kingdom	64.6	66.9	69.0	71.0	72.7	74.3
England	54.3	56.5	58.4	60.2	61.8	63.3
Wales	3.1	3.1	3.2	3.2	3.3	3.3
Scotland	5.3	5.4	5.5	5.6	5.7	5.7
Northern Ireland	1.8	1.9	1.9	2.0	2.0	2.0

Source: Office for National Statistics

Figure 2: Population pyramid for the UK, mid-2016 (blue bars) compared with mid-1990 (orange and green lines)



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-2016 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 (around age 70) and during the baby boom of the 1960s.
- The sharp narrowing of the pyramid for people aged around 15 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.

[26] https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationprojections/bulletins/nationalpopulationprojections/2015-10-29

- Females outnumber males at older ages, reflecting the higher life expectancy of females.

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.

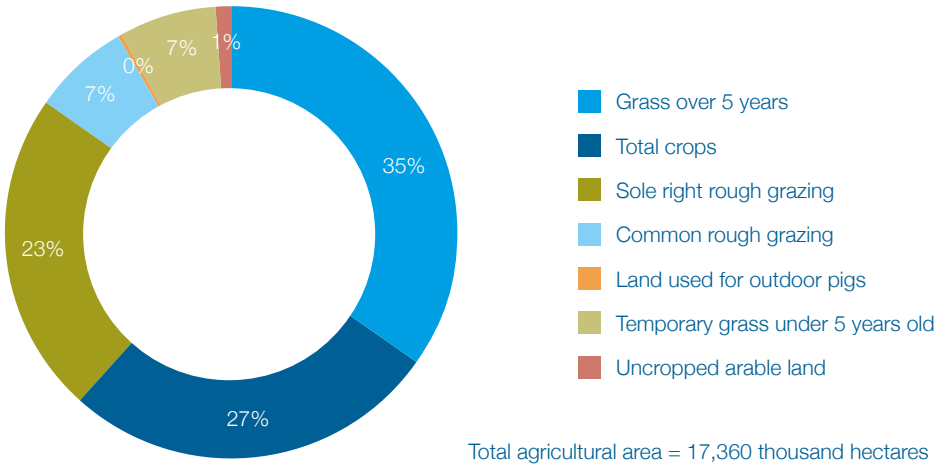
There are fourteen overseas territories:

- 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 2016, around 71% (17.4 million hectares) of the total UK land area was used for agriculture; Figure 3 shows UK land use data for the total agricultural area at June 2016[27]. In total, total agriculture area saw a 2% increase between 2012 and 2016, whereas total croppable area decreased by 3%. The biggest change in agricultural land use was seen in uncropped arable land which saw a 71% increase since 2012.

[27] Agriculture in the UK 2016: https://www.gov.uk/government/statistics/agriculture-in-the-united-kingdom-2016

Figure 3: Agricultural land use in the UK, 2016



Source: Agriculture in the UK 2016, Department for Environment, Food and Rural Affairs

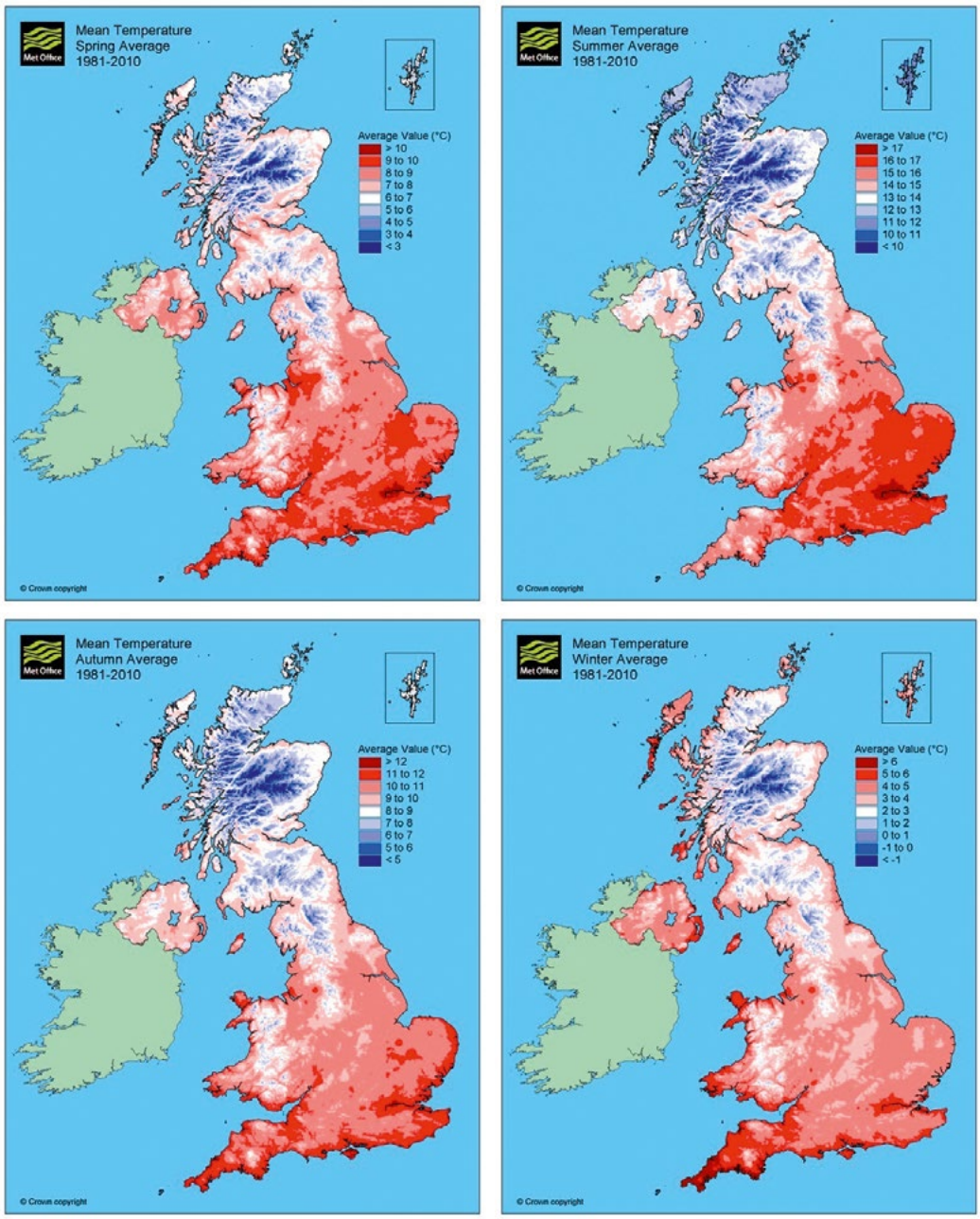
1.6 Climate profile

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 1,400 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 for space heating; and in summer, warmer-than-average temperatures increase demand for space cooling. Figure 4 shows the average daily mean temperature for the UK by season[28].

[28] https://www.metoffice.gov.uk/public/weather/climate

Figure 4: Average (1981-2010) daily temperature (°C) by season, UK



Source: Met Office

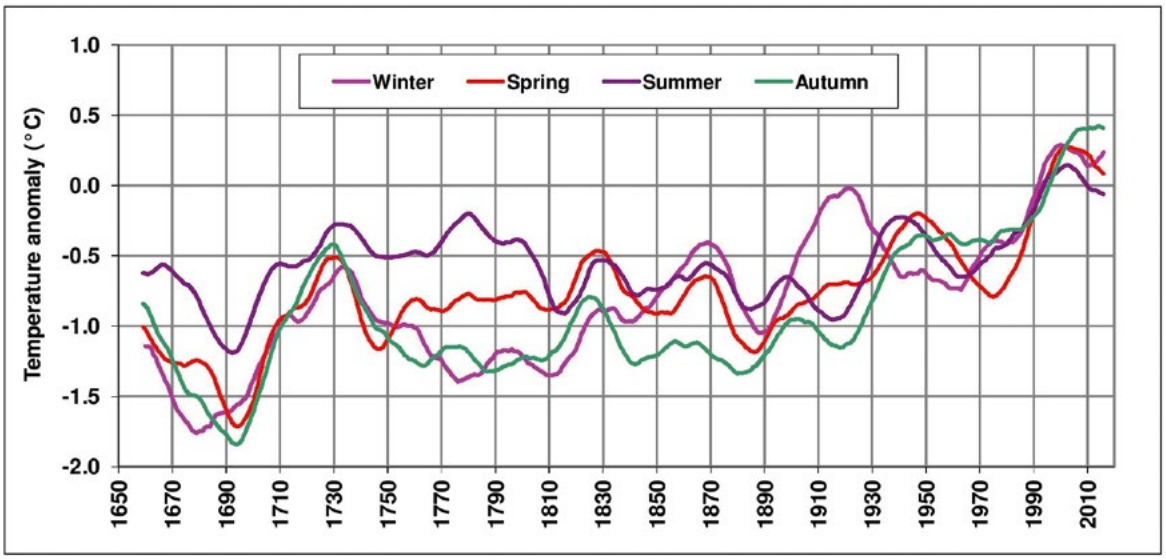
1.6.1 UK Climate trends[29]

1.6.1.1 Temperature

The Central England Temperature (CET) series is the longest-compiled temperature record in the world, beginning in 1659. Figure 5 shows that the CET for the early 21st century has been warmer than the previous three centuries for all seasons of the year.

[29] https://www.metoffice.gov.uk/binaries/content/assets/mohippo/pdf/uk-climate/state-of-the-uk-climate/mo-state-of-uk-climate-2016-v4.pdf

Figure 5: Seasonal Central England Temperature Anomaly series, 1650 to 2016, relative to 1981-2010 average



Source: Met Office: State of the UK Climate 2016

For the UK as a whole, temperature records begin in 1910, showing an increase in temperature from the 1970s to the 2000s with the most recent decade (2007-2016) on average 0.3°C warmer than the 1981-2010 average and 0.8°C warmer than 1961-1990. Eight of the ten warmest years recorded for the UK have been since 2002, with all top ten warmest years occurring since 1990.

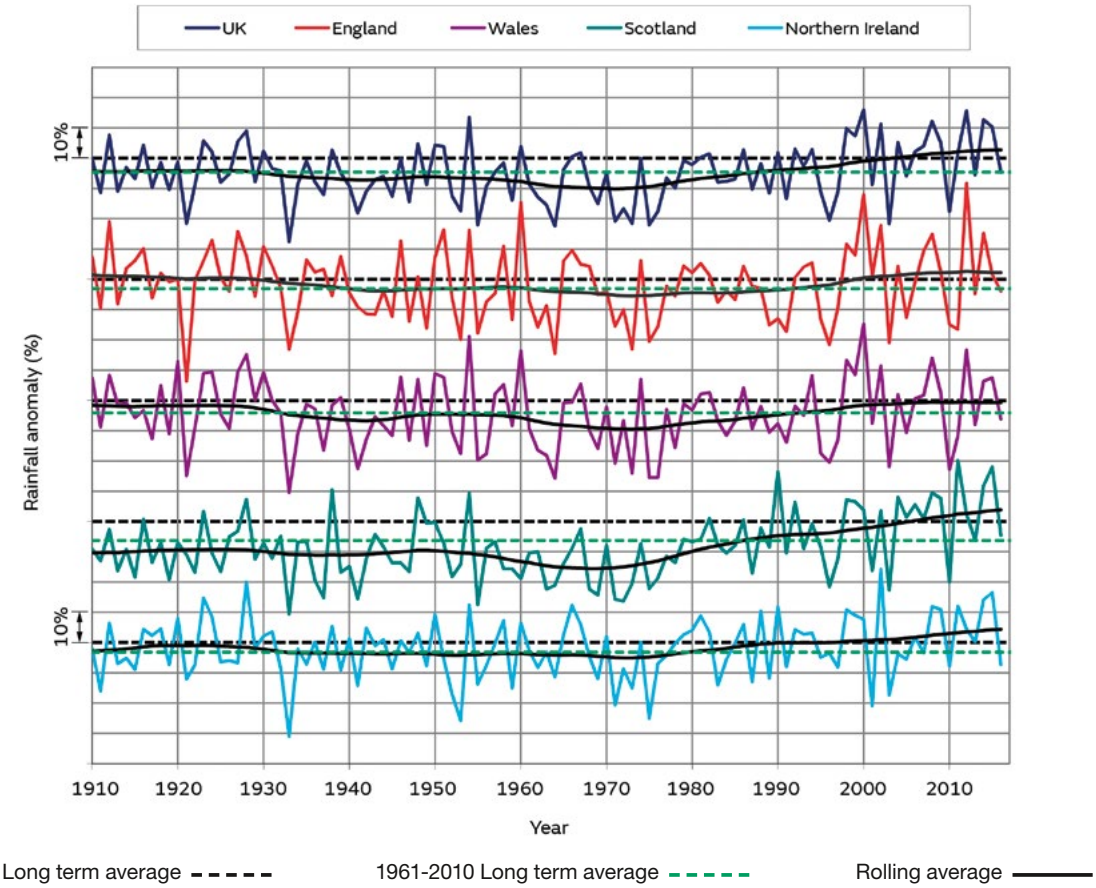
Cold years are still observed despite the warming trend: 2010 was the coldest year recorded since 1990 and the 12th coldest in the UK series since 1910. The effect of this cold year on emissions can be seen in Figure 30, which shows an increase in total UK GHG emissions for 2010.

1.6.1.2 Precipitation

Precipitation data for the UK show a slight increasing trend from the 1970s onwards (Figure 6) that is most pronounced for Scotland for which the most recent decade (2007–2016) has been on average 11% wetter than 1961–1990 and 4% wetter than 1981-2010. Seven of the ten wettest years for the UK have occurred since 1998, in a series beginning in 1910.

The two recent winters of 2013-2014 and 2015-2016 have been considerably wetter than previous years, each with over 150% of the 1981-2010 average UK rainfall. The long-running England and Wales Precipitation (EWP) series shows a marked increase in winter rainfall, offset by a slightly smaller reduction in summer rainfall.

Figure 6: Annual precipitation, UK, 1910–2016, as a percentage of 1981-2010 averages



Source: Met Office: State of the UK Climate 2016

1.6.1.3 Sea level

Mean sea level around the UK has risen by approximately 1.4mm/yr since 1910, when corrected for land movement.

Sea surface temperatures around the UK for the most recent decade (2007-2016) have been on average 0.3°C warmer than the 1981-2010 average and 0.6°C warmer than 1961-1990.

1.6.2 UK climate projections[30]

UK Climate projections presented here are based on climate modelling conducted by the Met Office Hadley Centre in 2009 (UKCP09). Following the Paris Agreement on Climate Change in December 2015, the UK Climate Projections will be updated in 2018 (UKCP18), to make sure decision-makers have the most up-to-date projections on the future of the UK climate. Until UKCP18 is published, UKCP09 will remain the best available evidence for projected changes in the UK climate.[31]

The projections below are summer, winter and annual mean changes by the 2080s (relative to a 1961-1990 baseline) under a medium emissions scenario (IPCC Special Report Emissions Scenario A1B). Central estimates of change (those at 50% probability level) are reported here. The full UKCP09 report additionally presents changes that are very likely to be exceeded and very likely not to be exceeded (10% and 90% probability levels, respectively).

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

[31] http://ukclimateprojections.metoffice.gov.uk/24127

1.6.2.1 Temperature

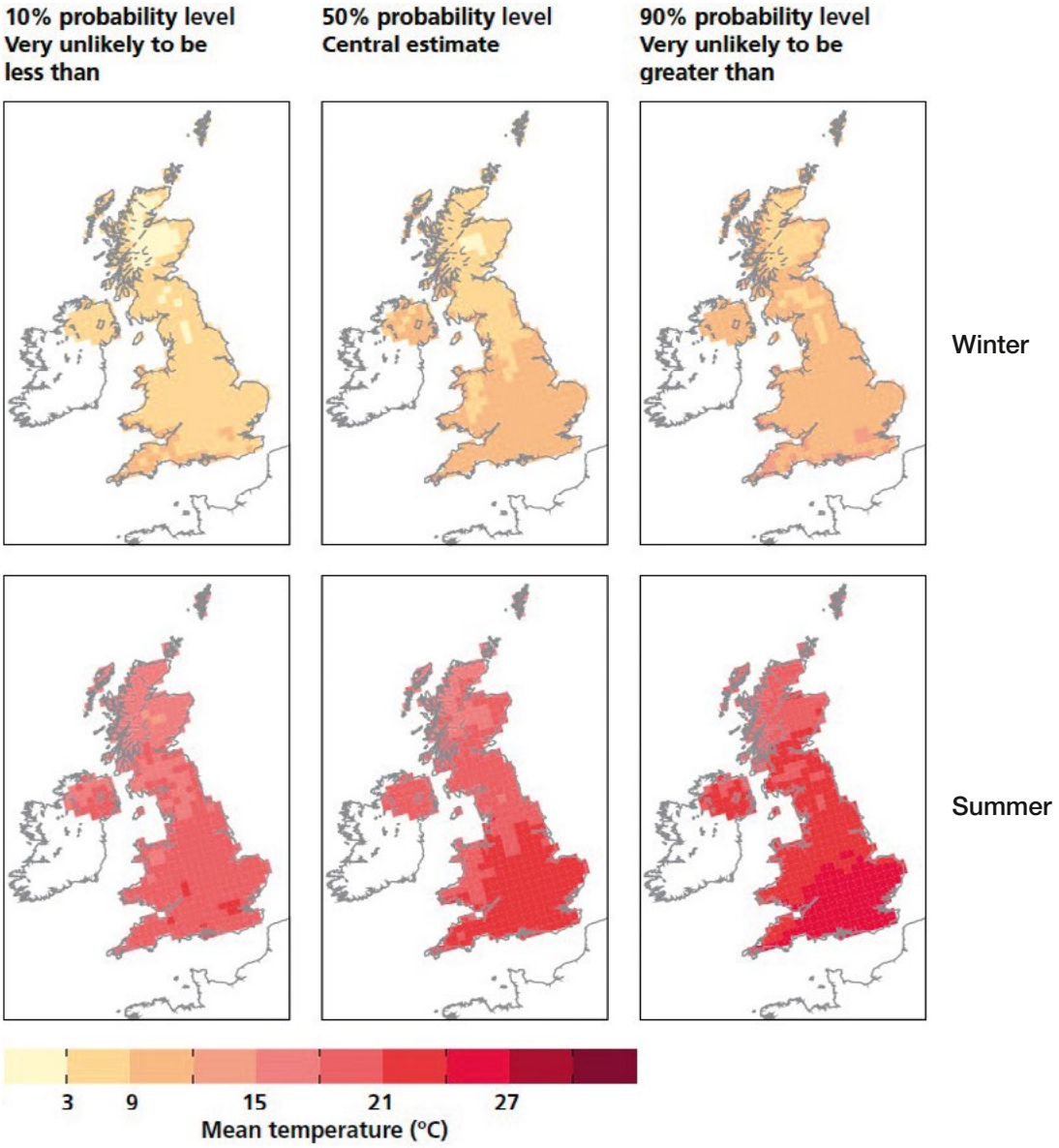
The projections indicate that all areas of the UK warm during this century, more so in summer than in winter. Changes in summer mean temperatures are greatest in parts of southern England (up to 4.2°C) and least in the Scottish islands (just over 2.5°C). This is shown in Figure 7 below.

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

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

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

Figure 7: 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

1.6.2.2 Precipitation

Central estimates of average 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 of 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 by around 40%. Almost no change is seen over parts of northern Scotland.

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

1.6.2.3 Other projections

Relative humidity decreases by around 9% in summer in parts of southern England, with smaller decreases seen everywhere else. 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

In 2015, the UK had a Gross Domestic Product (GDP) of $2.9 trillion, making it the world's 6th largest economy[32]. It is the tenth largest exporter of goods ($439 billion in 2015) and second largest exporter of services ($334 billion in 2015)[33]. Real GDP has grown considerably since 1990 as shown in Figure 8[34]. 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).

In 2008-09, the global financial crisis affected UK and global economic growth: UK real GDP fell by 4.5% between 2008 and 2009, in line with the average for European Union countries. Economic growth resumed towards the end of 2009 but at a slower rate than the period prior to 2008, with GDP not reaching pre-2008 levels again until 2012. The level of UK GDP was 7.0% higher in 2015 than it was in 2007 – a relative increase similar to that of Germany – and 12.6% higher in 2015 than it was in 2009 after the economy had contracted[35]. Up until the crisis, the rate of growth in UK real GDP had exceeded the rate of population growth. However in 2014, GDP per head remained below its level in 2007.

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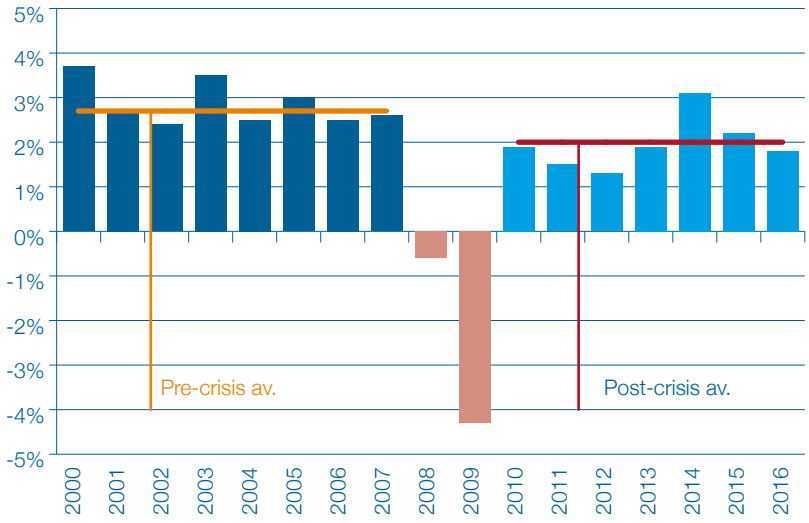
[32] United Nations Statistics Division: https://unstats.un.org/unsd/snaama/selbasicFast.asp

[33] United Nations conference on trade and development statistics: Exports and imports of goods and services, annual, 1980-2016: http://unctad.org/en/Pages/Statistics.aspx

[34] https://www.ons.gov.uk/economy/grossdomesticproductgdp/timeseries/abmi/ukea

[35] https://www.ons.gov.uk/economy/grossdomesticproductgdp/compendium/unitedkingdomnationalaccountsthebluebook/2016edition/nationalaccountsataglance

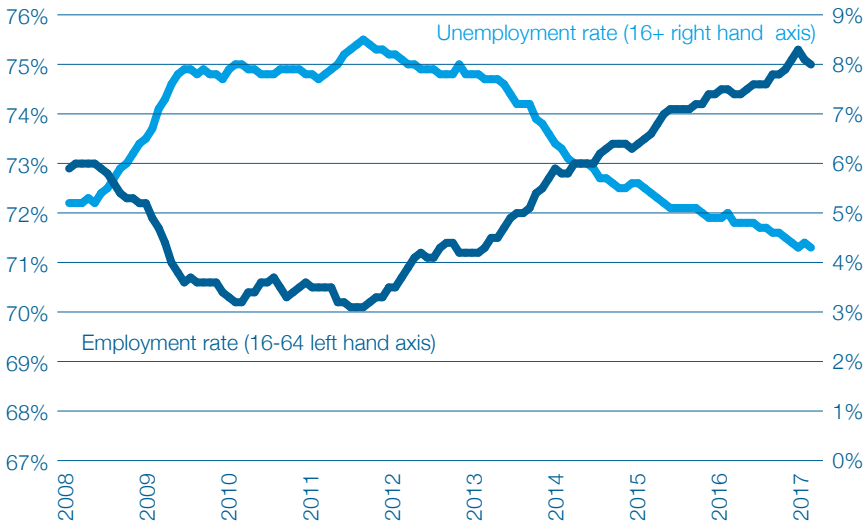
Figure 8: UK Economic Growth



Source: Office for National Statistics

Economic growth in recent years has been supported by strong growth in employment. The UK labour market continues to perform exceptionally well, with record high employment and low unemployment. The employment rate was 75.3% in the three months to June 2017, the highest since comparable records began in 1971. The unemployment rate was 4.3%; the lowest rate since 1975. However performance on productivity and wages has been weak.

Figure 9: UK Labour Market



Source: Office for National Statistics

Productivity declined sharply in 2009 during the economic downturn and has not recovered to its pre-crisis trend rate of growth. Output per hour worked in the UK is currently -0.4% below its pre-crisis peak in 2007 Q4. Demand was subdued in the years immediately following the crisis, as the rate of inflation outstripped nominal wage growth. Real wage growth picked up from late 2014 as pay awards increased and inflation fell, but growth has since returned to being negative in 2017.

The UK's economic performance in the latter half of 2016 following the EU referendum was robust; consumers remained resilient, and investment was largely unaffected. The economy grew by 0.6% in the fourth quarter – in line with historical trends – and over 2016 as a whole the UK economy grew by 1.8%, the 2nd fastest growth in the G7.

In the first quarter of 2017 there was a slowdown in economic activity, as the Pound's depreciation and rising inflation weighed on consumer expenditure. Growth continued to be historically weak in Q2, and the IMF expects the UK economy to grow by 1.7% this year. Forecasts for the UK economy generally predict moderate growth over the next few years, as business investment and consumer spending is dampened by heightened uncertainty as the UK negotiates its exit from the EU. In March the Office for Budget Responsibility forecast GDP growth of 2.0% in 2017, 1.6% in 2018, and then 1.7% in 2019, 1.9% in 2020 and 2.0% in 2021[36].

The UK economy is dominated by the service sector (79% of GDP), which has been the driver of growth in recent years. During 2016, the services industries were estimated to have increased by 2.8%, up on growth of 2.6% during 2015. The largest contributing services industry grouping was business services and finance, which grew by 2.8%. Financial and insurance services are a particularly important sector: In 2016, they contributed £124.2 billion in gross value added (GVA) to the UK economy, 7.2% of the UK's total GVA[37]. The services industry provided the sole positive contribution to growth in Quarter 2 2017.

Consumer spending and investment (gross capital formation) are the two expenditure components driving growth in the UK: Household expenditure contributed 5.6 percentage points of the 12.6% GDP growth between 2009 and 2016, and in 2016 it grew by 2.9% in real terms. The only expenditure component not to contribute to UK economic growth in recent years is net trade. The UK consistently imports more than it exports, having had a trade deficit since 1998, and net trade overall has detracted from GDP growth each year since 2012.

Table 3: Expenditure contributions to annual growth in total GDP, UK, from 2009 to 2015

	Change in GDP
Component	**Percentage points**
Households and non-profit institutions serving households final expenditure	5.6
Government consumption	1.3
Gross capital formation	7
Net trade	-1.8
Other*	0.4
Total	**12.6**

Source: United Kingdom National Accounts, The Blue Book 2016 Edition Release

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

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

Table 4 gives a broad overview of the number and type of industrial enterprises in the UK for 2014, 2015 and 2016.[38] In all three years the professional, scientific and technical sector

[36] http://cdn.budgetresponsibility.org.uk/ExecutiveSummaryMarch2017EFO.pdf

[37] http://researchbriefings.parliament.uk/ResearchBriefing/Summary/SN06193#fullreport

[38] https://www.ons.gov.uk/businessindustryandtrade/business/activitysizeandlocation/bulletins/ukbusinessactivitysizeandlocation/2016

accounted for the largest number of businesses. The second largest number of enterprises come from wholesale, retail and repairs of motor vehicles, with 14.5% in 2016. However this has fallen from the 15.7% seen in 2014.

The professional, scientific and technical sector had the largest growth between 2015 and 2016, an increase of 23,000 businesses. This was followed by the construction sector which increased by 18,000 businesses in 2016.

Table 4: Number of VAT and/or PAYE enterprise by broad industrial grouping, UK, 2014-2016

Nearest thousand						
	2014	*%*	**2015**	*%*	**2016**	*%*
Agriculture, forestry and fishing	146	*6.2*	147	*6*	148	*5.8*
Production	140	*5.9*	142	*5.8*	146	*5.7*
Mining, quarrying and utilities	11	*0.5*	12	*0.5*	13	*0.5*
Manufacturing	129	*5.5*	130	*5.3*	133	*5.2*
Construction	274	*11.6*	284	*11.6*	302	*11.8*
Wholesale and retail; repair of motor vehicles	372	*15.7*	369	*15*	370	*14.5*
Motor trades	71	*3*	72	*2.9*	73	*2.9*
Wholesale	105	*4.4*	104	*4.3*	104	*4.1*
Retail	196	*8.3*	192	*7.9*	192	*7.5*
Transport and storage (inc. postal)	74	*3.1*	83	*3.4*	93	*3.6*
Accommodation and food services	145	*6.2*	146	*6*	148	*5.8*
Information and communication	181	*7.6*	193	*7.9*	207	*8.1*
Finance and insurance	45	*1.9*	49	*2*	52	*2.1*
Property	85	*3.6*	88	*3.6*	91	*3.6*
Professional, scientific and technical	409	*17.3*	436	*17.8*	459	*18*
Business administration and support services	181	*7.7*	194	*7.9*	208	*8.2*
Public administration and defence	7	*0.3*	7	*0.3*	7	*0.3*
Education	39	*1.6*	40	*1.7*	42	*1.6*
Health	99	*4.2*	106	*4.3*	113	*4.4*
Arts, entertainment, recreation and other services	164	*6.9*	166	*6.8*	168	*6.6*
TOTAL	**2,361**	*100*	**2,449**	*100*	**2,555**	*100*

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

Note: Figures are rounded individually therefore the sum of component items may be slightly different to the totals shown.

1.8 Energy Profile

1.8.1 Energy Production

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 29% of the UK's GHG emissions in 2015, representing an emissions reduction of nearly 50% since 1990.

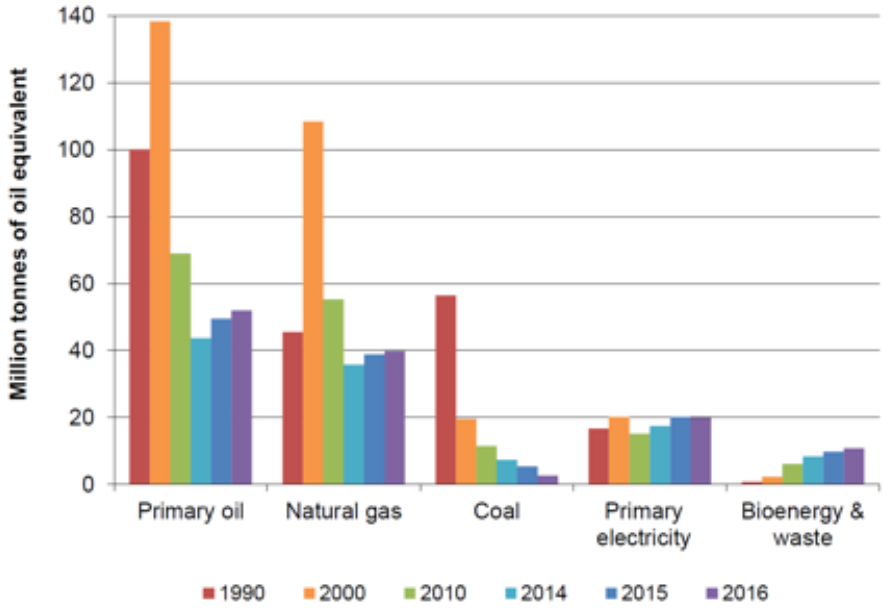
Trends in the production of primary fuels in the UK are illustrated in Figure 10[39]. During the period 1990 to 2000, UK production increased rapidly, mainly due to the growth of oil and gas. Production reached record levels for natural gas in 2000, a year after record levels were reached for overall energy and petroleum.

Total energy production in the UK has fallen between 2000 and 2014; this fall was driven by a sharp decrease in primary oil, gas and coal production. Since 2014 total energy production has increased due to increases in primary oil and gas production from new fields commencing production. In 2016, total energy production was 125 million tonnes of oil equivalent (mtoe), a decrease of 43% compared to 1990 production, and 58% lower than when output peaked at 298 mtoe in 1999.

In 2016 there has been a sharp reduction in coal output, down by over 50 per cent on the low output levels seen in 2015. The decrease is due to the last large deep mines closing in 2015 and a sharp reduction in demand from electricity generators. This represents a 95% reduction in coal production since 1990.

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, natural flow hydro and imports) a further 8%. In 2016 this altered, with 42% of total production coming from primary oil, 32% from natural gas, 16% from primary electricity, 2% from coal and 9% from other renewables (bioenergy and waste).

Figure 10: Production of primary fuels, UK, 1990-2016



Source: Digest of United Kingdom Energy Statistics, BEIS

1.8.2 Import dependency

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 11[40].

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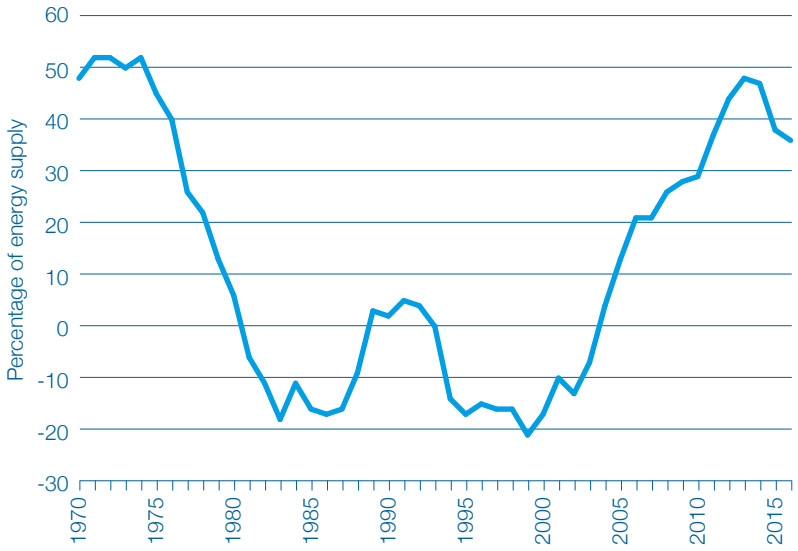
[39] Digest of United Kingdom Energy Statistics: https://www.gov.uk/government/collections/digest-of-uk-energy-statistics-dukes

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

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 being an energy importer in 2004. In 2013 imports of petroleum products exceeded exports following the closure of the Coryton refinery; the UK is now a net importer of all main fuel types although remains a net exporter of some products such as petrol and fuel oil. In 2016, 36% of energy used in the UK was imported, down sharply from the 2014 level due to the increases in indigenous oil and gas output.

Latest comparable data from Eurostat, for 2015, show that the UK had the eighth lowest level of import dependency in the EU. All EU countries are now net importers of energy.

Figure 11: UK import dependency, 1970-2016



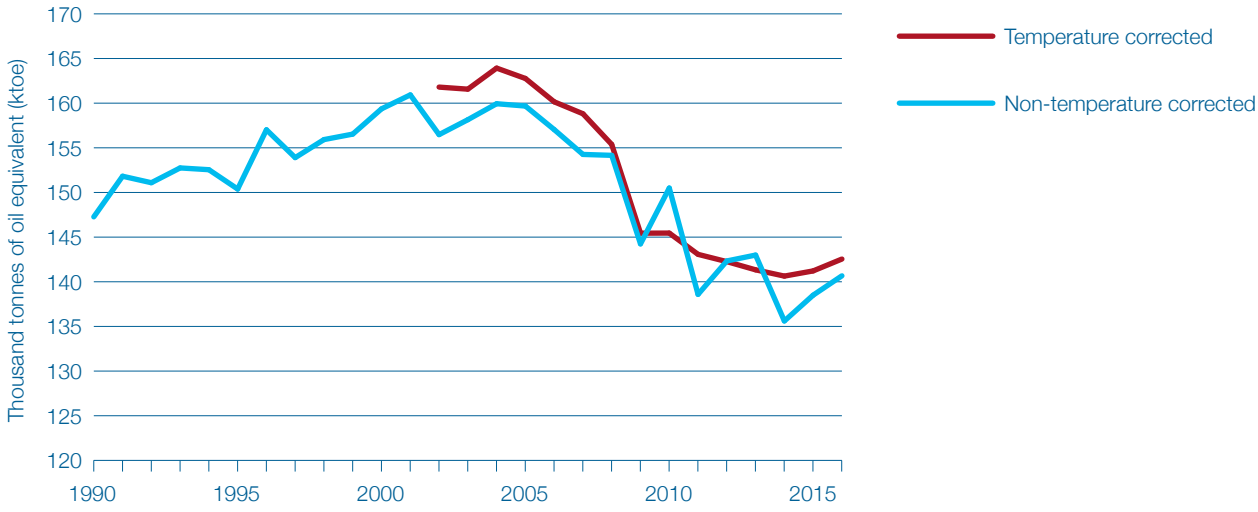
Source: UK Energy in Brief, BEIS

1.8.3 Primary energy consumption

In 2016, the total UK level of primary energy consumption (fuels obtained directly from natural sources) was 140.7 mtoe. In 2015, energy consumption was 138.5 mtoe. The level of primary energy consumption in 2016 was 4% lower than in 1990. Figure 12 shows how primary energy consumption has changed in the UK since 1990 for both the unadjusted and temperature corrected series.[41]

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

Figure 12: UK total primary energy consumption unadjusted and temperature corrected 1990 to 2016



Source: Energy Consumption in the UK, BEIS

On a temperature-corrected basis (to remove the impact a hot or cold year has on energy consumption) primary energy consumption in 2016 was 12% lower than in 2012.

1.8.4 Energy transformation

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.

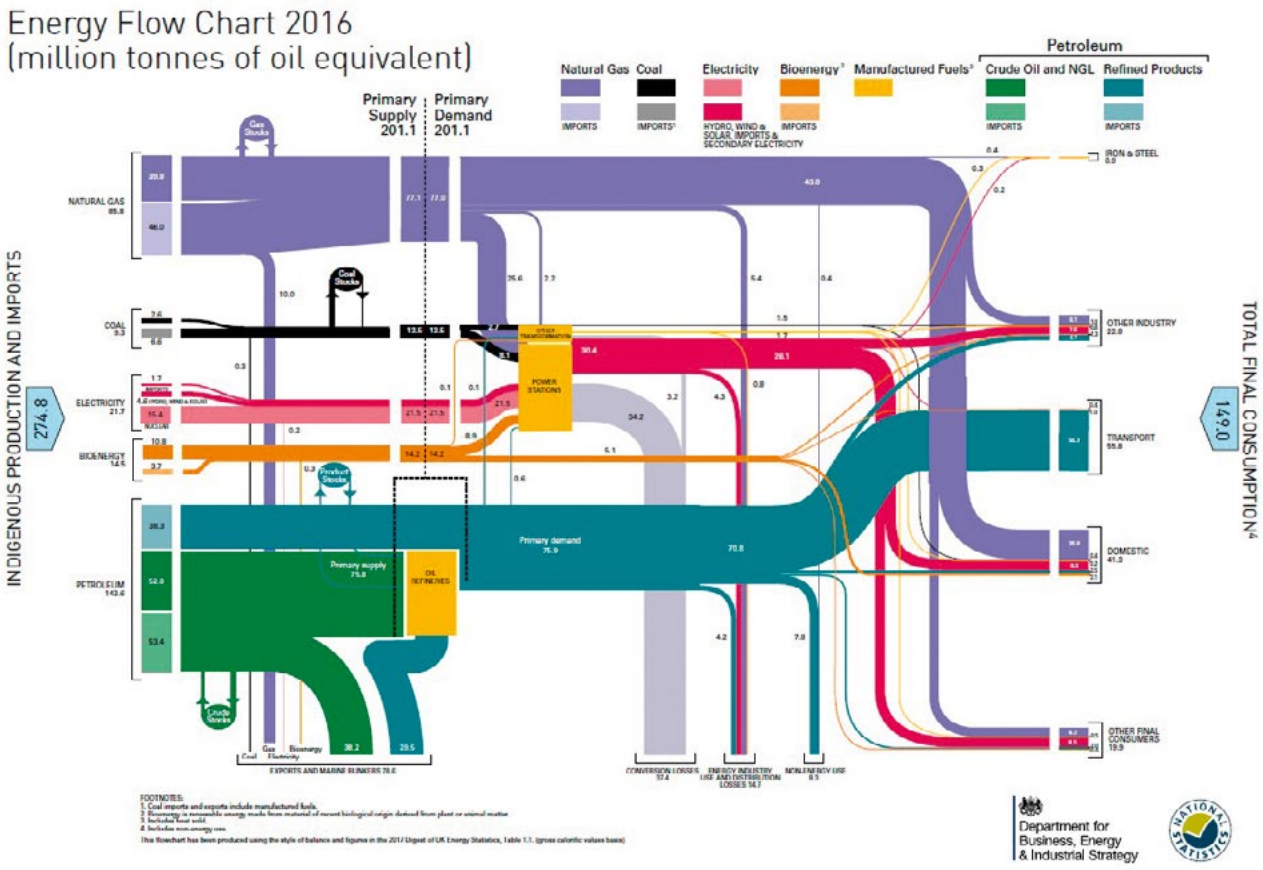
In the final part of this section demand is discussed, which can be calculated as:

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

The energy flow chart for 2016 in Figure 13 illustrates the flow of primary fuels from the point at which they become available from home production or imports, to their eventual final uses[42]. 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.

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

Figure 13: Energy Flow Chart, UK, 2016



Source: Energy Flow Chart, BEIS

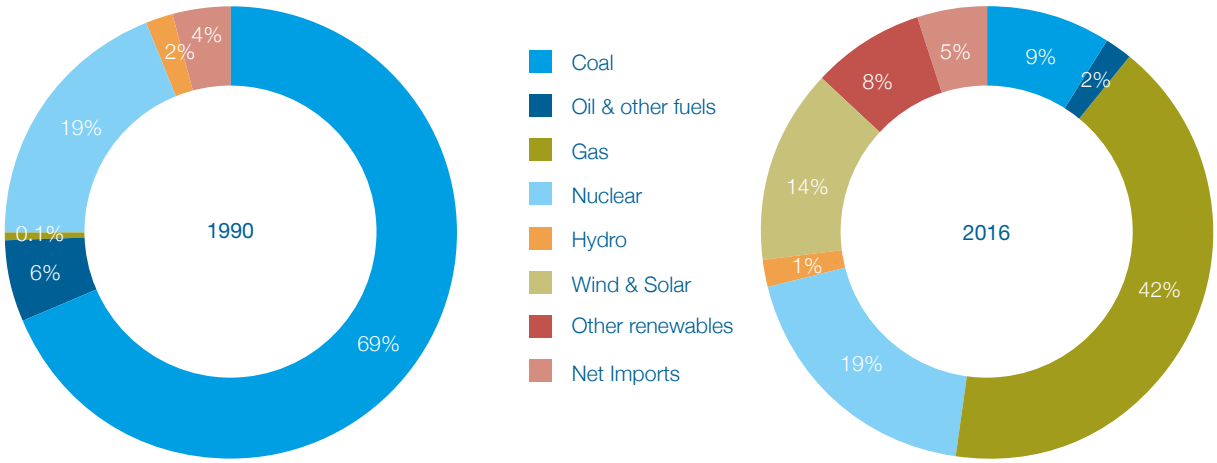
A number of transformations occur to get from primary energy sources to usable fuel with crude oil refined into various petroleum products. The majority of coal is burnt in power stations to generate electricity which is then consumed by final users. In 2016, just over a quarter of energy supplied was used to generate electricity.

1.8.5 Electricity

Between 1990 and 2016, supply of electricity rose by 15% from 308.7 TWh to 337.7 TWh. Electricity supplied from gas increased from less than 1% to 42%. Electricity supplied from coal fell from 69% to 9%. The share of net imports increased from 4% to 5%. Figure 14 shows electricity supplied by fuel for 1990 and 2016, to show how the fuel mix in electricity supplied has changed[43].

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

Figure 14: Electricity supplied by fuel type, UK, 1990 and 2016



Source: UK Energy in Brief, BEIS

1.8.6 Energy consumption

Table 5 shows inland energy consumption for 1990-2016. Between 1990 and 2016, primary energy consumption fell 10% to 192.8 mtoe, this was driven by a 81% (54.5 mtoe) fall in coal consumption and a 12% (9.1 mtoe) reduction in petroleum consumption[44]. Over this period natural gas inland energy consumption increased by 25.5 mtoe. Primary energy consumption was 1.4% lower in 2016 than in 2015. Consumption decreased as a result of the slightly warmer temperatures in 2016, where the mean heating degree days were 5.5 compared to 5.3 the previous year.

Table 5: Inland energy consumption, 1990 to 2016

	1990	1995	2000	2005	2010	2015	2016
Coal	66.9	48.9	38.5	39.9	32.6	25.1	12.4
Oil	77.2	75.4	76.7	78.2	70.2	67.3	68.0
Gas	51.2	69.2	95.9	94.3	93.5	68.1	76.7
Primary electricity	17.7	23.1	21.4	19.8	15.4	21.9	21.5
Bioenergy & waste	0.7	1.7	2.3	4.2	7.8	13.1	14.2
Total	**213.6**	**218.4**	**234.8**	**236.3**	**219.5**	**195.5**	**192.8**

Source: UK energy in brief

Figure 15 shows final energy consumption in the UK from 1990 to 2016 by fuel type[45]. Final energy consumption in 2016 in the UK was 140.7 mtoe. Final energy consumption in 2015, at 138.5 mtoe, was the second lowest level of consumption seen during the period 1990-2016. A 2% increase seen between 2015 and 2016 was driven by a 3% increase in gas consumption and a 9% increase in bioenergy and waste consumption.

Between 1990 and 2016, final energy consumption in the UK decreased by 4%, from 147.3 mtoe to 140.7 mtoe. This fall of 6.6 mtoe, was created from a reduction in the consumption of solid fuels of 11.9 mtoe and a reduction in natural gas of 2.7 mtoe; alongside increases in electricity (2.5 mtoe), bioenergy and waste (4.6 mtoe) and heat sold (1.1 mtoe).

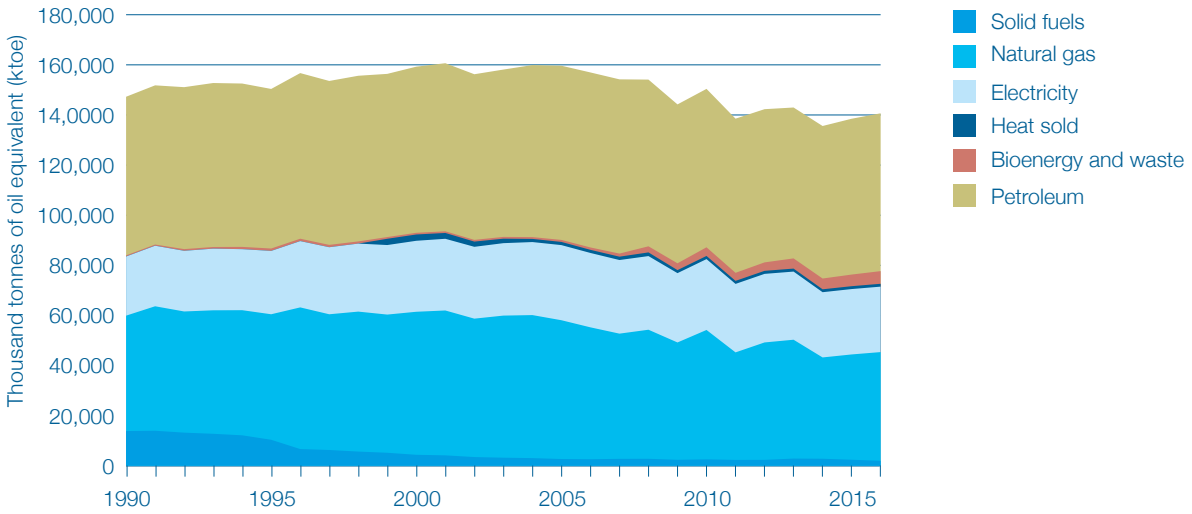
[44] UK Energy in Brief, BEIS: https://www.gov.uk/government/collections/uk-energy-in-brief

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

In 1990 final energy consumption from petroleum was 43% of total final energy consumption in the UK, increasing slightly to 45% in 2016. Over the same period, electricity increased from 16% to 19%, with solid fuels falling from 9% to 1%. In 2016, bioenergy and waste made up 4% of final UK energy consumption. The share of gas consumption remained at 31% between 1990 and 2016.

From 2005, a general declining trend in final energy consumption was driven by improvements in energy efficiency. However 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 and warmer weather in 2014 again saw demand decrease. In 2015 and 2016 demand has increased as the temperatures were cooler in the winter period and an increase in demand for travel resulted in increases of petroleum consumption.

Figure 15: Final energy consumption by fuel, UK, 1990-2016

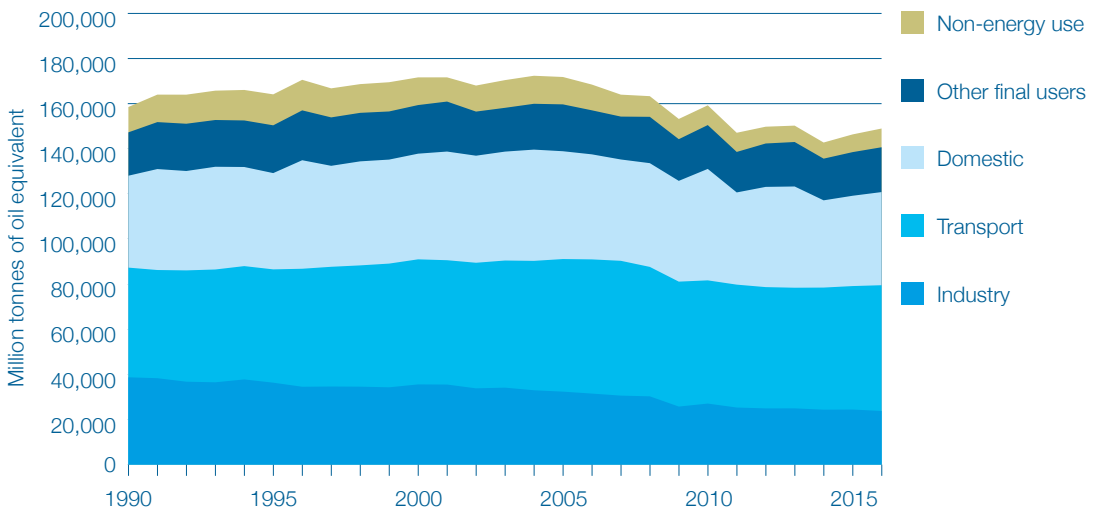


Source: Energy Consumption in the UK, BEIS

Figure 16 shows the changing levels of energy consumption (including non-energy use) in the UK by sector[46]. 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 2016 total UK consumption had declined by 6% to 148,971 thousand tonnes of oil equivalent. During this period, consumption from transport had risen to 37% of the UK total, domestic consumption had increased to 28% of UK consumption, with industrial consumption decreasing to 16% of total UK consumption and other final users increasing to 13%.

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

Figure 16: Final energy consumption by sector, UK, 1990-2016



Source: Energy Consumption in the UK, BEIS

1.8.7 Energy and Carbon Ratio

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 (2009) prices. The carbon ratio is calculated similarly by dividing carbon dioxide emissions by GDP.

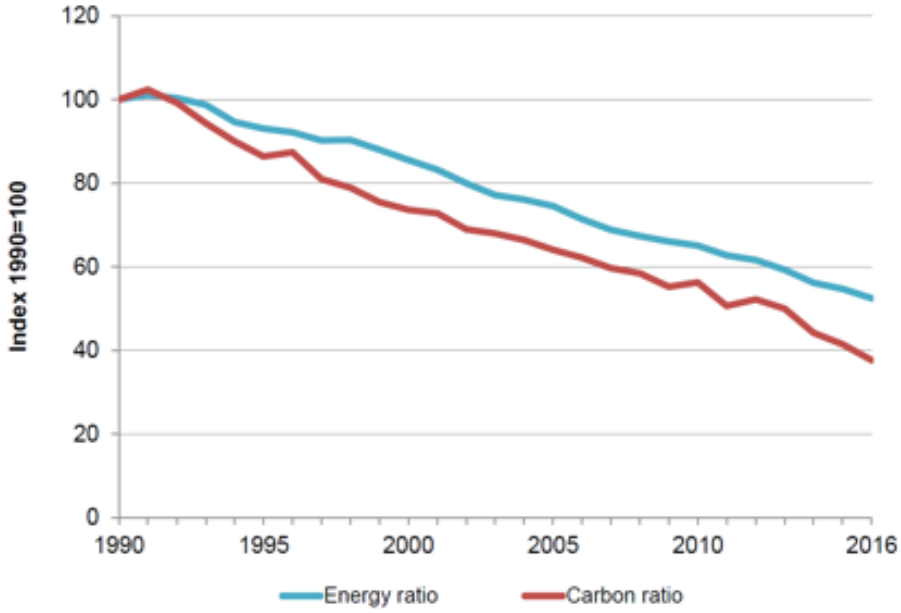
Both ratios have fallen steadily, with the energy ratio declining by around 2½% per year and the carbon ratio declining at a faster pace of around 3½% per year as shown in figure 17[47].

The downward trends are due to a number of factors, with improvements in energy efficiency and the decline in the relative importance of energy intensive industries affecting both ratios. The carbon ratio has been improved further by the increased use of more carbon efficient fuels and renewables.

The sharp downward ticks in the carbon ratio in both 2011 and 2014 are due, in the main, to temperatures, with energy consumption decreasing in response to the warmer weather. The reduction in 2016 is mainly down to fuel switching with less coal used for generation.

[47] UK Energy in Brief: https://www.gov.uk/government/statistics/uk-energy-in-brief-2017

Figure 17: UK Energy and Carbon ratio 1990-2016



Source: UK Energy in Brief, BEIS

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

- Sustained economic growth
- 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 coal to gas and renewables)
- Structural changes to the economy
- 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.

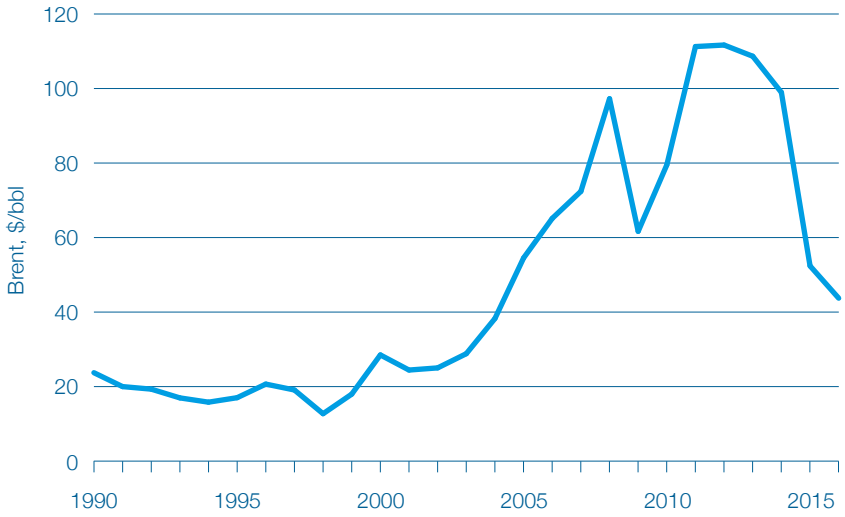
A key driver of energy use in the UK is price. UK energy prices are influenced by a number of factors, both local and global. Prices of primary fuels (gas, coal, oil) will obviously affect the price of secondary fuels (electricity, road fuels), but can also themselves be affected by the price of the 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 18 shows the Brent spot crude prices from 1990 to 2016. In 1990 the Brent spot price was 23.73 $/bbl (US dollars per barrel), in 2016 this was nearly twice that at 43.73 $/bbl. The 2012 price of 111.67 $/bbl was a high over the 1990 to 2016 period, whilst the average 1998 price was a low at 12.72 $/bbl[48].

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

Figure 18: Spot crude prices, 1990-2012



Source: BP Statistical review

1.9 Transport Profile

Transport accounted for around 24% of the UK's GHG emissions in 2015, representing an emissions reduction of 2% since 1990[49]. Petrol and diesel use in 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[50] and the vehicle kilometres travelled[51], emissions from passenger cars have generally decreased since the early 2000s due to lower petrol consumption outweighing an increase in diesel consumption[52] and more recently, improvements in fuel efficiency of both petrol and diesel cars[53].

This increase in the vehicle kilometres travelled is driven mainly by an increase in the distance travelled by cars, vans and taxis as shown in Figure 19[54].

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

[50] Transport Statistics Great Britain, Vehicles (TSGB09), Table TSGB0901 (VEH0103) Licensed vehicles by tax class, Great Britain, annually from 1909 https://www.gov.uk/government/statistical-data-sets/tsgb09-vehicles

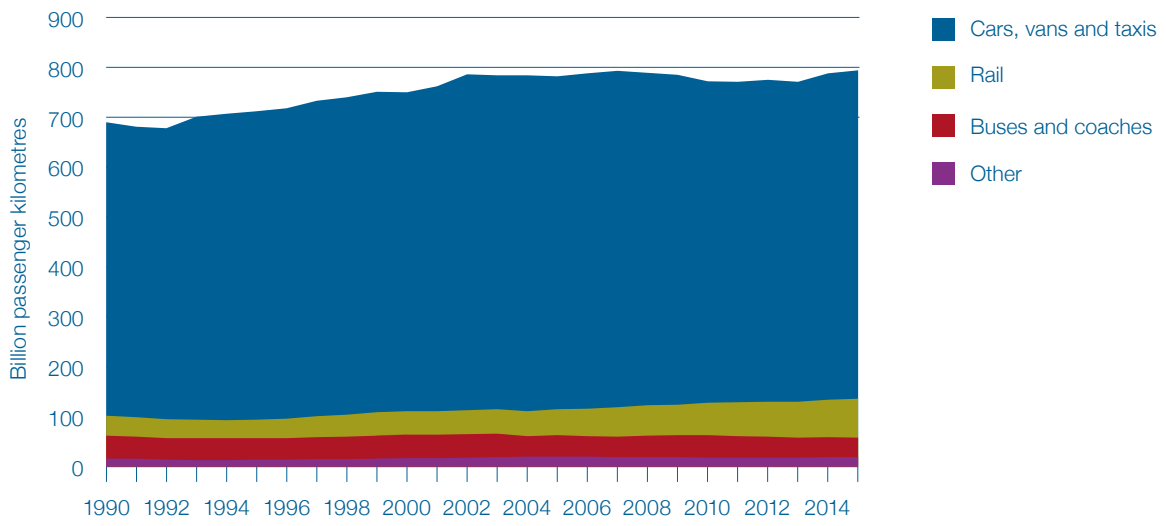
[51] Transport Statistics Great Britain, Modal comparisons (TSGB01), Table TSGB0101 Passenger Transport by mode, since 1952 https://www.gov.uk/government/statistical-data-sets/tsgb01-modal-comparisons

[52] Transport Statistics Great Britain, Energy and environment (TSGB03), Table TSGB0301 (ENV0101) Petroleum consumption by transport mode and fuel type: United Kingdom, 2000-2015 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/482684/env0101.xls

[53] Transport Statistics Great Britain, Energy and environment (TSGB03), Table TSGB0301 (ENV0103) Average new car fuel consumption: Great Britain 1997-2015 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/482686/env0103.xls

[54] Transport Statistics Great Britain 2016, https://www.gov.uk/government/statistics/transport-statistics-great-britain-2016

Figure 19: Passenger Transport by Mode, 1990 – 2015



Source: Transport Statistics Great Britain 2016, Department for Transport

The number of licensed vehicles in Great Britain has increased from about 25 million in 1990 to just over 36 million in 2015. 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 2015.

Most of the increase in new registrations has been in the private and light good vehicles tax class. 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[55] reward 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 in 2015 were approximately 32% more fuel efficient for petrol and approximately 28% more fuel efficient for diesel than they were in 2000[56].

In 2015, transport accounted for the largest share of all final energy consumption in the UK at 37%.[57] Road transport accounted for the largest share of transport consumption representing 74% of transport consumption in 2015, equivalent to its 2014 share.

Energy from renewable sources made up around 2.0% of transport energy consumption in 2015, up from 0.2% in 2005. Almost all transport renewable energy consumption is in the form of biofuels blended into petrol and road diesel. As shown in Figure 20 biofuels made up 2.5% of road transport energy consumption in 2015, up from 0.2% in 2005.

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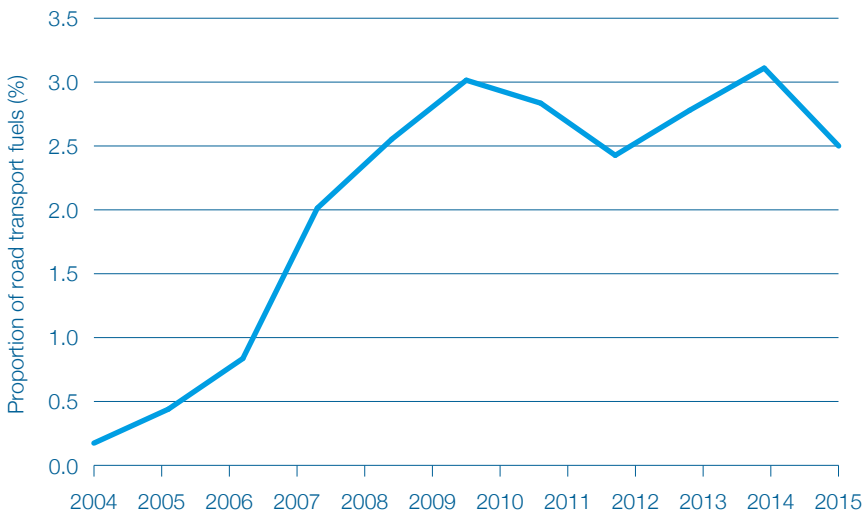
[55] Vehicle Certification Agency (VCA) website www.vca.gov.uk/fcb/index.asp

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

[57] https://www.gov.uk/government/statistics/energy-consumption-in-the-uk

Figure 20: Biofuels as a proportion of all road transport fuels 2004 – 2015

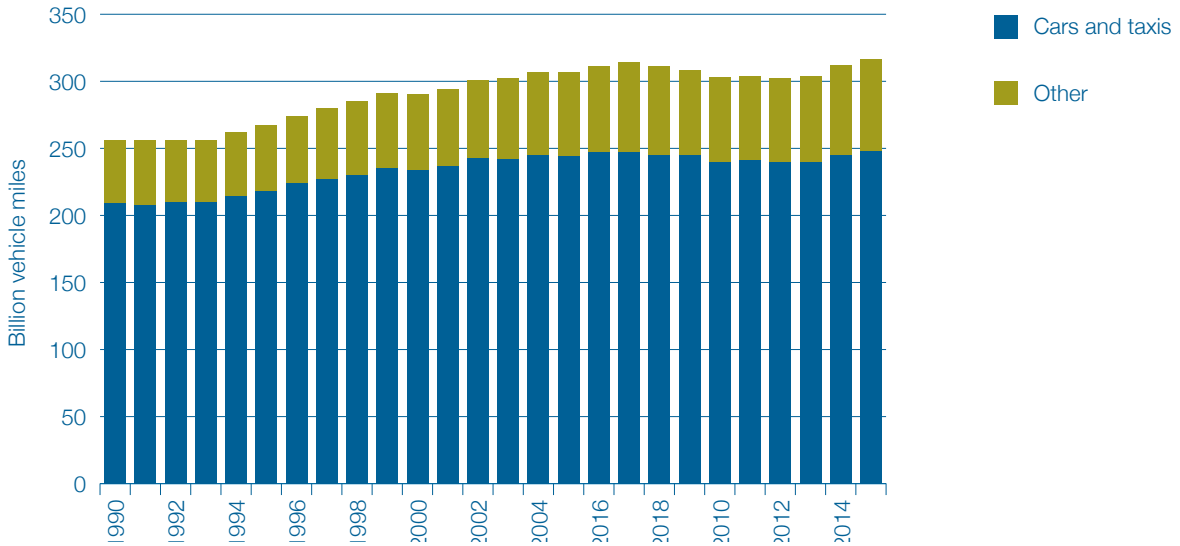


Source: Department for Transport

The UK's long term strategy to reduce transport emissions includes the Renewable Transport Fuels Obligation (RTFO), which requires 9.75% of transport fuel sold in the UK to come from renewable sources by 2020, rising to 12.4% in 2032. In 2017 the RTFO was amended to add an additional target for development fuels at 0.1% in 2019, rising to 2.8% in 2032. It will also now make sustainable renewable aviation fuels and renewable fuels of non-biological origin eligible for reward under the RTFO.

As can be seen in Figure 21, car traffic increased slightly (1.1%) between 2014 and 2015, from 245.0 to 247.7 billion vehicle miles. In the last ten years, traffic volumes for all vehicle types, except light commercial vehicles, have seen a generally decreasing trend up until 2013. After this traffic volumes have been increasing for all vehicle types.

Figure 21: Road Traffic by vehicle type (cars and all motor vehicles) 1990 – 2015

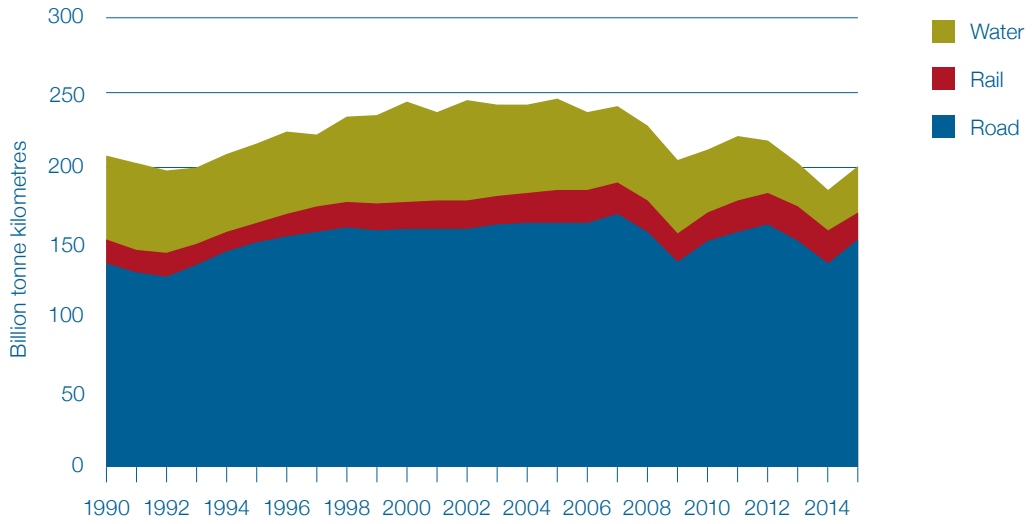


Source: Department for Transport

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 2040 road traffic will be 42% higher than in the level in 2010[58]. Despite this increase in traffic, CO_2 emissions are forecast to decline by around 17% from 2010 levels, reflecting fleet fuel efficiency improvements and use of biofuels.

Figure 22 shows that in 2015, the level of domestic freight had decreased by around 3.5% compared to 1990, at around 201 billion tonnes kilometres. Since 1990, 66% of goods moved have been transported by road. The amount travelling this way rose to 152 billion tonne kilometres in 2015 from 136 billion tonne kilometres in 1990, an increase of 12%. Goods moved by rail have increased slowly since the mid-1990s to account for around 9% of all goods moved in 2015. In recent years, rail freight has also accounted for around 5% of goods lifted, compared with 9% in 1980.

Figure 22: Domestic goods moved by mode: 1990-2015, Great Britain



Source: Department for Transport, Office of Rail Regulation, BEIS

1.10 Waste

In 2015 GHG emissions from waste contributed to 4% of total UK emissions; representing an emissions reduction of 73% since 1990. Approximately 67% of emissions from this sector are attributable to landfill methane.[59]

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.

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58 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/411471/road-traffic-forecasts-2015.pdf

59 2015 UK greenhouse gas emissions: final figures – data tables https://www.gov.uk/government/statistics/final-uk-greenhouse-gas-emissions-national-statistics-1990-2015

In 2015 households in the UK produced 26.7 million tonnes of waste, a reduction of 1% since 2010. The last data for commercial and industrial sources shows a significant decrease from 33.9 million tonnes in 2010 to 27.7 million tonnes in 2014[60].

In 2015, 44.3% of waste from households was recycled in the UK; this is a decrease from the rate of 43.9% achieved in 2014. Local Authorities recycled, composted or reused 9.8 million tonnes of the waste they collected.[61] In 2011 for the first time since records began, more has been recycled, composted or reused than landfilled. This trend has continued until 2015/16, although an increase in incineration may have partly accounted for the change in landfill.

UK Commercial & industrial waste sectors generated 27.7million tonnes of waste in 2014, of which 19.8 was in England. Slightly over half of this waste was from Commercial waste, in both the UK and England. Waste generation from both commercial and industrial sectors fell between 2010 and 2014 in the UK by just over 18%[62].

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 2014 there were around 28 million dwellings in the UK, of which 23.4 million were in England[63]. Most common are semi-detached houses (30%), followed by terraced houses (25%), detached houses (23%), purpose built flats (17%) and all other types of properties (5%)[64].

The number of households in the England is projected to increase by 10% between 2015 and 2025[65]. 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 13% between 2015 and 2035.

1.12 Agricultural Profile

The total area of agricultural land in the UK in 2016 was around 17.4 million hectares. About 4.5 million hectares of this was arable, of which around two thirds was under cereal production. 11.2 million hectares is currently under grass, (temporary, permanent and sole right rough grazing). The remainder was common rough grazing and land for outdoor pigs.[66]

Livestock numbers have a negative impact on GHG emissions due several processes including enteric fermentation.

The total number of cattle and calves in the UK saw a 1% increase between June 2015 and June 2016, to around 10 million. There is a general downward trend of cattle numbers in June since 2005, although in recent years this trend has started to reverse slightly. The UK's dairy herd remained static at 1.9 million and the UK's beef herd continues to fluctuate at around

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[60] Digest of waste and resource statistics https://www.gov.uk/government/statistics/digest-of-waste-and-resource-statistics-2017-edition

[61] ENV 23 – UK Statistics on waste data – December 2016 update (excel): Table 1.1 waste from households https://www.gov.uk/government/statistical-data-sets/env23-uk-waste-data-and-management

[62] Digest of Waste and Resource Statistics – 2017 Edition https://www.gov.uk/government/statistics/digest-of-waste-and-resource-statistics-2017-edition

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

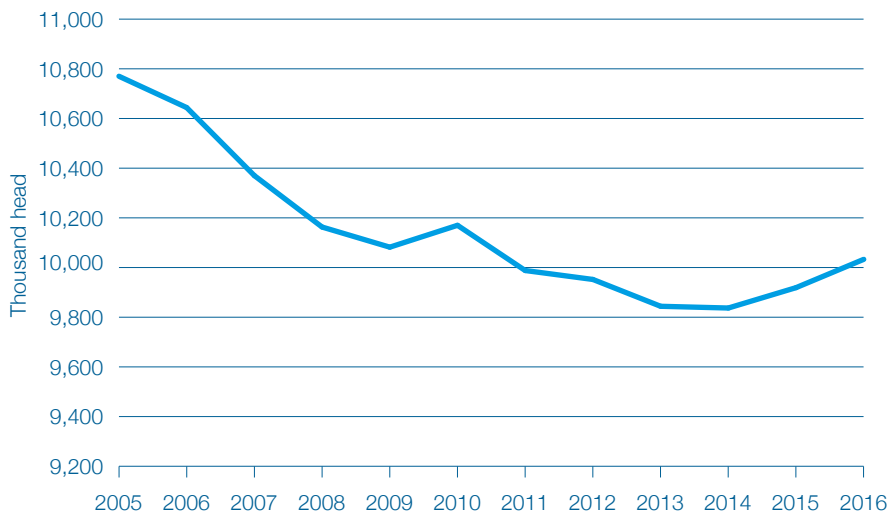
[64] 2011 Census http://www.ons.gov.uk/ons/guide-method/census/2011/index.html

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

[66] https://www.gov.uk/government/statistical-data-sets/agriculture-in-the-united-kingdom

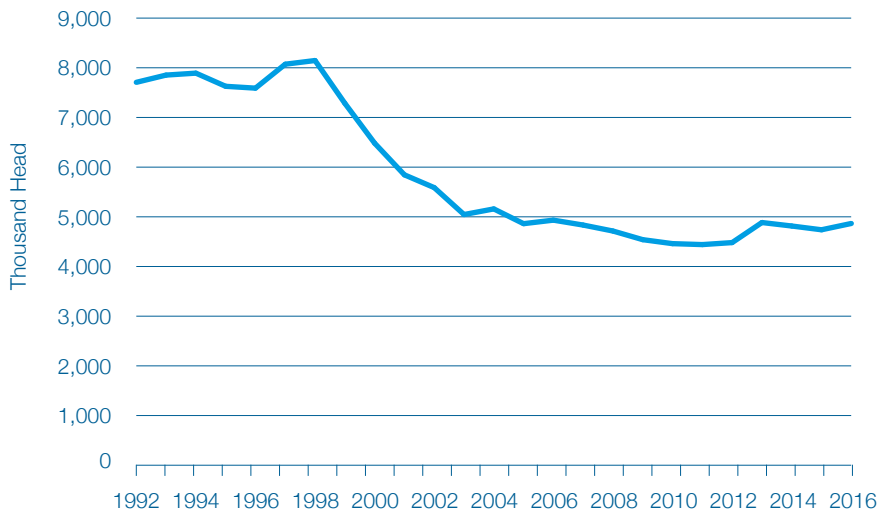
1.6 million. Total cattle and calves numbers in the UK during the period 2005-2016 are shown in Figure 23.[67]

Figure 23: Total Cattle and calves in the UK, June 2005-2016



The total number of pigs in the UK increased in June 2016 by 2.7% since June 2015, to just below 4.9 million. There was a 0.4% increase in the total number of breeding pigs in the UK, to just over 500,000 animals in June 2016. Total pig numbers in the UK during the period 1992-2016 are shown in Figure 24.

Figure 24: Total pig numbers in the UK, December 1992-2016



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

The total number of sheep and lambs in the UK increased by 1.8% between June 2015 and June 2016, to just below 34 million. The UK's female breeding flock increased by 1.7% to 16.3 million over the same period. Larger increases were seen in other sheep and lambs for the UK rising 1.9%. These include lambs less than 1 year of age, rams and other sheep that are 1 year or older. Total sheep and lamb numbers in the UK during the period 1984-2016 are shown in Figure 25.

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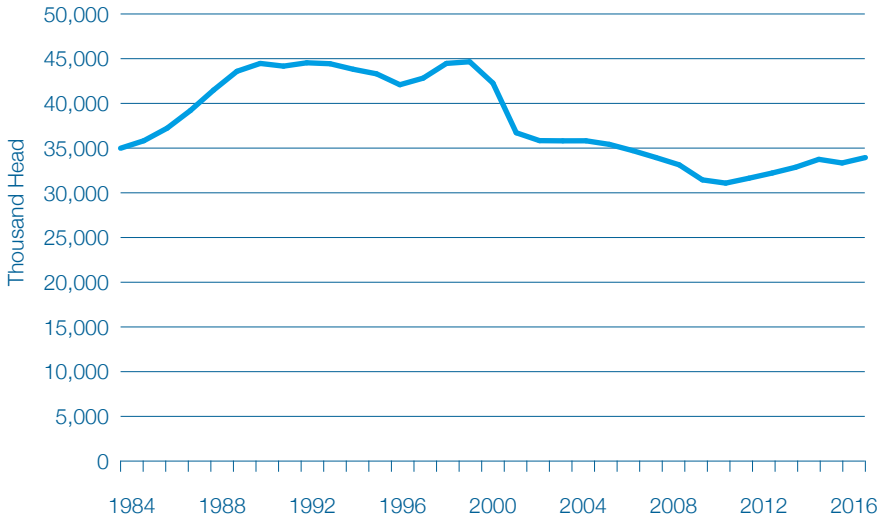
[67] Farming statistics: livestock populations at 1 December 2016 – UK and England https://www.gov.uk/government/statistics/farming-statistics-livestock-populations-at-1-december-2016-uk

Figure 25: Total sheep and lambs in the UK June 1984-2016

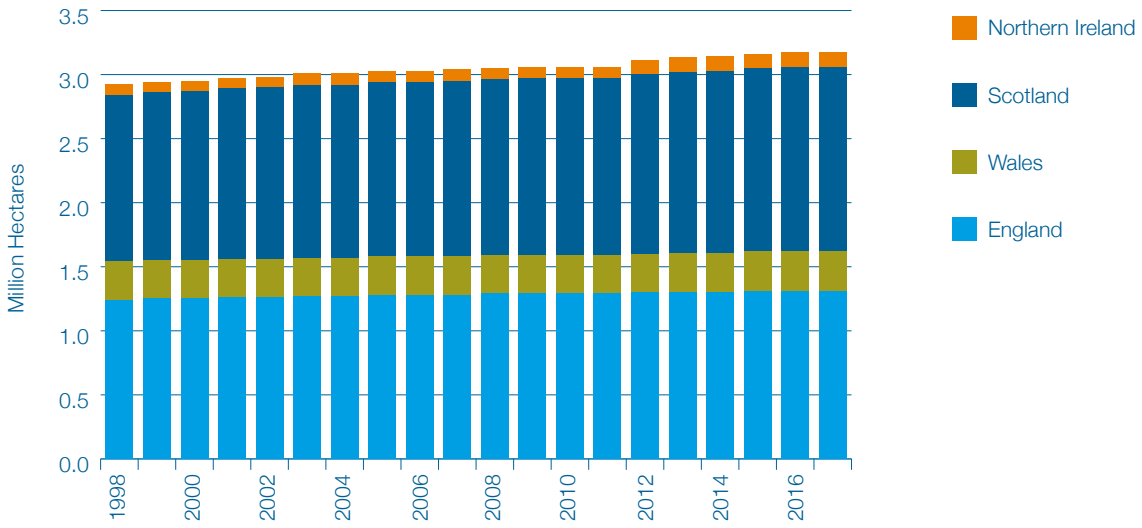


Source: Farming Statistics, Department for Environment, Food and Rural Affairs

1.13 Forestry Profile

The area of woodland in the UK at 31 March 2017 is 3.2 million hectares. Of this total, 1.4 million hectares (45%) is in Scotland, 1.3 million hectares (41%) is in England, 0.3 million hectares (10%) is in Wales and 0.1 million hectares (4%) is in Northern Ireland[68]. This has changed relatively little over the period 2007 to 2011 as can be seen in Figure 26. State forests account for 0.9 million hectares.

Figure 26: Area of woodland, 1998-2017



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.

[68] Forestry Statistics 2017 http://www.forestry.gov.uk/forestry/infd-7aqdgc

The total area of new planting and restocking in the UK was 23.6 thousand hectares in 2016-17. Restocking accounted for 72% of this total. Broadleaved species accounted for 46% of the new planting area but just 22% of the restocked area in 2016-17.

A total of 10.7 million green tonnes of softwood was produced in the UK in 2016 and accounted for 95% of removals from UK woodland. UK hardwood production totalled 0.6 million green tonnes in 2016. Softwood availability in Great Britain is projected to increase to an annual average of 17.2 million green tonnes over the five year period 2017 to 2021 and 18.4 million green tonnes from 2027 to 2031.

Apparent consumption of wood in the UK amounted to 56.7 million m^3 wood raw material equivalent in 2016, made up of 10.8 million m^3 UK production, 49.8 million m^3 imports and 3.9 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 2015, UK greenhouse gas (GHG) emissions on a UNFCCC basis were 499.4 million tonnes of carbon dioxide equivalent ($MtCO_2e$) – 37.8% lower than 1990 levels.[69]
- Between 1990 and 2015 carbon dioxide emissions including LULUCF fell by 32.0%. Methane emissions fell by 61.1% and nitrous oxide emissions fell by 54.8%.
- Between 1990 and 2015, hydrofluorocarbons emissions increased by 10.9%, perfluorocarbons emissions fell by 80.2%, and sulphur hexafluoride emissions fell by 64.2%.
- 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-carbon dioxide GHGs, most notably the increase in landfill methane capture and oxidation.

2.2 Introduction

This chapter presents information on UK GHG emissions and the National System established to produce and quality assure the UK GHG Inventory. A fuller description of this National System can be found in the UK's National Inventory Report (NIR), submitted to the United Nations Framework Convention on Climate Change (UNFCCC) in 2017[70]. 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.

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[69] 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).

[70] UK Greenhouse Gas Inventory, 1990–2015, Annual report for submission under the UN Framework Convention on Climate Change, April 2017: http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/6598.php

The GHG inventory covers the seven 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)
- Nitrogen Trifluoride (NF_3).

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, the emissions can be summed and presented as carbon dioxide equivalent emissions, referred to as CO_2e. Table 2(c) in the UK's third Biennial report (Annex A) contains a list of respective GWPs for each gas.

The Kyoto Protocol to the UNFCCC was established in 1997 as an international agreement in response to the threat of climate change. The UK met its emissions reductions target for the first commitment period of the Kyoto Protocol. Under the first commitment period (2008-12), the EU and its Member States, Iceland and Norway collectively made a commitment to reduce greenhouse gas emissions across the EU by 8 per cent on 1990 levels by 2012. Under the second commitment period (2013-2020), the EU and the Member States have a collective target to reduce emissions by 20 per cent relative to base year levels. The UK has now ratified the Doha Amendment, but it has not yet come into force. This report therefore does not include information on the UK's progress against its second commitment period.

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, SF_6 and NF_3. 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 domestic targets.

The UK has a legally binding commitment to ensure that the net carbon account for the year 2050 is at least 80% lower than the 1990 baseline – further information is detailed in Chapter 3 – Policies and Measures.

At the United Nations Conference on Climate Change in Paris in December 2015, 195 countries committed to adopt a global climate change Agreement. The Paris Agreement entered into force on 4 November 2016. It was ratified by the UK on 18 November 2016, during the United Nations Conference on Climate Change in Marrakesh. The EU and its Member States are committed to a target of at least a 40% domestic reduction in greenhouse gas emissions by 2030 compared to 1990 levels. The contribution of each EU Member State to this overall target will be set out in EU legislation (the Effort Sharing Regulation) which is currently being negotiated.

This chapter shows trends in UK GHG emissions between 1990 and 2015, 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[71], Wales[72] and Northern Ireland[73]), and to 391 local authorities[74] 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 B. Data from the GHG inventory are also used to monitor progress against the carbon budgets under the UK Climate Change Act 2008. A narrower definition of LULUCF emissions and removals is used to assess progress against the Kyoto target which includes only mandatory activities under Article 3.3 of the Kyoto Protocol, and forest management (formerly elective) has become mandatory for the second commitment period under 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 of the Kyoto Protocol the UK elects Cropland Management, Grazing Land Management, and Wetland Drainage and Rewetting, as activities under Article 3.4. The UK does not elect Revegetation, as the eligible land area for Revegetation within the UK is estimated to be very small, and therefore the associated potential sink will be very small also.

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 presents the full details of the institutional arrangements the UK has for inventory preparation.[75]

The UK's GHG inventory is compiled under contract to BEIS by a consortium led by the environment consultancy Ricardo Energy and Environment.[76] [77] Ricardo Energy and Environment 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 Energy and Environment 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 BEIS by the Centre for Ecology and Hydrology (CEH) and Forest Research.

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[71] Information on emissions in Scotland is available at http://www.gov.scot/climatechange.

[72] Information on emissions in Wales available at http://www.gov.wales/climatechange.

[73] https://www.daera-ni.gov.uk/articles/northern-ireland-greenhouse-gas-inventory.

[74] local authority is a designation of local government used in the United Kingdom.

[75] 2015 UK National Inventory Report (NIR): http://naei.beis.gov.uk/reports/reports?report_id=929

[76] Department of Business, Energy and Industrial Strategy, 1 Victoria Street, London, SW1H 0ET, Tel: 020 7215 5000, email: climatechange.statistics@BEIS.gsi.gov.uk

[77] Ricardo Energy and Environment, 30 Eastbourne Terrace, London, W2 6LA, Tel: +44 (0) 1235 753 000, email: enquiry-ee@ricardo.com

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)[78]. 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 BEIS, 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.

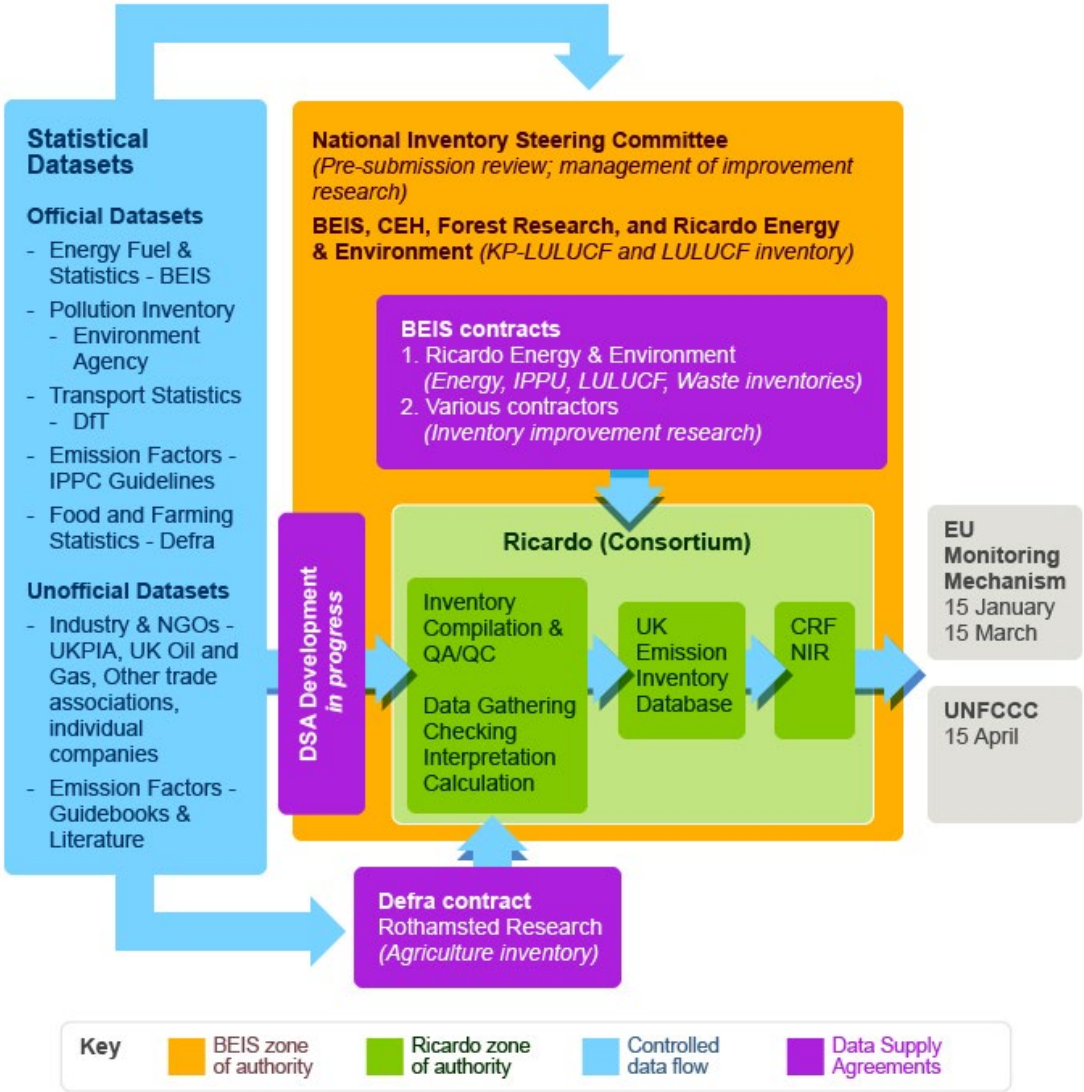
The NIR, including Common Reporting Format (CRF) tables, is reported to the UNFCCC, and to the EU Monitoring Mechanism (EUMM), by the deadlines set. Further details are provided in Section 1.4 of the NIR, and in subsequent chapters and appendices of the NIR. The national system ensures that the UK will 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 27 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.

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

Figure 27: 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.

BEIS 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 Energy and Environment is the delegated Inventory Agency with responsibility for the planning, preparation and reporting of the UK GHG inventory. Ricardo Energy and Environment is responsible for the quality and delivery of datasets to BEIS and reporting in BEIS's behalf. BEIS 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.

BEIS has an inventory improvement programme, which is a process for prioritising improvement needs, clarifying and consulting with stakeholders via the NISC and contracting the improvement work 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 F.

The UK National Registry[79] is operated and maintained by the Environment Agency[80] on behalf of BEIS.

The National Registry conforms to the technical standards for data exchange between registry systems as outlined in the Independent Assessment Report (IAR)[81]. 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 Independent 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[82]. Section 14 of the NIR contains further information on the changes in the National Registry.

2.4 Geographical Coverage

2.4.1 Geographical coverage used for National and International reporting

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. 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). They are territories under the jurisdiction and sovereignty of the United Kingdom, though not part of it, and requested to join the UK's commitments under the Kyoto Protocol and reduce their greenhouse gas emissions.

The UK inventory provides data to 1) assess progress with the UK's commitments under the Kyoto Protocol, 2) assess the UK's contribution to the EU's target under the Kyoto Protocol and 3) assess progress towards domestic targets, at the UK and devolved administrations levels, to reduce GHG emissions.

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79 https://ets-registry.webgate.ec.europa.eu/euregistry/GB/index.xhtml

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

81 http://unfccc.int/kyoto_protocol/registry_systems/independent_assessment_reports/items/4061.php

82 https://www.gov.uk/government/organisations/environment-agency

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

For 1) 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 joined the UK's ratification of the Convention and the Doha Amendment to the Kyoto Protocol (the Cayman Islands, the Falkland Islands and Gibraltar). This differs to the geographical coverage which is reported to the UNFCCC, since the UNFCCC coverage also includes data from the overseas territory Bermuda. Bermuda joined the UK's ratification of the Convention and the Kyoto Protocol and is included in the first commitment period, but is not included in the UK's coverage for the second commitment period.

For 2) 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).

For 3) the carbon budgets and targets under the UK Climate Change Act 2008 only apply 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[83]. Together these total the overall emissions estimates submitted to the UNFCCC[84].

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

	1990	1995	2000	2010	2014	2015
United Kingdom	799.0	748.5	709.7	605.9	515.1	495.7
Crown Dependencies	1.7	1.9	2.0	1.8	1.7	1.6
Overseas Territories[1] (excluding Gibraltar)	1.6	1.5	1.6	1.9	1.8	1.8
Gibraltar	0.2	0.2	0.2	0.3	0.3	0.3
Total	**802.5**	**752.1**	**713.6**	**609.9**	**518.9**	**499.4**
Change from 1990	0.0%	-6.3%	-11.1%	-24.0%	-35.3%	-37.8%

Source: UK GHG Inventory.

Note

[1] This includes all OTs, including Bermuda. Gibraltar is reported on a separate basis due to its additional inclusion in the EU Kyoto Protocol.

2.4.2 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. For table 9, emissions from each OT and CD that have signed up to be part of the second Kyoto Protocol commitment period are calculated individually and added to the UK total.

2.5 GHG emissions trends

Figure 28 shows the trend in emissions between 1990 and 2015 for the basket of seven GHGs covered by the Kyoto Protocol. Annual GHG emissions for 2015 were an estimated 37.8%

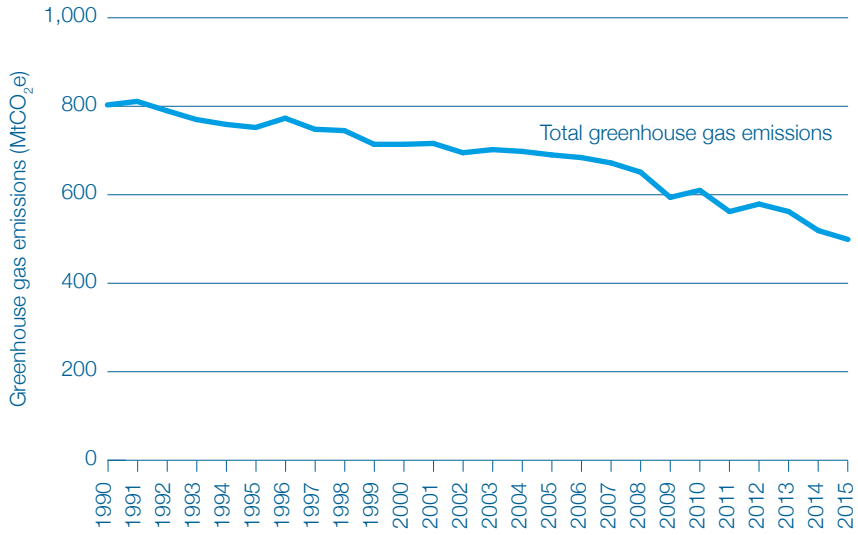
[83] UK National statistics: 2015 Final UK greenhouse gas emissions https://www.gov.uk/government/collections/final-uk-greenhouse-gas-emissions-national-statistics

[84] UK National Statistics publications have a geographical coverage that includes the United Kingdom only.

below the fixed base year[85] emission. This has been driven by a number of factors such as 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-carbon dioxide GHGs, most notably the increase in landfill methane capture and oxidation.

Information on individual gases is contained in sections below and Annex B contains tables summarising the UK's GHG emissions. More details can be found in the UK's annual GHG inventory, published in April 2017.

Figure 28: Total emissions of GHGs, 1990–2015, $MtCO_2e$.



Source: 2015 GHG Inventory

2.6 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.

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

Gas	1990	1995	2000	2005	2010	2015
Carbon dioxide	598.5	560.4	558.8	558.4	499.9	406.8
Methane	135.3	128.8	111.1	89.4	68.3	52.6
Nitrous oxide	51.3	41.9	31.4	27.3	24.2	23.2
Hydrofluorocarbons	14.4	19.1	9.9	13.2	16.5	16.0
Perfluorocarbons	1.7	0.6	0.6	0.4	0.3	0.3
Sulphur hexafluoride	1.3	1.3	1.8	1.1	0.7	0.5
Total GHG emissions by sources minus removals by sinks	**802.5**	**752.1**	**713.6**	**689.7**	**609.9**	**499.4**

[85] 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. The latest version of the report was submitted in 2017, based on emissions reported in the 1990-2014 Greenhouse Gas Inventory. For the purposes of calculating achievement of the Kyoto Protocol target emissions occurring in this base year are now fixed, in $MtCO_2$-eq.

Source: UK GHG Inventory

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 B has more detailed data available for all years from 1990-2015.

2.6.1 Carbon dioxide

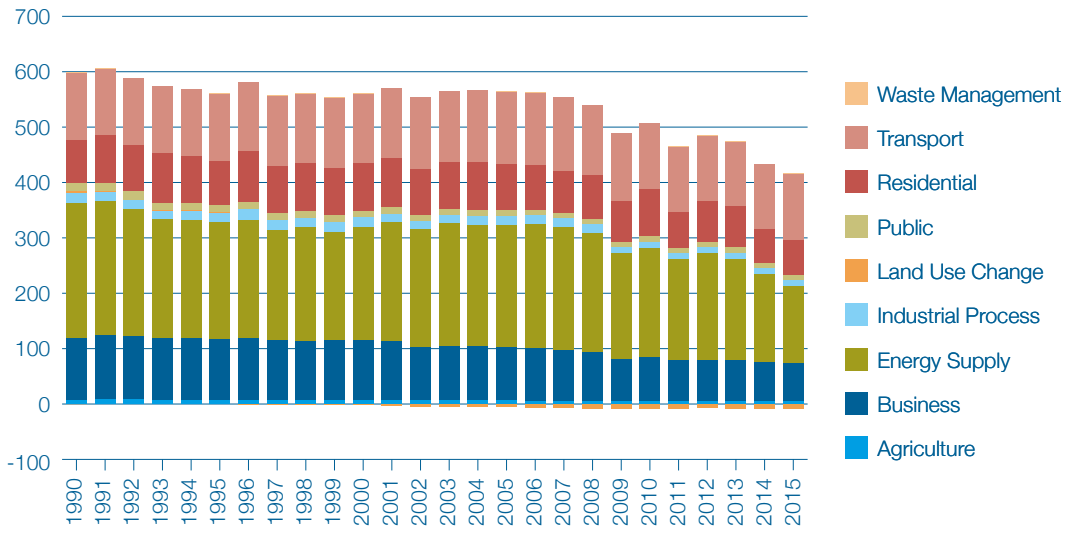
Carbon dioxide had the largest share of UK greenhouse gas emissions in 2015, making up 81.5% of the inventory. Net CO_2 emissions (all anthropogenic sources minus removals by sinks) in 1990 were estimated to be 598.5 $MtCO_2e$, or an estimated 75% of the UK's total emissions of GHGs. By 2015, CO_2 emissions estimates had been reduced by 32% to 406.8 $MtCO_2e$.

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 99.8 $MtCO_2e$, across the period) primarily due to a change in the fuel mix for electricity generation, with a decrease in the use of coal and greater use of nuclear and renewables. 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 woodland inventory is available to BEIS, and is being used to improve inventory estimates for this sector.

Figure 29 shows the contribution of each sector to the emissions of CO_2 between 1990 and 2015.

Figure 29: Carbon dioxide emissions by source, 1990-2015, $MtCO_2e$



Source: UK GHG Inventory

2.6.2 Methane

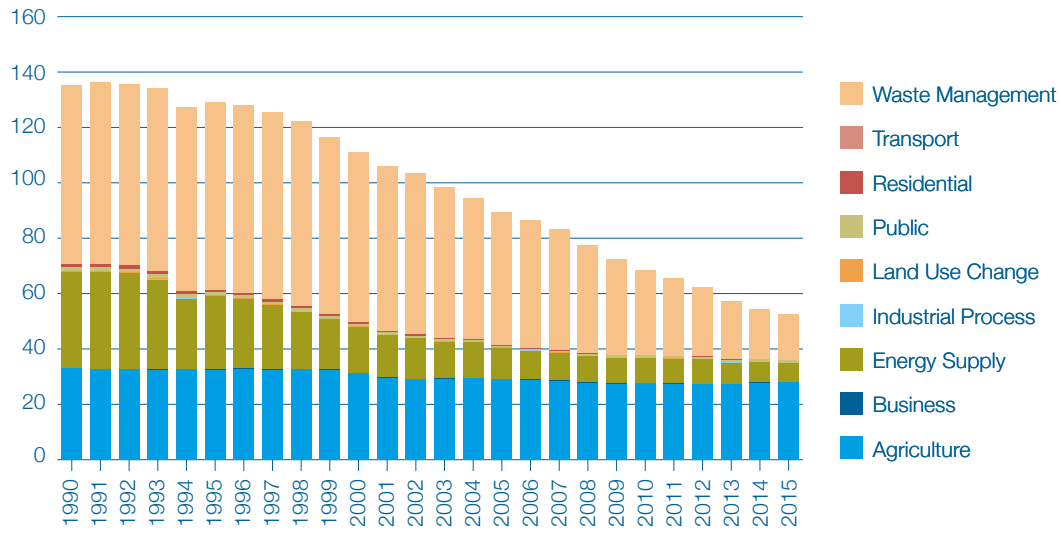
Methane is the second largest share of the UK's GHG emissions by gas. Estimated emissions of CH_4 in 1990 were 135.3 $MtCO_2e$, contributing an estimated 16.9% of the UK's total emissions of GHGs. By 2015 CH_4 emissions estimates had been reduced by 61% to 52.6 $MtCO_2e$, contributing an estimated 10.5% of UK GHG emissions in that year.

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. Landfill emissions have decreased by 48.1 $MtCO_2e$ since 1990, due to tighter regulations and increased utilisation of landfill methane in gas flares and engines.

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

Figure 30 shows the contribution of each sector to the emissions of CH_4 between 1990 and 2015.

Figure 30: Methane emissions by source, 1990-2015, $MtCO_2e$



Source: UK GHG Inventory

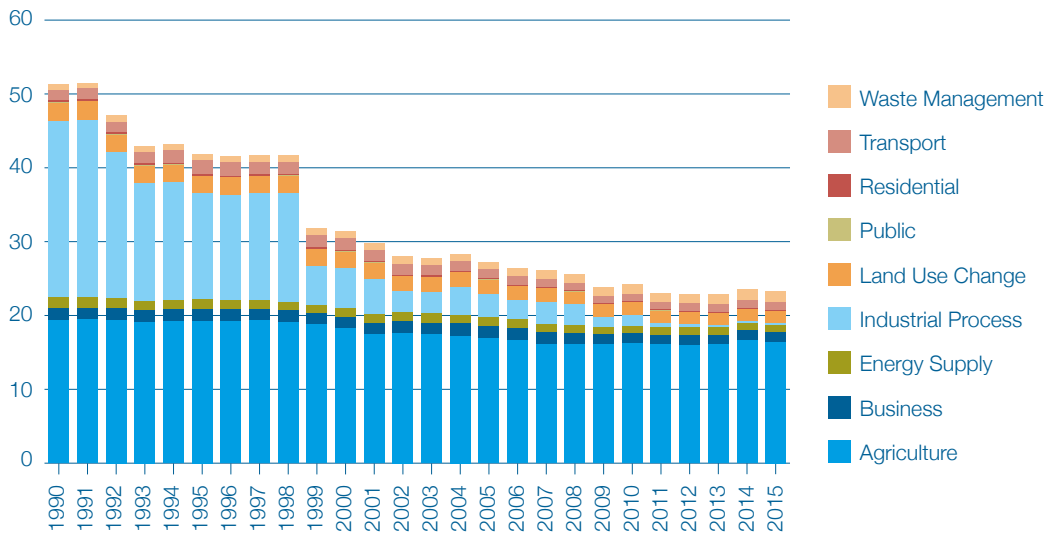
2.6.3 Nitrous oxide

Nitrous oxide emissions contributed 51.3 $MtCO_2e$ or an estimated 6.4% of the UK's total GHG emissions in 1990. By 2015 N_2O emissions estimates had been reduced by approximately 54.8% to 23.2 $MtCO_2e$, contributing an estimated 4.7% 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 2015 is agricultural soils, accounting for an estimated 60% of total N_2O emissions. Agricultural soil emissions have declined by an estimated 16.2% since 1990 due to improvements in farm management practices.

Figure 31 shows the contribution of each sector to the emissions of N_2O between 1990 and 2015.

Figure 31: Nitrous oxide emissions by source, 1990-2015, $MtCO_2e$



Source: UK GHG Inventory

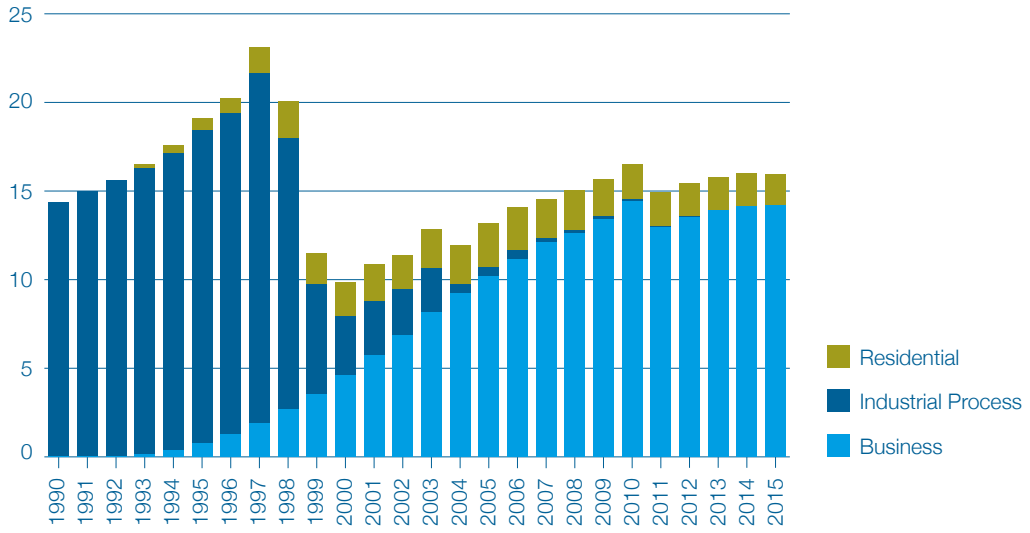
2.6.4 Fluorinated gases (hydrofluorocarbons, perfluorocarbons, sulphur hexafluoride and nitrogen Trifluoride)

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 third Biennial report (Annex A). 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 of the F-gases totalled 16.7 $MtCO_2e$ in 2015. Since 1995 the overall decrease in their emissions has been an estimated 20.1%, due mainly to the fall in emissions from F-gas manufacture, due to the installation of abatement equipment at two of the three manufacturers.

Since 1990, emissions of HFCs are estimated to have increased by 10.9%. The main reason for this is a large increase in emissions from refrigeration and air conditioning. Emissions from this sector were the largest contributor to HFC emissions in 2015, at an estimated 84% of total HFC emissions. 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 11%) 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 of HFC have increased by 62% since their minimum in 2000.

Figure 32 shows the contribution of each sector to the emissions of HFCs between 1990 and 2015.

Figure 32: Hydrofluorocarbons emissions by source, 1990-2015, $MtCO_2e$

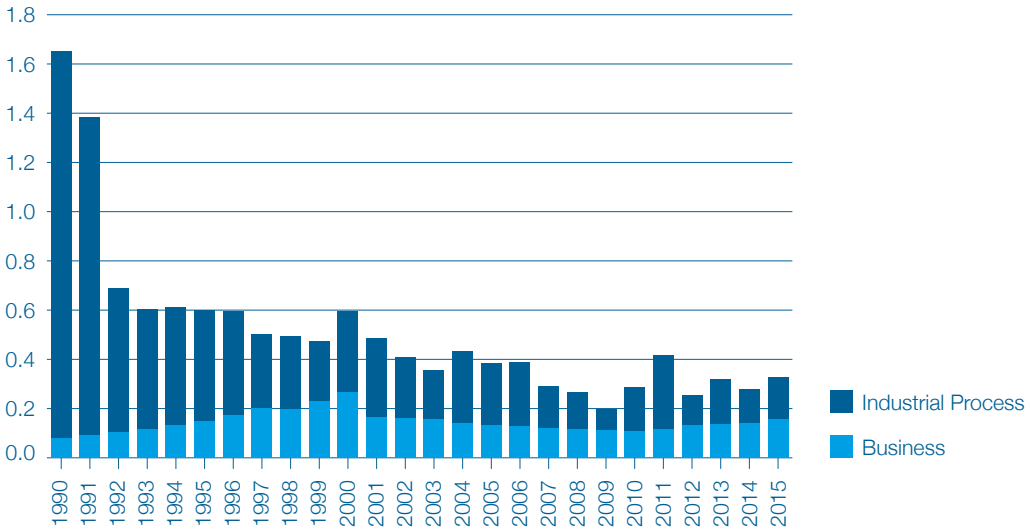


Source: UK GHG Inventory

Perfluorocarbons emissions have declined by an estimated 80.2% since 1990. The main source of PFCs emissions is fugitive halocarbon production and from electronics and sporting goods.

Figure 33 shows the contribution of each sector to the emissions of PFCs between 1990 and 2015.

Figure 33: Perfluorocarbons emissions by source, 1990-2015, $MtCO_2e$

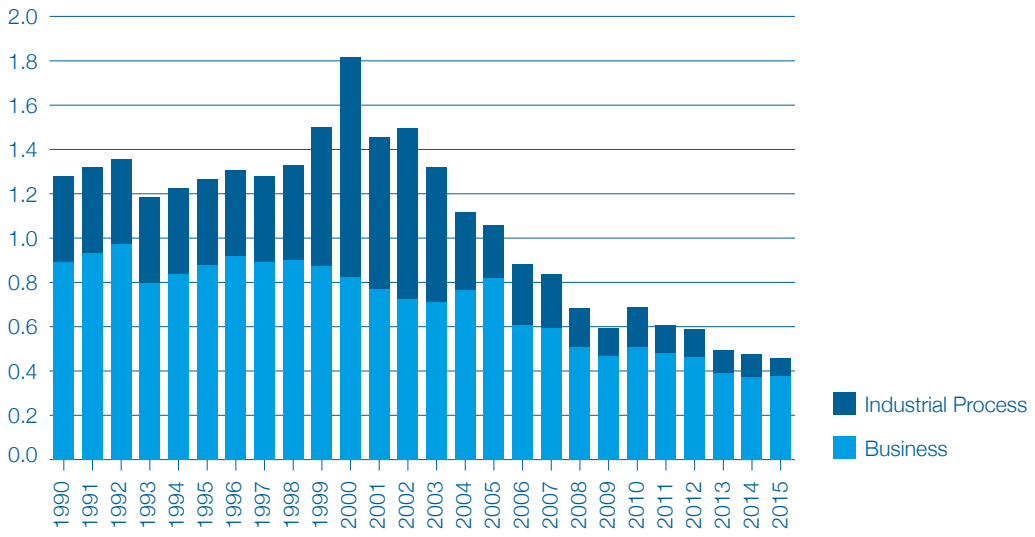


Source: UK GHG Inventory

Sulphur hexafluoride emissions have decreased by an estimated 64% since 1990. The use of SF_6 in electrical insulation contributed around 54% towards total SF_6 emissions in 2015, and total emissions from electrical insulation has decreased by an estimated 55%.

Figure 34 shows the contribution of each sector to the emissions of SF_6 between 1990 and 2015.

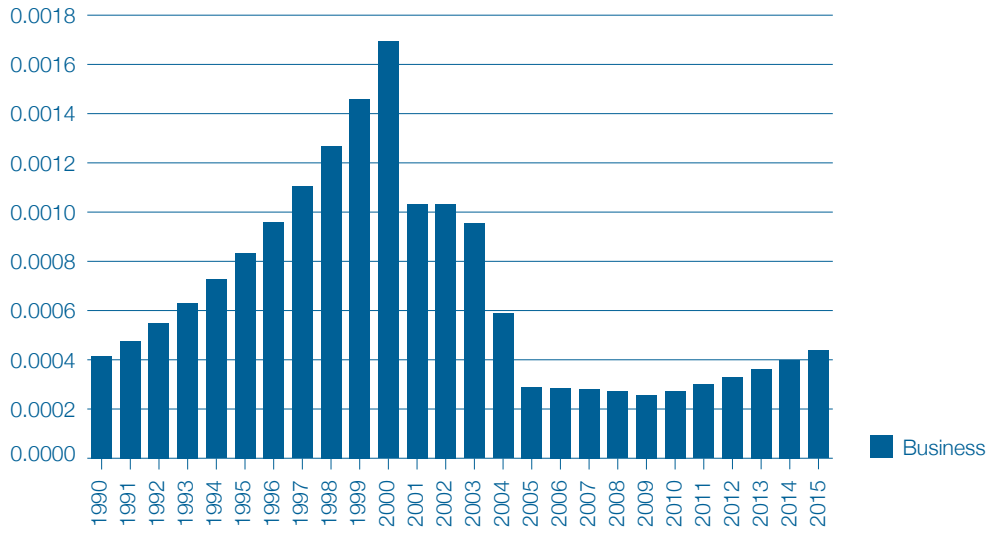
Figure 34: Sulphur hexafluoride emissions by source, 1990-2015, $MtCO_2e$



Source: UK GHG Inventory

Nitrogen Trifluoride was added to the "basket of greenhouse gases" in the 2015 inventory due to its high GWP and use in the electronics industry. NF_3 is the smallest of all the greenhouse gases with only $4.4x10^{-4}$ $MtCO_2e$ in 2015, all coming from the electronics industry.

Figure 35: Nitrogen Trifluoride emissions by source, 1990-2015, $MtCO_2e$



Source: UK GHG Inventory

2.7 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 B contains more detailed data available for all years from 1990-2015.

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

Sector	1990	1995	2000	2005	2010	2015
Agriculture	59.3	58.7	55.2	51.5	48.9	49.4
Business	114.6	112.5	116.5	110.1	95.1	84.9
Energy Supply	279.1	239.2	222.2	232.3	208.1	145.5
Industrial Processes	60.0	50.9	27.1	20.6	12.7	12.7
LULUCF	5.7	3.0	0.5	-3.2	-5.8	-7.4
Public	13.5	13.3	12.1	11.2	9.7	8.1
Residential	80.4	82.0	89.1	86.1	87.9	66.7
Transport	123.0	123.3	127.8	131.7	121.3	121.0
Waste Management	66.9	69.3	63.0	49.4	31.9	18.4
Total GHG emissions by sources minus removals by sinks	802.5	752.1	713.6	689.7	609.9	499.4
Change from 1990		-6%	-11%	-14%	-24%	-38%

Source: UK GHG Inventory

Energy supply was responsible for an estimated 145.5 $MtCO_2e$ or 29.1% of total greenhouse gas emissions in 2015, with CO_2 being the most prominent gas for this sector. Overall, between 1990 and 2015, there has been a 48% decrease in greenhouse gas emissions from the energy supply sector. This decrease has resulted mainly from changes in the mix of fuels being used for electricity generation, including the growth of renewables; together with greater efficiency resulting from improvements in technology. Electricity generation in 2015 was 2 per cent lower than in 1990, again it peaked in the early 2000s and has decreased since. 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 2015, emissions have again shown a decline, down an estimated 38.6% 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.

2.8 Sectoral emissions – by end-user

This section, including Table 9, shows GHG emissions on an end-user basis. This is the only section in this chapter reported on this basis. Emissions by end-user attribute the emissions from energy supply to the end-user of that energy rather than the source. This means that emissions on an end-user basis do include emissions from electricity; however these are attributed to different sectors than in the by-source chapters above. The by-source basis reports emissions from the energy supply industry separately in its own category.

Emissions from Crown Dependencies and 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	2015
Agriculture	62.8	61.5	57.5	53.9	51.2	51.1
Business	248.4	218.5	217.5	212.4	186.7	147.0
Industrial Processes	63.1	53.4	29.2	21.4	13.5	13.3
LULUCF	5.7	3.1	0.5	-3.2	-5.8	-7.4
Public	31.5	28.9	24.4	22.4	19.3	14.6
Residential	171.5	157.3	158.1	162.3	155.7	112.1
Transport	140.0	143.3	146.8	150.3	137.3	134.9
Waste Management	66.6	69.0	62.7	49.2	31.7	18.2
Exports	9.4	13.4	13.1	17.1	16.2	12.1
Crown Dependencies and Overseas Territories	3.5	3.6	3.8	3.9	3.9	3.6
Total GHG emissions by end-user minus removals by sinks	**802.5**	**752.1**	**713.6**	**689.7**	**609.9**	**499.4**

Source: UK GHG Inventory

2.8.1 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 amounts of emissions of CO_2 from the breakdown of pesticides. In 1990, GHG emissions from agriculture were estimated to be 62.8 $MtCO_2e$ or 7.8% of total UK GHG emissions. Emissions from this sector have fallen by an estimated 18.6% between 1990 and 2015. The fall in emissions is the result of decreasing animal numbers and fertiliser use. This is reported on an end-user basis, so includes emissions from electricity used in stationary and mobile combustion.

2.8.2 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 2015, emissions from this sector were estimated to be 41% below 1990 levels and represented an estimated 29% 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 (1.5) and building stock and urban structure profile in Chapter 1. This is reported on an end-user basis, so includes emissions from electricity used in business such as the iron and steel and other industries.

2.8.3 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 79% since 1990. The largest reductions are due to 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. This is reported on an end-user basis, so includes a small amount of emissions from electricity used in iron, steel and sinter production.

2.8.4 Land Use Change, Land Use 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. Between 1990 and 2015, total emissions of direct GHGs from the LULUCF sector decreased by an estimated 13.1MtCO_2e. The size of the net sink has decreased by 27% 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 (a net sink). Emissions from cropland have decreased by 24.2% since 1990 (7.5% since 2010). Net removals from land use change to grassland have increased by 18% since 1990.

2.8.5 Public sector

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 31.5 MtCO_2e in 1990 to 14.6 MtCO_2e in 2015; this has been largely driven by a reduction in the use of oil in this sector. In 2015 this sector represents 2.9% of total emissions. Further information describing the circumstances that affect this sector is presented in the government profile Subsection (1.3) in Chapter 1. This is reported on an end-user basis, so includes emissions from electricity used in the public sector.

2.8.6 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 2015, residential sector emissions (including those derived from electricity use in the sector) were estimated as 112.1 MtCO_2e, compared to 1990 emissions of 171.5 MtCO_2e, a reduction of approximately 35%. 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 (1.2), Climate Profile (1.4), Energy Profile and Building Stock and Urban Structure Profile (1.11) Subsections of Chapter 1. This is reported on an end-user basis, so includes emissions from electricity used in homes.

2.8.7 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 27% of UK GHG emissions in 2015, representing a reduction of 3.6% 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. The numbers of passenger vehicles and the vehicle kilometres travelled have both seen an increase across the time series. Despite these increases, 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. Due to the increased manufacture of more fuel efficient cars, new cars sold in the UK are approximately 32% more fuel efficient for petrol and approximately 28% more fuel efficient for diesel than they were a decade ago[86]. Further information describing the circumstances that affect this sector is presented in the Transport Profile Subsection (1.9) in Chapter 1. This is reported on an end-user basis, so includes emissions from electricity used in things such as electric vehicles.

2.8.8 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 73% 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.

2.9 Uncertainties

The UK GHG inventory uses 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 3% in 2015.

The likely percentage change in GHG emissions between 2015 and 1990 lies between -41% and -35%; with a central estimate of -38%. 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

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

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 for UK, CDs and OTs GHG emissions, 1990-2015

Gas	1990 emissions[5] (thousand tonnes CO_2 equivalent)	2011 emissions[5] (thousand tonnes CO_2 equivalent)	Uncertainty[1] in 2015 emissions	Percentage change between 1990 and 2015	Uncertainty in 2015 emissions as % of emissions category		Range of likely % change between 1990 and 2015[4]	
					2.5 percentile	97.5 percentile	2.5 percentile	97.5 percentile
CO_2[2]	597,827	406,134	2%	-32%	397,771	414,041	-34%	-30%
CH_4	135,472	52,578	16%	-61%	45,054	61,615	-70%	-50%
N_2O	51,550	23,604	28%	-53%	19,028	32,190	-68%	-34%
HFC	14,400	15,944	9%	11%	14,426	17,452	-7%	33%
PFC	1,651	327	23%	-80%	259	407	-84%	-75%
SF_6	1,280	457	13%	-64%	396	518	-70%	-58%
NF_3	0.4	0.4	47%	14%	0.2	0.7	-46%	108%
All greenhouse gases weighted by GWP[3]	802,180	499,044	3%	-38%	486,098	513,735	-41%	-35%

Source: 2015 Final UK greenhouse gas emissions.

Notes

1 Expressed as a percentage relative to the mean value 2015 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 GHG measures its effectiveness in global warming over 100 years relative to carbon dioxide.

4 Equivalent to a 95% probability that the percentage change between 1990 and 2015 is between the two values shown. Values include uncertainties for Overseas Territories data.

5 1990 and 2015 emissions are expressed as the central estimate from the Monte Carlo analysis of uncertainties. These differ from the actual emissions estimates.

2.10 Comparison of Sixth and Seventh National Communications

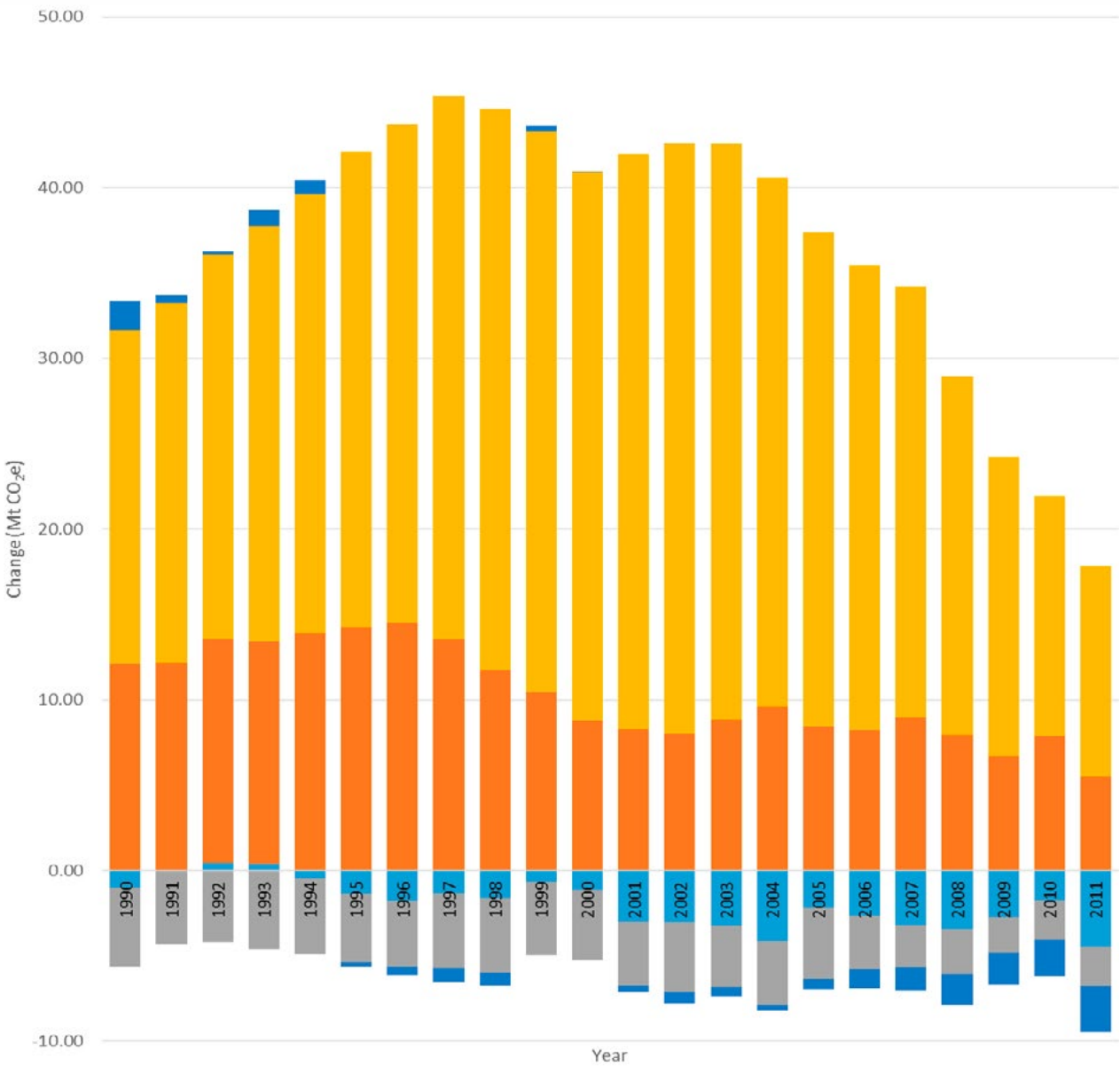
Since the publication of the Fifth National Communication in 2009, various updates and revisions to methodologies have been implemented in the UK GHG inventory that have impacted on the time-series of emissions. The most significant changes are highlighted in Table 11 below.

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

Change	Effect on inventory
Changes to the GWP values from the IPCC's Second Assessment Report (SAR) to the Fourth Assessment Report (AR4). The GWP for methane was increased and the GWP for nitrous oxide was decreased.	Increase in emissions from waste and a decrease in emissions from agriculture.
Inclusion of additional F-gases (new HFC species, NF_3) and new sources (e.g. particle accelerators, SF_6 used as a tracer gas)	Increase in estimated F-gases total.
In the waste sector, the method for estimating methane captured and flared at landfill sites has been revised in line with recommendations from UNFCCC reviews.	Significant increase in estimated emissions from landfills.
Inclusion of additional sources for industrial waste water treatment.	Increase in estimated CH_4 emissions from waste.
Reallocation of source categories from energy to industrial processes.	Increase in estimated industrial processes emissions.
Inclusion of new activity data estimates for chemical industry (e.g. methanol and carbon black production) and categories including zinc production, and uses of N_2O (anaesthesia, propellant for cream).	Increase in estimated industrial processes emissions.

How these and other changes have impacted on total emissions over the time series when compared to data presented in the 6th National Communication (1990-2011) is summarised, by sector, in Figure 36 below. Compared to what was presented previously, changes have differed depending on the sector, but we can see that in the waste and industrial processes have seen increases across all years due to the changes made to the inventory. In comparison, agriculture and energy are now lower than previously reported.

Figure 36: Changes in emissions by source due to revision to the UK GHG inventory since the 6th National Communication



Source: 2015 National Inventory Report2.11 Quality Assurance/ Quality Control.

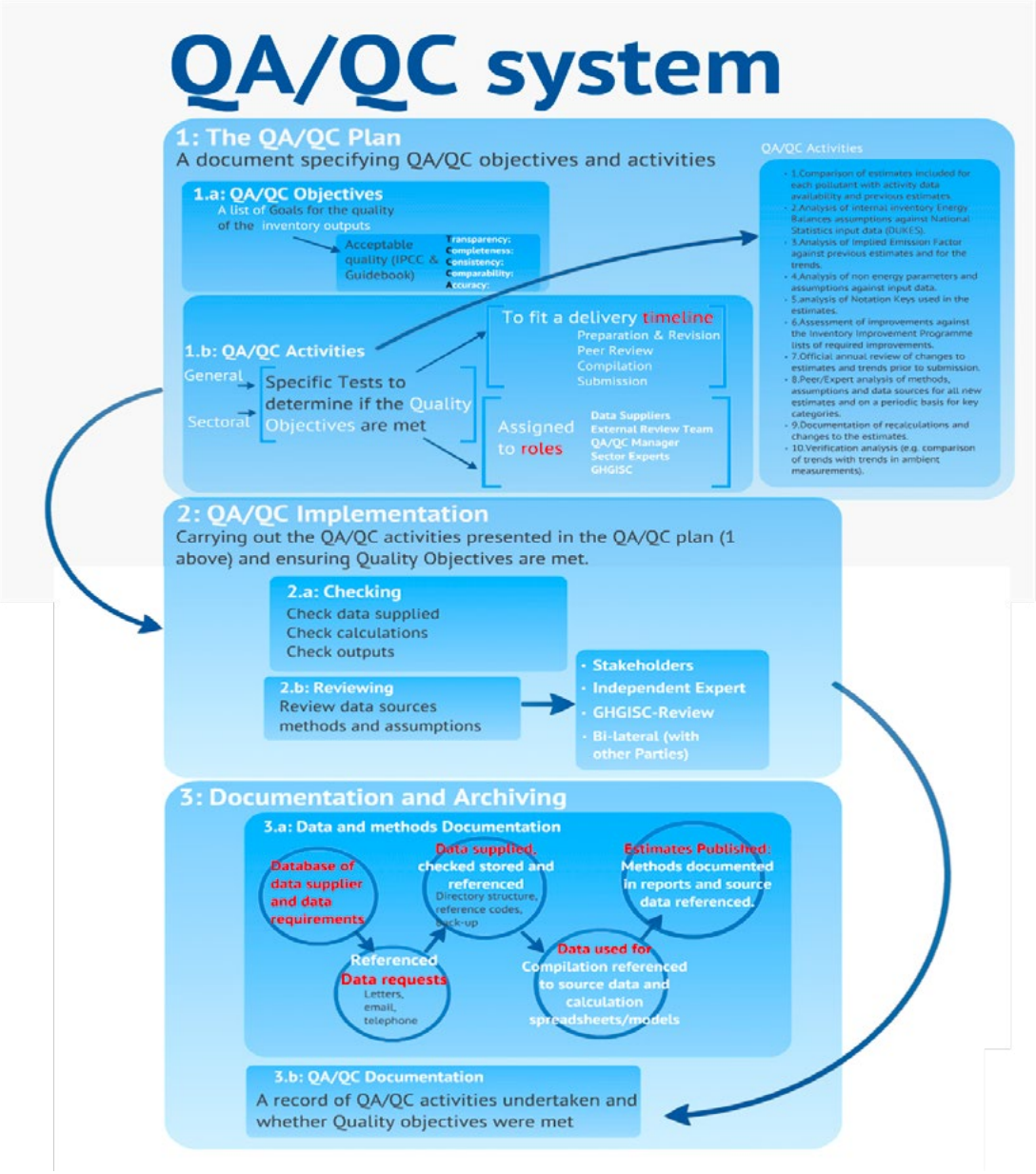
The current UK GHG inventory complies with the relevant IPCC Guidelines and Good Practice Guidance. The inventory agency is fully accredited to ISO 9001 standards that provide institutional standards that the agency must apply to all projects. Much of the data received by Ricardo Energy and Environment 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. BEIS, 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 Energy and Environment is responsible for co-ordinating inventory-wide QA/QC activities relating to the submitted datasets. In addition, Ricardo Energy and Environment 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. 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 36.

Figure 37: QA/QC system used within UK greenhouse gas inventory



Source: National Inventory Report.

To verify the emissions levels and trends reported in the GHG inventory, BEIS 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. The UK DECC Network[87] is a network of tall tower measurement sites set up to complement these measurements as part of BEIS's GHG inventory verification programme. The network of towers were established by the University of Bristol in 2012 and is located at Ridge Hill (Herefordshire) and Tacolneston (Norfolk), and used an existing tower at Angus (Dundee). In 2013 and 2014 two additional tall towers became operational as part of the NERC funded GAUGE project, Heathfield (W. Sussex) and Bilsdale (N. Yorkshire). In 2016, the tall tower at Angus was decommissioned, and the site at Bilsdale was incorporated into the UK DECC Network. The site at Heathfield was taken over by NPL but continues to measure GHGs as an affiliated UK DECC network site.' The observations enable estimates of UK emissions to be derived using a technique designed specifically for the

[87] http://www.bris.ac.uk/chemistry/research/acrg/current/decc.html

BEIS research programme, which provide an important cross-check for the GHG inventory. Establishment an expanded UK programme of atmospheric observations delivers increased spatial and temporal resolution in emissions estimates for a wide range of GHGs (CO_2, CH_4, N_2O, SF_6, and CO at all sites; and the full suite of GHGs and ODS species at Tacolneston). The UK is one of very few countries verifying its inventory in this manner.

2.11 Indirect Greenhouse Gases

The indirect GHGs emitted in significant volumes in the UK consist of Nitrogen Oxides (NO_x), Carbon Monoxide (CO), Non-Methane 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	2015
NO_x	2,929	2,352	1,825	1,616	1,145	922
CO	7,425	6,013	4,089	2,970	2,010	1,670
NMVOC	2,951	2,325	1,634	1,177	901	837
SO_2	3,696	2,379	1,229	714	425	237

Source: National Inventory Report.

Total emissions of CO in 2015 were 1670 Kt, and since 1990, emissions have decreased by 78%. 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 2015, total emissions of NOx were 922 Kt, and since 1990, emissions have decreased by 69%. 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 2015 were 237 Kt, and since 1990, emissions have decreased by 94%. 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 2015 were 837 Kt, and since 1990, overall emissions have decreased by 78%. This has been for 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 made impressive progress against its carbon reduction target. In 2016, 47 % of UK electricity came from low carbon sources, around double the level in 2010[88], and the UK now has the largest installed offshore wind capacity in the world. Homes and commercial buildings in the UK have become more efficient in the way they use energy which helps to reduce emissions and also cut energy bills, for example average household energy consumption has fallen by 17% since 1990[89].

Automotive engine technology has helped drive down emissions per kilometre driven by up to 16% and driving a new car bought in 2015 will save car owners up to £200 on their annual fuel bill, compared to a car bought new in 2000[90]. England also recycles nearly four times more than it did in 2000[91].

This progress has been aided by the falling costs of many low carbon technologies:

renewable power sources like solar and wind are comparable in cost to coal and gas in many countries[92]; energy efficient light bulbs are over 80% cheaper today than in 2010[93]; and the cost of electric vehicle battery packs has tumbled by over 70% in this time[94].

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88 BEIS (2017): Digest of UK Energy Statistics 2017 https://www.gov.uk/government/statistics/energy-chapter-1-digest-of-united-kingdom-energy-statistics-dukes

89 BEIS (2017) Energy Consumption in the UK https://www.gov.uk/government/statistics/energy-consumption-in-the-uk Change in average consumption per household 1990-2016.

90 Annual average household saving from driving a car purchased new in 2015 (the latest year for which data is available) compared to driving a car purchased new in 2000. Fuel savings valued using 2015 prices. DfT (2017) National Travel Survey; DfT (2017) Vehicles Statistics; ICCT (2015) From Laboratory to Road; BEIS (2016) Green Book supplementary appraisal guidance.

91 Defra (2016) ENV18 – Local authority collected waste: annual results tables: https://www.gov.uk/government/statistical-data-sets/env18-local-authority-collected-waste-annual-results-tables

92 New Climate Economy (2014) Better Growth, Better Climate http://newclimateeconomy.report/

93 International Energy Agency (2016) Energy Efficiency Market Report https://www.iea.org/eemr16/files/medium-term-energy-efficiency-2016_WEB.PDF

94 Bloomberg New Energy Finance (2016) 2016 lithium-ion battery price survey https://www.bnef.com/core/insights/15597

This progress has meant that the UK has outperformed the target emissions reductions of the first carbon budget (2008 to 2012) by one %[95] and it is projected that the UK will outperform against the second and third budgets, covering the years 2013 to 2022, by about four % and six % respectively[96].

To build on this progress, and to address the challenges ahead, the UK Government published its Clean Growth Strategy, setting out a comprehensive set of policies and proposals that aim to accelerate the pace of decreasing emissions, while delivering economic growth.

3.2 Introduction

The UK was one of the first countries to recognise and act on the economic and security threats of climate change. The Climate Change Act, passed in 2008, committed the UK to reducing greenhouse gas emissions by at least 80% by 2050 when compared to 1990 levels, through a process of setting five year caps on greenhouse gas emissions termed 'Carbon Budgets'. This approach has now been used as a model for action across the world, and is mirrored by the United Nations' Paris Agreement.

The UK has been among the most successful countries in the developed world in growing its economy while reducing emissions. Since 1990, the UK Government has cut emissions by 42% while our economy has grown by two thirds. This means that the UK has reduced emissions faster than any other G7 nation, while leading the G7 group of countries in growth in national income over this period.

This chapter sets out the policies and measures that contribute to the UK meeting its obligations to reduce GHG emissions by 80% by 2050.

3.3 Policy making process

3.3.1 UK

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

Some policies are the responsibility of BEIS directly, while others are the responsibility of HMT, DfT, Defra, Department for Communities and Local Government, Foreign and Commonwealth Office, Department for Exiting the European Union, and Department for International Development.

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 Paris Agreement 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.

3.3.2 Welsh Government

The Environment (Wales) Act 2016 sets a statutory target and a duty on Welsh Ministers to reduce Wales' emissions by at least 80% by 2050. It requires interim targets for 2020, 2030

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[95] DECC (2014) https://www.gov.uk/government/statistics/final-statement-for-the-first-carbon-budget-period

[96] Figures available in Energy and Emission Projection report due to be published in January 2018.

and 2040 and a framework of five-yearly carbon budgets. The interim targets and the first two carbon budgets (2016 to 2020 and 2021 to 2025) must be set in regulations by the end of 2018. The Welsh Government must publish a delivery plan of policies and proposals for meeting each carbon budget.

Before the first Welsh budget is set in 2018, the Welsh Government needs to quantify Welsh emissions and take into account Wales-specific industry, science, technology and the latest Future Trends reports, as well as exploring what potential action will mean for people and businesses in Wales.

The Welsh Government is currently reviewing existing policies for their emission reduction potential, as well as exploring potential new areas to take action to decarbonise. This is being carried out across the Welsh Government and through working closely with stakeholders.

Prior to the interim targets and carbon budgets being set, the Welsh Government continues to work towards targets in the 2010 Climate Change Strategy for Wales. This includes a target to reduce greenhouse gas emissions in areas of devolved competence by 3% a year from 2011 (against a baseline average between 2006 and 2010) and achieve at least a 40% reduction in all emissions in Wales by 2020 (against a 1990 baseline).

The Welsh Government has consistently achieved the 3% target. In 2014 emissions were 27.34 $MtCO_2e$, a reduction of 20% from the baseline which is in excess of its target of 12% for 2014. This means there has been a 6% reduction compared with the previous year.

In terms of progress against the 40% target, by 2015 Wales had reduced emissions by 20% compared to the base year. This is mainly due to a reduction in the use of coal in the power generation sector, a reduction in emissions from refineries and the residential sector. There was an 1% decrease in greenhouse gas emissions in 2015 compared with 2014.

3.3.3 Scottish Government

Action to mitigate climate change is a key component of the Scottish Government's aim to create a growing, sustainable and inclusive economy.

The Climate Change (Scotland) Act 2009 sets targets to reduce Scotland's emissions of greenhouse gases by at least 42% by 2020 and 80% by 2050, compared to the 1990/1995 baseline. The Act also requires that annual emissions reduction targets are set for each year in the period 2010-2050, consistent with achieving the long-term targets. The Act anticipated that reducing greenhouse gas emissions would be required across all major sectors of the economy and society. Specifically, it requires the Scottish Government to set out policies and proposals for energy efficiency, energy generation, land use and transport.

In February 2018, the Scottish Government will publish its third Climate Change Plan setting out how it intends to meet emission reduction targets in the period 2017-2032. The draft Plan contains transformational outcomes in transport, heat, electricity generation, and energy efficiency along with increased natural carbon sinks and more efficient and profitable agricultural practices.

In recognition of cross-government responsibility, the Cabinet Sub-Committee on Climate Change, chaired by the Cabinet Secretary for the Environment, Climate Change and Land Reform, has overseen the development and production of the draft Climate Change Plan. Scottish Ministers have worked collaboratively to develop policies and proposals for emissions reductions across sectors in ways that maximise opportunities and minimise costs.

Local government, other public bodies, the private sector, the third sector, and communities and households all have important roles to play. Throughout the Scottish Government's draft Climate

Change Plan there are examples of how and where other actors are, or will be, taking action to reduce greenhouse gas emissions and reaping the wide range of other social and economic benefits that such actions bring.

To accompany the draft Climate Change Plan, the Scottish Government has developed a new, overarching Scottish Energy Strategy. The strategy is the first of its kind, providing a full explanation of the energy system in Scotland. The Scottish Government's vision for 2050 is for a flourishing, competitive local and national energy sector, delivering secure, affordable, clean energy for Scotland's households, communities and businesses.[97]

3.3.4 Northern Ireland Executive

Northern Ireland continues to contribute to the achievement of the UK target of an at least 80% reduction in greenhouse gas emissions by 2050 and the UK carbon budgets. From 1990 to 2015 there has been a reduction in Northern Ireland emissions of 17.8%.

Supporting efforts to reduce greenhouse gas emissions the draft Northern Ireland Programme for Government (2016-2021) includes an indicator for the reduction in greenhouse gas emissions to contribute to the outcome, 'We live and work sustainably – protecting the environment.' Targets and actions, agreed with stakeholders, will be monitored for progress and reported on annually to Government.

To increase recycling and reduce waste to landfill communications campaigns are being developed to build public awareness, understanding and confidence in council led recycling. Work is also on going to identify gaps in recycling so that support can be provided to local councils and other stakeholders to address the areas identified.

The NICS Energy Management Strategy being developed will focus on energy efficiency, procurement and usage across the government estate. Contributing to the strategy is a study to identify how the forestry estate may be able to generate renewable energy, storage and energy efficient measures that reduce costs of power and benefits emissions reduction. The Energy Management Strategy also encompasses work by Northern Ireland Water to reduce the production of greenhouse gases from its operations through investment of at least £6m on a programme for energy efficiency and renewable energy generation.

Across government the Department of Education is undertaking a pilot project to install automated meter reading systems in a number of the most inefficient school buildings, the Department of Health is taking forward the Royal Victoria Hospital Energy Centre Project and the Forestry Strategy is currently being reviewed and will identify actions to increase tree planting. In transport, work is progressing to encourage a shift to cycling, increase use of public transport and support the introduction of Ultra Low Emission Vehicles to the Northern Ireland market.

The Department for the Economy (DfE) is currently progressing the development of a new longer term energy strategy to replace the current Strategic Energy Framework (SEF 2010-20). DfE Officials have already undertaken significant work in relation to the development of a new strategy and continue to progress this. It is anticipated that the new energy strategy will cover a timeframe up to 2050 (dependent on Ministerial decisions). The future directions for renewable energy and energy efficiency policy are expected to form integral parts of the overall strategy. The Northern Ireland Executive's target of 40% of electricity consumption coming from renewable sources by 2020 remains in place (with the figure as of 31 March 2017 standing at 27.1%).

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[97] http://www.gov.scot/Publications/2017/01/3414

Through the Northern Ireland Sustainable Energy Programme (NISEP) energy companies provide energy saving measures to low income households. This has been extended to March 2019 and options for a new energy efficiency scheme (Energy Wise) to replace the scheme from April 2019 is currently being considered. Work is also being progressed on the introduction of new building regulations in 2018 that will further improve the energy efficiency of new buildings.

3.3.5 Quantified economy-wide emissions reduction targets (QEWER)

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), which remains in place as detailed in the Sixth National Communication.

The EU has also agreed on a new 2030 framework for Climate and Energy under the Clean Energy Package, which includes targets and policy aims and objects for the period 2020-2030. The EU-wide targets for 2030 are:

- At least a 40% cut in greenhouse gas emissions
- at least a 27% share of renewable energy consumption
- at least 27% energy savings

3.3.5.2 Domestic Target

The Sixth National Communication highlighted the 2008 Climate Change Act which established the world's first legally binding framework. It also discussed the ensuing 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 updated carbon budgets and the UK's progress in achieving the limits.

The targets:

- The UK has put the first five carbon budgets in law through secondary legislation, covering the period from 2008 to 2032, with the sixth carbon budget due to be set in 2021.
- These carbon budgets limit GHG emissions to, and do not include emissions savings from all policies and proposals in the Clean Growth Strategy:

Targets and projected performance

	CB1 (2008-12)	CB2 (2013-17)	CB31 (2018-22)	CB4 (2023-27)	CB5 (2028-32)
Carbon budget level ($MtCO_2e$)	3,018	2,782	2,544	1,950	1,725
of which traded	1,233	1,078	985	690	590
of which non-traded	1,785	1,704	1,599	1,260	1,135
Percentage reduction below base year levels	25%	31%	37%	51%	57%

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.

3.3.6 The Kyoto mechanisms

The Kyoto Protocol agreed in 1997, set quantitative limits to emissions but only for industrialised nations. The UK was set a target of a 12.5% reduction by 2008-12 below 1990 levels (within an EU-wide target of 8%), which it comfortably exceeded. A second Kyoto commitment period was agreed for the period of 2013-20. 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. The UK is also on track to meet this target.

In accordance with the Kyoto protocol, the Environment Agency is the UK's designated national authority (DNA) under the Clean Development Mechanism (CDM).

3.3.7 The Paris Agreement

Under the Paris Agreement, as well as seeking to limit warming to well below 2 degrees, and to pursue 1.5 degrees, the UK is committed to working with other countries to achieve global net zero emissions in the second half of the century.

3.3.8 Summary of policies and measures

The UK has a significant package of policies and measures to meet the targets. Many of the policies described in this chapter cut across different sectors and involve a number of different delivery mechanisms. The UK has also published its Clean Growth Strategy, identifying areas where greatest progress is required, and setting out future policies, proposals and aspirations.

The Scottish Government has published a draft of its third Climate Change Plan setting out policies and proposals to achieve Scotland's ambitious targets[98] . The final plan will be published in February 2018.

[98] http://www.gov.scot/Publications/2017/01/2768

Table CTF3: Progress in achievement of the quantified economy-wide emissions reductions 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 implementation
New Energy Supply policies 1 *	Energy, Industry/Industrial Processes	CO_2, (CH_4, N_2O)	To increase the proportion of low carbon (Nuclear, CCS) and renewables electricity generation.	Regulatory, Economic	Various
Renewables Obligation 1 *	Energy	CO_2, (CH_4, N_2O)	To increase in the proportion of electricity generation and supply from renewables.	Regulatory, Economic	Implemented
EU Emissions Trading System *	Energy, Industry/ Industrial Processes, Other (Public sector)	CO_2, (CH_4, N_2O, PFCs)	To reduce the use of emissions intensive fossil fuels and increase the use of renewables.	Economic	Implemented
Large Combustion Plant Directive *	Energy, Industry/ Industrial Processes	CO_2, (CH_4, N_2O)	To improve air quality by limiting industrial emissions of nitrogen oxides, sulphur dioxide and dust. This indirectly acts to mitigate GHG emission by reducing the use of high carbon (coal) generation in the electricity supply industry.	Regulatory	Expired
Additional renewables in generation (Renewable Energy Strategy) 1 *	Energy	CO_2, (CH_4, N_2O)	To further increase in the proportion of electricity generation and supply from renewables.	Regulatory, Economic	Implemented
Feed in Tariffs (FITS) *	Energy	CO_2, (CH_4, N_2O)	Encourage small-scale, low carbon generation.	Regulatory, Economic	Implemented
Industrial Emissions Directive (as it applies to Large Combustion Plant) *	Energy, Industry/ 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
Capacity Mechanism 1 *	Energy	CO_2, (CH_4, N_2O)	To increase the proportion of low carbon (Nuclear, CCS) and renewables electricity generation.	Economic	Adopted
Contract for Difference (CfD) (2014-2020) 1 *	Energy	CO_2, (CH_4, N_2O)	To increase the proportion of low carbon (Nuclear, CCS) and renewables electricity generation.	Economic	Implemented

Brief Description	Start Year of Implementation	Implementing Entity or Entities	Greenhouse Gas Saving ($ktCO_2$ eq)					
			2010	2015	2020	2025	2030	2035
Grouped savings produced by a selection of post-2009 energy supply policies as indicated in this table with a label '1'.	2002	Department for Business, Energy & Industrial Strategy (BEIS), Office of Gas and Electricity Markets (Ofgem)	-	12,952	36,170	42,863	43,240	47,279
Sets an annual obligation on electricity suppliers to source a proportion of their generation from renewable sources. Targets can be met by providing Renewable Energy Certificates (ROCs) or paying into the RO buy-out fund. The RO closed to new applicants on 31 March 2017.	2002	Department for Business, Energy & Industrial Strategy (BEIS), Office of Gas and Electricity Markets (Ofgem)	IE	IE	IE	IE	IE	IE
It sets an emissions target (cap) for installations covered by the system (across the EU), with the carbon market determining the carbon price, and therefore where emissions can be reduced most cheaply. It guarantees that total emissions in the sectors covered will not exceed the cap set, and in doing so drives investments in low-carbon technologies, leading to cutting emissions of carbon dioxide (CO_2) and other greenhouse gases at least cost.	2005	European Commission, Department for Business, Energy & Industrial Strategy (BEIS)	IE	IE	IE	IE	IE	IE
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. Has now been replaced by the Industrial Emissions Directive.	2007	Department for Food, Environment and Rural Affairs (DEFRA)	IE	IE	IE	IE	IE	IE
Increases Renewable Obligation (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 for Business, Energy & Industrial Strategy (BEIS), Office of Gas and Electricity Markets (Ofgem)	IE	IE	IE	IE	IE	IE
Feed-in Tariffs (FITs) support organisations, businesses, communities and individuals to generate low-carbon electricity using small-scale (5 MW or less total installed capacity) systems. Electricity suppliers are obliged to pay the regulated tariffs to eligible generators.	2010	Department for Business, Energy & Industrial Strategy (BEIS)	IE	IE	IE	IE	IE	IE
As transposed into UK law, the IED replaced the LCPD from 1 January 2016 with similar although more stringent provisions set out in chapter III of the Industrial Emissions Directive (2010/75/EU) (IED). Those provisions already apply in respect to any plant newly permitted since 7 January 2013. Three compliance routes were available to generating plants; to abate emissions and comply with more stringent limits by 2020; to comply with less stringent limits but face a 1,500 hour per year load factor constrain; or to close by 2023.	2016	Department for Food, Environment and Rural Affairs (DEFRA)	IE	IE	IE	IE	IE	IE
Part of the government's Electricity Market Reform package, the Capacity Market ensures that sufficient capacity is available to meet peak demand, encouraging construction and use of new low carbon generation capacity.	2017	Department for Business, Energy & Industrial Strategy (BEIS)	IE	IE	IE	IE	IE	IE
Offers Contracts for Difference (CfDs) in the electricity generation market for low carbon and renewable sources, CfDs will replace Renewable Obligation Certificates (ROCs) which are due to be phased out from 2017. Current policy offers CfD for new capacity through auctions should Government's choose to hold them. There is also a bilateral negotiation underway for Hinkley point C Nuclear plant.	2014	Department for Business, Energy & Industrial Strategy (BEIS)	IE	IE	IE	IE	IE	IE

Name of Mitigation Action	Sectors affected	GHG affected	Objective and or activity affected	Type of Instrument	Status of implementation
Contract for Difference (CfD) (2021-2035)	Energy	CO_2, (CH_4, N_2O)	To increase the proportion of low carbon (Nuclear, CCS) and renewables generation.	Economic	Planned
Carbon Price Floor 1 *	Energy	CO_2, (CH_4, N_2O)	To reduce the use of emissions intensive fossil fuels and increase the use of renewables in electricity generation.	Economic	Implemented
Building Regulations Part L (2002+2005/6) *	Energy, Industry/ Industrial Processes, Other (Public sector), Other (Residential)	CO_2, (CH_4, N_2O)	Improve energy efficiency of buildings.	Regulatory	Implemented
Building Regulations 2010 Part L *	Energy, Industry/ Industrial Processes, Other (Public sector), Other (Residential)	CO_2, (CH_4, N_2O)	Improve energy efficiency of buildings.	Regulatory	Implemented
Building Regulations 2013 Part L *	Energy, Industry/ Industrial Processes, Other (Public sector), Other (Residential)	CO_2, (CH_4, N_2O)	Improve energy efficiency of buildings.	Regulatory	Implemented
Products Policy (Implemented) *	Energy, Industry/ Industrial Processes, Other (Public sector), Other (Residential)	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
Products Policy (Adopted) *	Energy, Industry/ Industrial Processes, Other (Public sector), Other (Residential)	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
Renewable Heat Incentive *	Energy, Industry/ Industrial Processes, Other (Public sector), Other (Residential)	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
Renewable heat incentive (planned funding)	Energy, Industry/ Industrial Processes, Other (Public sector), Other (Residential)	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	Planned

Brief Description	Start Year of Implementation	Implementing Entity or Entities	Greenhouse Gas Saving ($ktCO_2$ eq)					
			2010	2015	2020	2025	2030	2035
Planned continuation of Contracts for Difference (CfDs) for new low carbon capacity after 2020.	2021	Department for Business, Energy & Industrial Strategy (BEIS)	IE	IE	IE	IE	IE	IE
The Carbon Price Floor (CPF) is designed to further reduce the use of emission-intensive fossil fuels and increase the proportion of electricity generation and supply from low carbon sources.	2013	Department for Business, Energy & Industrial Strategy (BEIS)	IE	IE	IE	IE	IE	IE
Building Regulations set minimum energy performance standards for new buildings and when people carry out controlled 'building work' to existing properties including extensions, conversions and certain categories of renovation and replacement windows and boilers.	2002	Department for Communities and Local Government (DCLG)	5,544	8,801	10,140	7,708	5,110	2,733
Building Regulations set minimum energy performance standards for new buildings and when people carry out controlled 'building work' to existing properties including extensions, conversions and certain categories of renovation and replacement windows and boilers.	2010	Department for Communities and Local Government (DCLG)	-	3,232	5,382	6,376	4,832	3,772
Building Regulations set minimum energy performance standards for new buildings and when people carry out controlled 'building work' to existing properties including extensions, conversions and certain categories of renovation and replacement windows and boilers.	2013	Department for Communities and Local Government (DCLG)	-	22	88	100	95	84
The EU Ecodesign Directive and the Energy Labelling Framework Regulation respectively operate by setting minimum performance and information requirements for energy using products placed to take the least efficient products off the market and to give consumers clear information to make informed purchasing decisions. This is implemented through product specific EU regulations.	2008	Department for Business, Energy & Industrial Strategy (BEIS)	825	5,923	5,593	3,082	1,631	485
The EU Ecodesign Directive and the Energy Labelling Framework Regulation respectively operate by setting minimum performance and information requirements for energy using products placed to take the least efficient products off the market and to give consumers clear information to make informed purchasing decisions. This is implemented through product specific EU regulations.	2017	Department for Business, Energy & Industrial Strategy (BEIS)	-	-	83	132	128	65
The Non-Domestic Renewable Heat Incentive (RHI) provides financial incentives to increase the uptake of renewable heat by businesses, the public sector and non-profit organisations. Eligible installations receive quarterly payments for 20 years based on the amount of heat generated. The Domestic RHI is a government financial incentive to promote the use of renewable heat. Eligible installations receive quarterly payments for seven years for the amount of renewable heat it is estimated their system produces.	2011	Department for Business, Energy & Industrial Strategy (BEIS)	-	1,491	2,401	2,444	2,418	1,014
The Non-Domestic Renewable Heat Incentive (RHI) provides financial incentives to increase the uptake of renewable heat by businesses, the public sector and non-profit organisations. Eligible installations receive quarterly payments for 20 years based on the amount of heat generated. The Domestic RHI is a government financial incentive to promote the use of renewable heat. Eligible installations receive quarterly payments for seven years for the amount of renewable heat it is estimated their system produces.	2017	Department for Business, Energy & Industrial Strategy (BEIS)	-	-	2,132	2,589	2,600	2,609

Name of Mitigation Action	Sectors affected	GHG affected	Objective and or activity affected	Type of Instrument	Status of implementation
Smart Metering *	Energy, Industry/ Industrial Processes, Other (Residential)	CO_2, (CH_4, N_2O)	Reduce consumption of electricity and gas though provision of better management information.	Information	Implemented
Carbon Trust measures *	Energy, Industry/ Industrial Processes, Other (Public sector)	CO_2, (CH_4, N_2O)	Improve energy efficiency in buildings	Information, Education	Expired
CRC Energy Efficiency Scheme *	Energy, Industry/ Industrial Processes, Other (Public sector)	CO_2, (CH_4, N_2O)	To drive emission reductions from large non-energy intensive private and public sector organisations.	Economic, Information	Implemented
Climate Change Levy (CCL)	Energy, Industry/ Industrial Processes, Other (Public sector)	CO_2, (CH_4, N_2O)	To incentivise businesses to reduce their energy consumption	Economic, Regulatory	Implemented
CCL Budget 2016 Changes	Energy, Industry/ Industrial Processes, Other (Public sector)	CO_2, (CH_4, N_2O)	To incentivise businesses to reduce their energy consumption	Economic, Regulatory	Adopted
Energy Company Obligation *	Energy, Other (Residential)	CO_2, (CH_4, N_2O)	To improve the energy efficiency of residential and commercial buildings and address fuel poverty.	Economic, Regulatory	Expired
Energy Company Obligation Extension *	Energy, Other (Residential)	CO_2, (CH_4, N_2O)	To improve the energy efficiency of residential and commercial buildings and address fuel poverty.	Economic, Regulatory	Implemented

Brief Description	Start Year of Implementation	Implementing Entity or Entities	Greenhouse Gas Saving ($ktCO_2$ eq)					
			2010	2015	2020	2025	2030	2035
The smart metering programme will replace 53 million meters with smart electricity and gas meters in all domestic properties, and smart or advanced meters in smaller non domestic sites in Great Britain by the end of 2020. Smart meters will deliver consumers with near-real time information on their energy consumption to help them control energy use, and avoid wasting energy and money. It will deliver energy networks with better information upon which to manage and plan current activities. Smart meters will also assist the move towards smart grids which support sustainable energy supply and will help reduce the total energy needed in the system.	2012	Department for Business, Energy & Industrial Strategy (BEIS)	-	327	2,058	2,021	1,851	1,744
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 organisations of all sizes.	2002	Carbon Trust	3,567	1,615	353	66	-	-
The Carbon Reduction Commitment (CRC) is a mandatory UK-wide emissions trading scheme (launched in 2010). It 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. It covers 1800-1900 large users of energy across the business and public sector. The scheme is split into phases. Phase 1 ran from 1 April 2010 until 31 March 2014. Phase 2 runs from 1 April 2014 until 31 March 2019. In the 2016 Spring Budget, the Chancellor announced the closure of the CRC after Phase 2 (i.e. following the 2018/19 compliance year).	2010	Department for Business, Energy & Industrial Strategy (BEIS), Environment Agency (EA). Devolved Administrations.	18	572	972	909	-	-
The Climate Change Levy (CCL) was introduced in 2001. It is levied on the supply of energy to business and public sector consumers. Each of the four main groups of taxable commodities (electricity, gas, solid fuels, and liquefied petroleum gas [LPG]) has its own main rate per unit of energy. The main rates of the CCL are intended to incentivise businesses to reduce their energy consumption. Eligible energy-intensive industries may pay reduced main rates of CCL through CCAs, or be exempt from the CCL for mineralogical/metallurgical processes.	2001	Department for Business, Energy & Industrial Strategy (BEIS)	IE	IE	IE	IE	IE	IE
Budget 2016 announced that CCL rates will increase from April 2019, moving to an electricity-to-gas ratio of 2.5:1 compared to the previous 2.9:1 ratio. In the longer term, the government intends to rebalance the rates further, reaching a ratio of 1:1 by 2025. The changes in CCL between 2019 and 2025, as well as the rates from 2025 onwards, have not yet been announced.	2019	Department for Business, Energy & Industrial Strategy (BEIS)	-	-	689	1,035	841	780
The Energy Company Obligation (ECO) is a statutory obligation on energy suppliers with over 250,000 domestic customers and delivering over a certain amount of electricity or gas to make reductions in carbon emissions or achieve heating cost savings in domestic households. ECO focuses on insulation measures, and also heating improvements to low income and vulnerable households. It ran until March 2017. ECO initially ran to Mar 15 (also known as 'ECO1'), although was extended in April 2014 to March 2017('ECO2').	2013	Department for Business, Energy & Industrial Strategy (BEIS), Large Energy Suppliers	-	856	665	622	596	577
The 2015 Spending Review announced that ECO will be replaced with a new, lower cost scheme that will run for 5 years (to March 2022) and will tackle the root causes of fuel poverty. The 5 year extension will take place in the two phases, with the ECO Extension (April 2017 – Sept 2018) acting as a bridge between the expired ECO scheme and the new fuel poverty focussed scheme, ECO 3, which will run from Oct 2018 to March 2022.	2017	Department for Business, Energy & Industrial Strategy (BEIS), Large Energy Suppliers	-	-	204	188	189	187

Name of Mitigation Action	Sectors affected	GHG affected	Objective and or activity affected	Type of Instrument	Status of implementation
Energy Company Obligation 3 *	Energy, Other (Residential)	CO_2, (CH_4, N_2O)	To improve the energy efficiency of residential and commercial buildings and address fuel poverty.	Economic, Regulatory	Planned
Warm Front *	Energy, Other (Residential)	CO_2, (CH_4, N_2O)	Tackling fuel poverty, improving energy efficiency for poorer households.	Economic	Expired
EEC1, EEC2 (2002-2008) & Baseline Carbon Emissions Reductions Target (CERT) (2008-2010) *	Energy, Other (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	Expired
Carbon Emissions Reduction Target (CERT) Uplift and Extension (2010-12) *	Energy, Other (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	Expired
Community Energy Saving Programme (CESP) *	Energy, Other (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	Expired
Energy Performance of Buildings Directive (EPBD) *	Energy, Industry/ Industrial processes, Other (Residential), Other (public sector)	CO_2, (CH_4, N_2O)	Encourage uptake of energy efficiency measures.	Regulatory, Information	Expired

Brief Description	Start Year of Implementation	Implementing Entity or Entities	Greenhouse Gas Saving ($ktCO_2$ eq)					
			2010	2015	2020	2025	2030	2035
The 2015 Spending Review announced that ECO will be replaced with a new, lower cost scheme that will run for 5 years (to March 2022) and will tackle the root causes of fuel poverty. The 5 year extension will take place in the two phases, with the ECO Extension (April 2017 – Sept 2018) acting as a bridge between the expired ECO scheme and the new fuel poverty focussed scheme, ECO 3, which will run from Oct 2018 to March 2022.	2018	Department for Business, Energy & Industrial Strategy (BEIS), Large Energy Suppliers	-	-	374	467	457	452
Warm Front installed heating and insulation measures to make homes warmer and more energy efficient for private sector households in England vulnerable to fuel poverty. The scheme offered 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 for Business, Energy & Industrial Strategy (BEIS), Devolved Administrations, Carillion Energy Services.	1,125	332	247	251	262	259
Energy Efficiency Commitment I (EEC I): GB wide regulation that 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 incentivising their customers to install energy-efficiency measures in homes. 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) – GB regulation that required all domestic energy suppliers with a customer base in excess of 50,000 domestic customers to make savings in the amount of CO_2 emitted by householders.	2002	Department for Business, Energy & Industrial Strategy (BEIS), Office of Gas and Electricity Markets (Ofgem). Large domestic energy suppliers.	5,446	4,627	2,987	2,476	2,293	2,258
CERT extension – increased the targets originally set under CERT by 20% and required domestic energy suppliers with a customer base in excess of 50,000 (later increased to 250,000) to make savings in the amount of CO_2 emitted by householders. The extension also refocused subsidy towards insulation measures and away from electricity saving measures such as low energy lighting – and introduced a super priority group (households in receipt of certain means-tested benefits) to make energy reductions in low income and vulnerable households.	2010	Department for Business, Energy & Industrial Strategy (BEIS), Office of Gas and Electricity Markets (Ofgem). Larger Energy Suppliers.	553	1,914	1,680	1,420	1,317	1,247
Community Energy Saving Programme (CESP) – area based regulation that targeted households across Great Britain, in areas of low income, to improve energy efficiency standards, and reduce fuel bills. CESP was funded by an obligation on larger energy suppliers and also the larger, electricity generators.	2009	Department for Business, Energy & Industrial Strategy (BEIS), Office of Gas and Electricity Markets (Ofgem). Larger Energy Suppliers.	-	132	102	73	63	54
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) Energy Performance Certificates (EPCs) are required when any building is sold, rented out or constructed, and after refurbishment when construction work is undertaken to a building and the modifications change the number of parts designed or altered for separate use and include the provision or extension of any fixed services for heating, hot water, air-conditioning and mechanical ventilation. EPCs give information on a building's energy efficiency in a sliding scale from 'A' (very efficient) to 'G' (least efficient).	2007	Department for Communities and Local Government (DCLG) and the Devolved Administrations.	754	751	564	442	379	333

Name of Mitigation Action	Sectors affected	GHG affected	Objective and or activity affected	Type of Instrument	Status of implementation
Energy Performance of Buildings Directive (EPBD) Recast 2010 *	Energy, Other (Public sector)	CO_2, (CH_4, N_2O)	Encourage uptake of energy efficiency measures.	Regulatory, Information	Adopted
Energy Performance of Buildings Directive (EPBD) 2017 Cost Optimal Review and Nearly Zero Energy Buildings (NZEB) (2018 and 2020)	Energy, Industry/ Industrial processes, Other (residential), Other (public sector)	CO_2, (CH_4, N_2O)	Encourage uptake of energy efficiency measures.	Regulatory, Information	Planned
Private Rented Sector (PRS) Energy Efficiency Regulations *	Energy, Industry/ Industrial processes, Other (Residential)	CO_2, (CH_4, N_2O)	Improve energy efficiency of private rented property.	Regulatory, Information	Implemented
Public Sector Energy Efficiency Loans Scheme *	Energy, Other (Public sector)	CO_2, (CH_4, N_2O)	To address funding barriers to achieving energy efficiency in the Public sector.	Economic	Implemented
Small and Medium Enterprises (SME) Loans *	Energy, Industry/ Industrial Processes	CO_2, (CH_4, N_2O)	To address funding barriers to achieving energy efficiency by the small and medium enterprises (SMEs).	Economic	Expired
Climate change agreements (CCA) *	Energy, Industry/ Industrial Processes	CO_2, (CH_4, N_2O)	To provide an incentive for energy-intensive industries to reduce energy consumption.	Economic, Voluntary Agreement/ negotiated agreement	Implemented

Brief Description	Start Year of Implementation	Implementing Entity or Entities	Greenhouse Gas Saving ($ktCO_2$ eq)					
			2010	2015	2020	2025	2030	2035
Extension of the EPBD requirement for public buildings to display Energy Performance Certificates to include buildings over 250m² from 9 July 2015.	2015	Department for Communities and Local Government (DCLG) and the Devolved Administrations.	-	-	-	-	-	-
The Government is required to report to the European Commission by June 2017 to demonstrate that UK building standards for energy performance remain 'cost optimal'. Cost-optimal energy performance means that the lifetime cost-benefit analysis is positive. Minimum energy performance requirements must be compared against calculated cost-optimal levels using the Comparative Methodology Framework.	2017	Department for Communities and Local Government (DCLG) and the Devolved Administrations.	-	-	-	-	-	-
From the 1 April 2018 there will be a requirement for any properties rented out in the private rented sector to have a minimum energy performance rating of E on an Energy Performance Certificate (EPC). The regulations will come into force for new lets and renewals of tenancies with effect from 1 April 2018 and for all existing tenancies on 1 April 2020 (1 April 2023 for non-domestic properties). It will be unlawful to rent a property which breaches the requirement for a minimum E rating, unless there is an applicable exemption.	2016	Department for Business, Energy & Industrial Strategy (BEIS)	-	1	452	427	281	178
The Public Sector Energy Efficiency Loans Scheme, managed by Salix Finance Ltd, provides interest-free loans in England to public sector organisations for energy efficiency schemes. These loans are intended to provide the capital cost of energy efficiency retrofit work and other measures to be installed. These loans have a payback period of five years (eight for schools) during which the repayments are met with the energy bill savings from the energy efficiency measures. Thus, once the loan has been paid off, the organisations continue to benefit from energy savings for the lifetime of these measures. This funding is then recycled once it has been returned to the Scheme and once again loaned out. BEIS provides the most amount of funding to the Scheme but there is also some funding from Scotland, Wales and the Department for Education.	2004	Department for Business, Energy & Industrial Strategy (BEIS). Administered by the Carbon Trust.	82	174	297	398	331	215
The Carbon Trust provided interest free loans of £3,000 – £400,000 for small and medium sized businesses to invest in energy efficiency equipment and renewable technologies. These loans were designed so that in most cases the forecast reduction in energy costs would be similar to the total repayment amount.	2004	Department for Business, Energy & Industrial Strategy (BEIS). Administered by the Carbon Trust.	142	121	80	31	-	-
Climate Change Agreements offer participating energy-intensive industries a discount from the Climate Change Levy in return for meeting targets for energy reductions. From 2013 these are a 90% discount for electricity and a 65% discount for other fuels. From 2019 this will increase to a 93% discount for electricity and 78% discount for other fuels.	2013	Department for Business, Energy & Industrial Strategy (BEIS). Industry Associations.	IE	IE	IE	IE	IE	IE

Name of Mitigation Action	Sectors affected	GHG affected	Objective and or activity affected	Type of Instrument	Status of implementation
Energy Savings Opportunity Scheme (ESOS) *	Energy, Industry/ Industrial Processes	CO_2, (CH_4, N_2O)	To encourage the uptake of energy saving opportunities.	Regulatory/ Information	Implemented
Heat Networks Investment Project *	Energy, Other (Residential)	CO_2	To increase the volume of heat networks built through providing central Government funding.	Economic	Adopted
Rail Electrification *	Transport	CO_2, (CH_4, N_2O)	To reduce travel times, costs and fossil fuel emissions.	Economic	Implemented
Renewable Transport Fuel Obligation, (RTFO) – current 5% by volume *	Transport	CO_2	Reduce the fossil carbon content of transport fuels.	Regulatory	Implemented
Renewable Transport Fuel Obligation, (RTFO) – Increase target to meet RED	Transport	CO_2	Reduce the fossil carbon content of transport fuels.	Regulatory	Planned
Car Fuel Efficiency Policies *	Transport	CO_2, (CH_4, N_2O)	Improve fuel efficiency and reduce CO_2 emissions of cars.	Regulatory, Information, Voluntary Agreement	Implemented

Brief Description	Start Year of Implementation	Implementing Entity or Entities	Greenhouse Gas Saving ($ktCO_2$ eq)					
			2010	2015	2020	2025	2030	2035
A mandatory energy assessment scheme for all large undertakings (non-SMEs) in response to requirements contained Article 8 of the EU Energy Efficiency Directive (2012/27/EU). Organisations which employ 250 or more people, or employ fewer than 250 people but have both an annual turnover exceeding £38.9m and an annual balance sheet total exceeding £33.4m, must measure their total energy consumption and carry out audits of the energy used by their buildings, industrial processes and transport to identify cost-effective energy saving measures, by 5 December 2015 and every four years thereafter. It is estimated that around 10,000 organisations will participate in the scheme.	2014	Department for Business, Energy & Industrial Strategy (BEIS). Environment Agency.	-	-	716	572	509	455
The Heat Networks Investment Project (HNIP) capital investment programme is expected to support up to 200 projects by 2021 through grants and loans and other mechanisms and to lever in up to wider investment, reducing bills, cutting carbon and forming a key part of wider urban regeneration in many locations.	2017	Department for Business, Energy & Industrial Strategy (BEIS)	-	-	-63	-88	-96	43
Major programme of rail electrification underway to replace older diesel trains with modern, low-emission electric trains.	2013	Department for Transport (DfT), Network Rail	-	-	197	242	264	284
The RTFO set a phased 5% target for biofuel use by diesel and petrol suppliers to be achieved by 2014. Targets are by volume rather than by energy. Implements the EU Renewables Directive (2009/28/EC).	2007	Department for Transport (DfT)	2,757	2,385	2,344	2,228	2,150	2,112
To set enhanced targets for biofuel use by diesel and petrol suppliers to be achieved by 2020. Implements the EU Renewables Directive (2009/28/EC) as amended by Directive (2015/1513).	2009	Department for Transport (DfT)	-	-	5,818	5,587	5,400	5,297
EC Regulation 443/2009 sets fuel efficiency targets for new cars to be achieved by 2015 and 2020. The regulation translates a fleet average CO_2 tailpipe emissions target for new vehicles sold into the EU market into specific targets for individual manufacturers according to the mass of their fleet. Heavy fines are imposed for non-compliance. The 2021 target is for a fleet average of 95g CO_2/km across the single market, with a transition period where 95% of a manufacturer's fleet must meet the 95g target by 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. Measures to support the uptake of ultra low emission vehicles include the Plug-in Car and Plug-in Van Grants towards ultra-low emission vehicle (ULEV) cars and vans, as well as various tax incentives including lower rates for Vehicle Excise Duty and Company Car Tax. EV infrastructure is directly supported through the Workplace Charging Scheme grants for EV charge points for employees and fleets, the Electric Vehicle Home charge Scheme grants towards home EV charge points and the On-street Residential Charging Scheme. Highways England have committed £15m to ensure EV charge points are available every 20 miles on the Strategic Road Network.	2012	Department for Transport (DfT)	6	821	4,882	11,255	17,297	22,448

Name of Mitigation Action	Sectors affected	GHG affected	Objective and or activity affected	Type of Instrument	Status of implementation
Van Fuel Efficiency Policies *	Transport	CO_2, (CH_4, N_2O)	Improve fuel efficiency and reduce CO_2 emissions of light goods vehicles.	Regulatory, Information, Voluntary Agreement	Implemented
HGV Fuel Efficiency Policies *	Transport	CO_2, (CH_4, N_2O)	Improve fuel efficiency and reduce CO_2 emissions of heavy goods vehicles.	Regulatory, Information, Voluntary Agreement	Implemented
HGV natural gas policy	Transport	CO_2, CH_4, N_2O	Fuel-switching.	Economic, Research	Implemented
PSV Fuel Efficiency Policies *	Transport	CO_2, (CH_4, N_2O)	Improve fuel efficiency and reduce CO_2 emissions of buses.	Regulatory, Information, Voluntary Agreement	Implemented

Brief Description	Start Year of Implementation	Implementing Entity or Entities	Greenhouse Gas Saving ($ktCO_2$ eq)					
			2010	2015	2020	2025	2030	2035
EC Regulation 510/2011 sets fuel efficiency targets for new Light Commercial Vehicles (LCV) 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. The regulation translates a fleet average CO_2 tailpipe emissions target for new vehicles sold into the EU market into specific targets for individual manufacturers according to the mass of their fleet. Heavy fines are imposed for non-compliance. The 2020 target is for a fleet average of 147g CO_2 /km and represents a reduction of 19% from the 2012 average. Measures include the Plug-in Car and Plug-in Van Grants towards ultra-low emission vehicle (ULEV) cars and vans, as well as various tax incentives including lower rates for Vehicle Excise Duty and Company Car Tax. EV infrastructure is directly supported through the Workplace Charging Scheme grants for EV charge points for employees and fleets, the Electric Vehicle Home charge Scheme grants towards home EV charge points and the On-street Residential Charging Scheme. Highways England have committed £15m to ensure EV charge points are available every 20 miles on the Strategic Road Network.	2012	Department for Transport (DfT)	-155	223	908	2,300	3,795	5,353
EC Regulation 661/2009 sets minimum requirements and introduces 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, which encourages members to record, report and reduce emissions from freight. The Mode Shift Revenue Support scheme encourages modal shift from road to rail or inland waterway where the costs are higher than road, and where there are environmental benefits to be gained. It currently helps to remove around 800,000 lorry journeys a year from Britain's roads. A similar scheme, Waterborne Freight Grant, can provide assistance with the operating costs associated with coastal or short sea shipping.	2012	Department for Transport (DfT), Transport Association.	1	1	551	1,121	1,124	1,118
The Government has implemented measures to encourage alternatively fuelled HGVs including through reduced fuel duty rates for road fuel gases, and increasing rewards for renewable gaseous fuels under the Renewable Transport Fuel Obligation. We have recently consulted on proposed legislative amendments which would further increase support for renewable transport fuels suitable for heavy goods vehicles. The Government has helped operators establish and run fleets of alternatively fuelled HGVs through the Low Carbon Truck Trial. £11.3m funding has been provided, via competition, to part fund and test around 370 commercial vehicles, with most using a gas or dual fuel system (diesel and gas), and to develop refuelling infrastructure. Savings for this policy are captured within HGV fuel efficiency policies.	2012	Department for Transport (DfT)	IE	IE	IE	IE	IE	IE
The Green Bus Fund (GBF) allowed bus companies and local authorities in England to compete for funds to help them buy new low carbon emission buses. The four rounds of the fund, which ran from 2009- 2014, added around 1250 Low Carbon Emission Buses onto England's roads. The GBF has now been replaced by the Low Emission Bus Fund (LEBS) which offered £30m for bus operators and local authorities across England and Wales to bid for low emission buses and supporting infrastructure. This scheme funding is open from 2016-2019 and the successful bidders were announced in July 2016, adding more than 300 extra low emission buses to fleets.	2006/07	Department for Transport (DfT)	10	47	88	142	251	312

Name of Mitigation Action	Sectors affected	GHG affected	Objective and or activity affected	Type of Instrument	Status of implementation
Local Sustainable Transport Fund *	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
Agricultural Action Plan *	Agriculture	CH_4, N_2O	Reduce emissions from farming.	Voluntary Agreement, Information, Education	Implemented
Agri- Tech Strategy *	Agriculture	CH_4, N_2O	Reduce emissions from farming.	Economic	Implemented
Nitrates Action Plan *	Agriculture	N_2O	Reduce nitrate pollution to water under the nitrates directive.	Regulatory, Information	Implemented
Catchment Sensitive Farming *	Agriculture	N_2O	Reducing pollution to water.	Economic, information	Implemented
Environmental Stewardship (Entry Level Schemes and Higher Level Stewardship) *	Agriculture	N_2O	Biodiversity and resource protection.	Economic	Implemented
Waste measures *	Waste	CH_4	There are a number of waste measures whose overarching objective is to increase recycling/reuse and reduce harmful disposal. These include the Waste Framework Directive (2008/98/EC), Landfill Directive (1999/31/EC), Waste Incineration Directive (2000/76/EC) and the UK Landfill Tax, an escalating tax on biodegradable waste.	Fiscal, regulatory	Implemented

Brief Description	Start Year of Implementation	Implementing Entity or Entities	Greenhouse Gas Saving ($ktCO_2$ eq)					
			2010	2015	2020	2025	2030	2035
£600m of capital and revenue funding between 2011 and 2015 to support sustainable travel investments by Local Government. The projects include promoting public transport, encouraging uptake of cycling and walking, and raising awareness of the alternative transport modes available to commuters and residents Awards were made through competitive bidding processes. Since then revenue central Government has made funding of £65m (2015/16) and £20m((p.a. 2016/17 to 2019/20)) available for similar schemes.	2011	Department for Transport (DfT), Local government.	618	1,034	931	523	328	197
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.	-	1,000	2,429	3,197	3,197	3,197
Co-funded by industry and addressing industry priorities. Funding is split been projects – "the Agri-Tech Catalyst" – and new Centres of Agricultural Innovation. These technologies can contribute to agricultural efficiency and reduce GHG emissions.	2014	Department for Food, Environment and Rural Affairs (DEFRA), Department of Business, Innovation and Skills (BIS)	IE	IE	IE	IE	IE	IE
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
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
Provides income foregone support under Pillar 2 of the Common Agricultural Policy (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
There are a number of waste measures with the aim of increasing recycling/reuse and reduce harmful disposal. The Waste Framework Directive (2008/98/EC): is the general framework of waste management requirements and sets rules governing the separate collection of waste. The Landfill Directive (1999/31/EC): sets rules governing the disposal of waste to landfill, The UK Landfill Tax: a tax on waste sent to landfill. There are other waste measures targeting other waste streams, such as the Waste Incineration Directive (2000/76/EC). The overall effect is reducing environmental impacts of waste, such as landfilling biodegradable waste and its associated CH_4 emissions.	Various (earliest 1996)	Department for Food, Environment and Rural Affairs (DEFRA)	IE	IE	IE	IE	IE	IE

Name of Mitigation Action	Sectors affected	GHG affected	Objective and or activity affected	Type of Instrument	Status of implementation
Ozone Depleting Substances Regulation *	Industry/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 by-product but increased their use as a substitute.	Regulatory	Implemented
Fluorinated GHG Regulation *	Industry/Industrial Processes, Other (Residential)	HFCs, PFCs, SF6	Implementation of EU MAC (2006/40) Directive and F-Gas Regulation (EC 842/2006) to reduce emissions of fluorinated greenhouse gases.	Regulatory	Implemented
F-gas regulation 2014 *	Industry/Industrial Processes	HFCs, PFCs, SF6	Implementation of F-Gas Regulation (EC 517/2014) to reduce emissions of fluorinated greenhouse gases.	Regulatory	Adopted
Recent forestry policies *	LULUCF	CO_2, CH_4, N_2O	Increase afforestation.	Regulatory, Economic, Voluntary Agreement, Information	Implemented
Woodland Carbon Code * 2	LULUCF	CO_2	Increase rate of afforestation.	Voluntary Agreement, Information	Implemented
Woodland Carbon Fund * 2	LULUCF	CO_2	Increase rate of afforestation.	Voluntary Agreement, Information	Implemented
Revised UK Forestry Standard *	LULUCF	CO_2, CH_4, N_2O	Enhance removals and reduce emissions through woodland creation and sustainable forest management.	Regulatory, Information	Implemented
Forestry Act, Felling Licence Regulations and Environmental Impact (Forestry) regulations *	LULUCF	CO_2	Regulatory framework to limit deforestation and forest degradation.	Regulatory	Implemented
Grown in Britain *	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
Rural Development Programme * 2	LULUCF	CO_2	Grant aid for afforestation.	Economic	Implemented
Woodland Creation Planning Grant * 2	LULUCF	CO_2	Strategy to increase wood fuel supply for renewable heat.	Information, Education, Economic	Implemented

* Indicates that a mitigation action has been included in the 'with measures' projection.
IE – included elsewhere. The impact of measure has been included in the UK's emissions projection baseline, however no 'without-measure' counterfactual is available.

BR guidance on table completion
Note: The final columns of this table specify the year identified by the Party for estimating impacts (based on the status of the measure and whether an ex post or ex ante estimation is available). Years may be selected by the party
Abbreviations: GHG = greenhouse gas; LULUCF = land use, land-use change and forestry.
a Parties should use an asterisk (*) to indicate that a mitigation action is included in the 'with measures' projection.
b To the extent possible, the following sectors should be used: energy, transport, industry/industrial processes, agriculture, forestry/LULUCF, waste management/waste, other sectors, cross-cutting, as appropriate.
c To the extent possible, the following types of instrument should be used: economic, fiscal, voluntary agreement, regulatory, information, education, research, other.
d To the extent possible, the following descriptive terms should be used to report on the status of implementation: implemented, adopted, planned.
e Additional information may be provided on the cost of the mitigation actions and the relevant timescale.

Brief Description	Start Year of Implementation	Implementing Entity or Entities	Greenhouse Gas Saving ($ktCO_2$ eq)					
			2010	2015	2020	2025	2030	2035
This regulation implements obligations under the Montreal Protocol and EU Regulations (2037/2000/ EC and 1005/2009/EC) on ozone depleting substances. With the exemption of some critical use exemptions, CFCs and halon use is banned and HCFC use was banned from 2015. Most ozone depleting substances are potent greenhouse gases, so reductions in their use both protects the ozone layer and provides some GHG emissions mitigation.	2001	Department for Food, Environment and Rural Affairs (DEFRA)	IE	IE	IE	IE	IE	IE
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.	2007	Department for Food, Environment and Rural Affairs (DEFRA)	-	-	-	-	-	-
Introduced an 80% phase down in the quantities of F gases that can be placed on the EU market delivered via a gradually reducing quota system; a number of bans on the use of certain F gases in some new equipment; a ban on the use of very high GWP HFCs for the servicing of certain types of refrigeration equipment; some strengthening of obligations in 2006 Regulation related to leak checking, repairs, F gas recovery and technician training.	2015	Department for Food, Environment and Rural Affairs (DEFRA)	-	-	4,569	8,470	12,343	14,458
Grouped savings produced by a selection of post-2009 forestry policies as indicated in this table with a label '2'.	Various	Forestry Commission, Department for Food, Environment and Rural Affairs (DEFRA)	-	-	-178	-111	10	148
Woodland Carbon Code (UK coverage): voluntary standard for forest carbon projects to attract private finance to woodland expansion.	2011	Forestry Commission	IE	IE	IE	IE	IE	IE
Exchequer-funded grant to support the creation of large-scale productive woodlands which also enhance natural capital.	2016	Forestry Commission	IE	IE	IE	IE	IE	IE
Revised (2017) national standard for sustainable forest management to include a new guideline on climate change, covering both adaptation and mitigation.	2017	Forestry Commission	IE	IE	IE	IE	IE	IE
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
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
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
Grant to support the planning of large-scale productive woodlands, compliant with the UK Forestry Standard.	2015	Forestry Commission	IE	IE	IE	IE	IE	IE

3.4 Cross cutting measures

3.4.1 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, which the Government is required to respond to.

Scotland has set targets to reduce Scottish emissions of greenhouse gases by 80% by 2050 with an interim target of 42% by 2020 in the Climate Change (Scotland) Act 2009. Delivery of these targets is supported by a framework of annual targets set in secondary legislation.

3.4.2 Carbon Budgets

In October 2017, the Government published its Clean Growth Strategy[99], setting out policies and proposals for meeting future carbon budgets and illustrative pathways for the 2050 target. Table 1 provides an updated version of the Clean Growth Strategy's summary of performance against carbon budgets[100] with the initial estimates of a subset of new early stage policies and proposals included.

The updated projections for the fourth and fifth carbon budgets (including estimates of emission reductions from a subset of Clean Growth Strategy policies and proposals) suggests that the UK could deliver 97% and 95% of the required performance against 1990 levels – for carbon budgets which will end in ten and fifteen years' time respectively.

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[99] Clean Growth Strategy: published in October 2017. https://www.gov.uk/government/publications/clean-growth-strategy

[100] The Clean Growth Strategy quoted the latest available projections at the time of publication (EEP 2016). Emissions projections from the Clean Growth Strategy are therefore not directly comparable to the projections within this report.

Table 5: Performance against carbon budgets, UK, with additional measures and CGS policies ($MtCO_2e$)

		Carbon budget:				
		1 (2008-12)	2 (2013-17)	3 (2018-22)	4 (2023-27)	5 (2028-32)
		Actual	Projection	Projection	Projection	Projection
Carbon Budget level, cumulative emissions		3,018	2,782	2,544	1,950	1,725
Average required reduction vs 1990 emissions, %		-25%	-31%	-37%	-51%	-57%
Existing policies[101]	Projected emissions, Mt	2,982	2,657	2,401	2,044	1,921
Existing and new policies and proposals[102]	Projected emissions, Mt	*2,982*	2,657	2,401	2,014	1,841
	Result vs. Budget, emissions, Mt	*-36*	*-125*	*-143*	*64*	*116*
	Result vs. Budget, %	-1.2%	-4.5%	-5.6%	3.3%	6.7%

Source: Energy and Emissions Projections Report due to be published January 2018.

Based on the 'with additional measures' scenario, progress against future carbon budgets is projected to be as follows:

- The 2017 projections show that the second and third carbon budgets, covering 2013 to 2022, are likely to be achieved. The reference case projection would meet the second carbon budget with a margin of 125 $MtCO_2e$ and the third carbon budget with a margin of 143 $MtCO_2e$.
- There are projected shortfalls for the fourth carbon budget. These projections are highly uncertain and only some of this uncertainty is captured in modelling and presented in the ranges here, and do not include emissions savings from all policies and proposals in the Clean Growth Strategy.
- As policies and proposals in the Clean Growth Strategy are developed more fully, their impacts will be included as appropriate in future EEP editions.

Further details on this QEWER target are contained in the Biennial Report.

3.4.3 The European Emissions Trading System

The European Union Emissions Trading System (EU ETS) was established in 2003 by Directive 2003/87/EC and was launched in 2005. It is the largest emissions trading system in the world. The system covers approximately 45% of the EU's greenhouse gas emissions and is designed to meet an EU target to cut emissions by 40% below 1990 levels by 2030. 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.

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 and out of an airport in the European Economic Area (EU plus Norway, Iceland and Liechtenstein). Phase IV of the EU ETS will run from 2021–2030.

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[101] This represents the 'with additional measures' scenario, i.e. including planned policies but not including new policies and proposals from the Clean Growth Strategy.

[102] Includes emissions reduction estimates of a subset of new early stage policies and proposals from the Clean Growth Strategy showing an additional potential reduction of up to 30Mt and 80Mt over the fourth and fifth carbon budget periods respectively.

In order to further increase the effectiveness of the EU ETS a number of strengthening measures have been agreed. For example, from 2019 the Market Stability Reserve (MSR) will act to help address the imbalance between the supply and demand in the market by removing a number of surplus allowances from circulation on an annual basis (or re-introducing them in the case of high demand). This will act to strengthen the carbon price, and create a meaningful low-carbon investment signal. The MSR will be further strengthened through the improvements to the EU ETS agreed as part of the phase IV negotiations. At the time of writing, these improvements have been informally agreed between Member States and the European Parliament and await formal approval.

The phase III EU cap for stationary installations reduces the number of available allowances by 1.74% each year, delivering an overall reduction of 21% below 2005 verified emissions by 2020. The cap for aviation is set at 5% below the average annual level of aviation emissions over 2004–2006. Many 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 and protect them from carbon leakage[103]. Throughout phase IV the cap is set to reduce by 2.2% each year.

Installations in the EU ETS can meet their obligations by purchasing allowances, which might come from installations in other EU countries, government auctions, free allocation to mitigate the risk of carbon leakage[104], 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. In phase IV the option to use Kyoto Protocol credits for EU ETS compliance will expire.

The Government is considering the UK's future participation in the EU ETS after UK exit from the EU and remains firmly committed to carbon pricing as an emissions reduction tool whilst ensuring energy and trade intensive businesses are appropriately protected from any detrimental impacts on competitiveness. In the event that UK leaves the System, the government will seek to ensure that any future approach is at least as ambitious as the existing scheme and provide a smooth transition for the relevant sectors.

3.4.4 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 are 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. In phase IV, the auctioned amount is set to be 57% of allowances, which can be reduced by a limited amount if necessary to protect industries at risk of carbon leakage.

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.

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[103] 'Carbon leakage' refers to the process where production and/or investment moves abroad to areas with a lower carbon price or regulatory standards.

[104] Carbon leakage' refers to the process where production and/or investment moves abroad to areas with a lower carbon price or regulatory standards.

3.4.5 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.

3.4.6 Non-domestic and domestic renewable heat incentive

The Renewable Heat Incentive (RHI) opened for Non-domestic applicants at the end of November 2011. The Domestic scheme opened for applicants in April 2014. Both schemes are designed to incentivise uptake of renewable heat by paying owners of eligible technologies tariffs to assist with the costs of installing and running the systems. The RHI pays participants of the scheme that generate and use renewable energy to heat buildings or water, carry out processes involving heat or to generate and inject biomethane into the national gas grid. The reformed RHI is expected to deliver 22TWh of renewable heat in 2020–21 and carbon savings up to around 40 $MtCO_2e$ over each of Carbon Budgets 4 and 5.

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 technologies supported are: biomass boilers, biomass CHP, biogas combustion, biomethane injection to the grid, ground-, water-source and air-water heat pumps, solar thermal and geothermal systems.

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 injecting to the gas grid.

The Domestic RHI scheme is targeted at, but not limited to, offgas grid households in England, Scotland and Wales. Support is 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 reflects 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 is open to homeowners, private and social landlords, third party owners of heating systems and people who build their own homes.

In 2013, the Government announced in the introduction of degression as a mechanism to control the RHI budget, consulted on tariff levels for some of the technologies covered by the scheme and simplified metering requirements. At the same time, air quality requirements were introduced, requiring all applicants with biomass boilers to submit an RHI emissions certificate or a valid environmental permit with their application.

In 2014, the Domestic RHI was opened. The Non-domestic scheme was expanded to include air-water heat pumps and commercial and industrial energy from waste. Tariffs were increased for biomass CHP, biomass boilers of 1MWth capacity and above, deep geothermal, ground source heat pumps, solar thermal and biogas combustion. Government also published final decisions relating to a review of the tariff for biomethane injection to grid, following consultation.

In 2015, Government introduced sustainability requirements to the RHI, similar to those in use by the Renewables Obligation. The Government also confirmed continued funding for the RHI until 2020/21 and committed to reforming the scheme. Participants on the Domestic RHI must

now purchase their biomass fuel from a supplier on the Biomass Suppliers List, a register of sustainable suppliers. The Government also confirmed continued funding for the RHI until 2020/21 and committed to reforming the scheme.

In 2016, the Government consulted on reforms to the RHI scheme and published its response. The reformed RHI aims to:

- Contribute directly to decarbonisation of heating in the UK and to meeting Carbon Budgets;
- Contribute to renewable energy in order to help meet the UK's 2020 renewable energy target for sourcing 15% of energy demand from renewable sources;
- Develop the renewable heat market and supply chain so that it is in a position to support the mass roll out of low carbon heating technology required in the 2020s and onwards in order to meet the UK's Carbon Budgets.

In 2017, the Government consulted on implementing a power efficiency threshold for biomass CHP and implemented the first tranche of the 2016 reforms. The reforms implemented were:

- The alignment of the different tariffs available for small, medium and large biomass in the Non-domestic RHI with revised tiering for all sizes of plant. This includes changing the tiering threshold from 15% to 35% of heat load for small and medium biomass and introducing a 35% threshold for large biomass;
- Increases to biomass and heat pump tariffs on the Domestic scheme;
- The introduction of heat demand limits for biomass and heat pumps on the Domestic scheme; and
- The extension of expenditure and growth thresholds for both schemes, for the calculation of degression out to July 2018.

The Government aims to implement the remaining reforms announced in the 2016 Government response later in 2017/early 2018, subject to Parliamentary scheduling.

As at the end of September 2017, there were 17,636 accreditations to the Non-domestic scheme, representing nearly 3,703 MW of installed capacity. The 16,855 Non-domestic installations that had received RHI support had generated 13,954 GWh of renewable heat. The Domestic scheme had 58,338 accreditations. The 58,449 Domestic installations that had received RHI support had generated 2,056,044 MWh of renewable heat.

The RHI scheme is implemented and administered by Ofgem. According to Ofgem's public reports, £991.33 million of RHI payments have been made to the Non-domestic scheme since it began, and £217.76 million of RHI payments to the Domestic scheme.

The scheme helps to strengthen security of energy supply by increasing diversification of heating technologies and sources, and reducing dependence on imports. 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.

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.

3.5 Business and Industry

Since 1990, emissions from business and industry have almost halved, mainly due to efficiency gains and a shift in manufacturing to cleaner fuels, as well as changes to the industrial structure of the UK economy. Much of this reduction has taken place in the most energy intensive industries. For instance, each tonne of steel produced in the UK requires 40% less energy to produce than 40 years ago155. In addition, we have also improved the energy efficiency of non-domestic buildings since 1990 with emissions 18% lower in 2015156. The number of properties registering as having the lowest Energy Performance Certificates (EPC Bands F and G) has dropped from 19% to 13% between 2010 and 2016157.

Overall, business and industry now account for approximately 25% of the UK's emissions (excluding fluorinated gases or F-gases)159, with around two thirds of industrial emissions coming from a small number of energy intensive sectors (for example chemicals, iron and steel)160. Businesses and industry are also major users of electricity, accounting for over 50% of electricity use161.

3.5.1 Framework for action

UK Government analysis says that up to £6 billion162 could be saved in 2030 through investment in cost-effective energy efficiency technologies. Roughly half of these savings are available through improving the efficiency of buildings and processes, including by fitting better insulation and smarter energy controls. The other half can be realised through eliminating electricity waste in business for example using better lighting and energy management systems. This is consistent with research from EEF, the manufacturers' trade association, which found that a 14% reduction in electricity consumption could be made across the manufacturing sector, equivalent to over £1 billion a year in savings163.

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.

3.5.2 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.. 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.

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 Department for Business, Energy and Industrial Strategy (BEIS) 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.

In 2015 the UK Government carried out a consultation on reforming the business energy tax landscape. The UK Government recognised that the range of energy efficiency policies created complexity and added burden to business consumers and in March 2016 the UK Government announced reforms to improve the tax and reporting regime. This included the announcement that the Government has decided to close the CRC energy efficiency scheme following the 2018-19 compliance year, with no purchase of allowances required to cover emissions for energy supplied from April 2019. The Government will work with the devolved administrations on scheme closure arrangements. The price signal from the CRC would be absorbed into the Climate Change Levy and a consultation on a simplified energy and carbon reporting framework for introduction by 2019 was published in October 2017.

3.5.3 Non-domestic Green Deal and energy efficiency

The Sixth National Communication reported on the establishment of the Green Deal, which enables consumers to take out loans to pay for energy efficiency improvements in their properties, with repayments made through their energy bill. Repayments are made on a Pay-As-You-Save (PAYS) basis: after the improvement has been made, the consumer begins to save energy, their energy bills are less than they would have been without the improvement, and these savings are used to repay the loan.

The National Communication reported some early interest in the Green Deal. At that stage, there had been over 100,000 Green Deal Assessments in properties (the first step before taking out a Green Deal loan). The initial interest was in domestic properties, and the Government had envisaged that the non-domestic Green Deal market would take longer than the domestic market to develop.

In the event, uptake across both sectors was significantly below expectations. In July 2015, the Government announced there would be no further public investment in the scheme. The Framework set up to support the programme, however, remained in place to service existing Green Deal Plans and for any private finance providers wishing to enter the market.

The Government is now considering options for the future of the Green Deal Framework in the light of a number of factors. There may be several reasons why the uptake of the Green Deal was below expectations, and the Government will learn from these. The Government believes, however, that the PAYS mechanism at the heart of the Green Deal could still play a valuable role, in both the domestic and non-domestic market. A key factor for optimism that PAYS can play a role is the interest from a number of finance providers, not least from the new owners of the Green Deal Finance Company, which was the vehicle originally created to finance Green Deal loans and in which the Government ended public investment during 2015.

In October 2017, the Government launched a “Call for Evidence on the reform of the Green Deal Framework”. The outcomes of this call for evidence will help to inform Government decisions on the future of the Green Deal, including for the non-domestic sector.

3.5.4 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 supply 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. The CCA scheme allows

energy intensive participants to pay significantly reduced rates of CCL in exchange for signing up to energy efficiency or carbon reduction targets agreed with Government. Participants can remain compliant with the CCA Scheme and retain their entitlement to a reduced rate of CCL by meeting their targets or by paying a buyout fee if they fall short of meeting their targets.

3.5.5 Energy Savings Opportunity Scheme (2014)

Government established the Energy Savings Opportunity Scheme (ESOS) to implement Article 8 (4 to 6) of the EU Energy Efficiency Directive (2012/27/EU)[105]. The ESOS Regulations 2014[106] give effect to the scheme. ESOS is a mandatory energy assessment scheme for organisations in the UK that meet the qualification criteria. The Environment Agency is the UK scheme administrator.

Organisations that qualify for ESOS must carry out ESOS assessments at least every 4 years. These assessments include energy audits of the energy used by their buildings, industrial processes and transport to identify cost-effective energy saving measures (including those done under the implementation of energy management systems under Article 8(6)). Organisations must notify the Environment Agency by a set deadline that they have complied with their ESOS obligations.

3.5.6 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.

3.5.7 The Industrial Emissions Directive

The Industrial Emissions Directive (2010/75/EU) replaced the Large Combustion Plant Directive (LCPD, 2001/80/EC) on 1 January 2016. It 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, a Transitional National Plan has been agreed to allow plants to reduce emissions before tightened limits apply from 2020.

3.5.8 The UK Green Investment Bank

The UK Green Investment Bank (GIB) started operating in October 2012, as a 100% government owned company, following state aid approval. Its role was to provide finance on commercial terms, alongside private sector partners, to mobilise additional capital into UK green infrastructure and help the UK achieve its environmental policy targets. By the end of 31 March 2017, GIB had committed over £3 billion into 100 UK green infrastructure projects with a total value of over £12 billion, mainly in the offshore wind, waste to energy and non-domestic energy efficiency sectors. Its work in the offshore wind sector included establishing the world's first dedicated offshore wind fund and Europe's largest dedicated renewable energy fund. The fund passed its initial £1 billion target in January 2017.

Previously, in March 2016, the UK government launched a sale process for GIB. It had proved itself a successful commercial enterprise but it needed a greater volume of private capital, and freedom from the constraints of public sector ownership, to grow and increase its green impact. In August 2017, the government completed the sale of GIB to Macquarie Group Limited in a £2.3bn deal, which ensured that all taxpayer funding invested in GIB since its creation was returned with a gain of approximately £186 million.

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

[106] http://www.legislation.gov.uk/uksi/2014/1643/contents/made

The deal secured the future of GIB with an ambitious new owner committed to growing the business. GIB, now known as the Green Investment Group to enable it to expand outside the UK, has become Macquarie's primary vehicle for renewable energy investment in the UK and Europe, and will target at least £3bn of new investment into the green economy over the next 3 years. Macquarie has also committed to maintain GIB's green purpose and green objectives, in line with the special share arrangements to safeguard GIB's green purposes which will be held by five independent trustees.

3.5.9 Green Finance

The UK is also targeting increased domestic green finance action in order to mobilise additional private investment into sustainable and environmental projects and infrastructure. The UK has an established reputation in green finance innovation and leadership, and is considered to be a thought leader on green finance.

The City of London Corporation's Green Finance Initiative (GFI) was established in 2016 at the request of Government. The Initiative acts as a hub for private sector-led innovation, and promotes London and the UK as the global centre of green finance. The UK also partnered with China to co-chair the G20 Green Finance Study Group, making the links between climate risks and opportunities and global financial stability.

The UK has established a **UK Green Finance Taskforce** consisting of senior leaders from across the financial sector and academia. This Taskforce will work with their industry peers to provide Government with recommendations on how to: accelerate the growth of green finance; deliver the investment required to meet the UK's domestic carbon reduction targets; and to consolidate the UK's leadership in financing international clean investment.

The UK government has formally endorsed the recommendations of the **Taskforce on Climate-related Financial Disclosure**. These recommendations establish a new voluntary reporting framework that helps align climate-related risk management with wider financial governance.

The UK government is working with the British Standards Institute (BSI) to develop a set of voluntary green and sustainable management standards to promote responsible investment practices globally. The BSI will be working with industry to identify a suitable scope for these standards, and will have the first standard in production by the first half of 2018.

In order to support the commercialisation of innovative clean technologies, the UK Government will also be providing up to £20 million to support a new clean technology investment fund.

The UK Government is working with mortgage lenders to promote the development of green lending products that reflect the lower risk associated with more efficient energy use, and the associated reduction in bills.

3.5.10 Local Enterprise Partnerships (LEPs)

It is important that economic growth and the housing and wider infrastructure needed to support that growth is low carbon. To support them in this the Government has provided support to the development of Local Energy Strategies in each of the LEP areas. These will identify and prioritise the opportunities both for low carbon energy industries across the area but also the decarbonisation of heat power and transport to allow wider economic growth to be clean. The National Government are also providing support for a range of national tools to reduce costs and investing in developing expert project development support locally to unlock existing opportunity in local areas.

3.5.11 Wales

3.5.11.1 Business carbon reduction support

Business Wales is the Welsh Government Business support scheme supporting individuals to start a business and established businesses to grow[107]. The service provides resource efficiency support through specialist advisers and has a close working relationship with the Carbon Trust in respect of their energy efficiency loan scheme.

Welsh Government officials meet with the Carbon Trust on a quarterly basis to review the operation of the loan scheme in Wales and to ensure that Business Wales are working with them in the best way.

For the agriculture industry in Wales, the Welsh Government will integrate the delivery of energy efficiency and renewable energy advice through the existing Knowledge Transfer, Innovation and Advice provision, Farming Connect. The aim of the Farming Connect Advisory service is to provide independent, bespoke advice to improve the sustainable management and the economic and environmental performance of farming and forestry SME's operating in rural areas. Advice will be available on a one-to-one or group basis. It is envisaged that the service will be available in early .

3.5.11.2 Wales national tourism strategy

A Partnership for Growth: The Welsh Government Strategy for Tourism 2013-2020 was reviewed in November 2016, taking into account the Wellbeing of Future Generations (Wales) Act 2015 and progress made to date.

Following recommendations made through the Sustainable Tourism Framework and Forum, a Business Resilience document and online self-assessment toolkits were produced to assist businesses in future-proofing their investments and be mindful of minimising their environmental impacts.

In line with the Strategy Visit Wales is supporting projects to improve sustainable transport options for tourists wishing to travel around Wales. The opportunity to broaden collaborative working with external partners is also being realised. This broader working is also being delivered in the food and drink sector with the promotion of produce being sourced and delivered locally improving the short supply chains, local economy and Sense of Place.

Additionally there continue to be activities undertaken with national partners both along the coast of Wales and in the grounds management of sites aimed at consolidating and conserving the quality and biodiversity of Wales. In delivering funding programmes for capital expenditure on large scale works, the requirements for all developments to comply with the latest BREEAM (Building Research Establishment Environmental Assessment Method) standards has been made a stipulation of grant, with area-changing destination projects assessed by and in line with Wales European Funding Office (WEFO) on their contribution to the three cross-cutting themes, including sustainability.

3.5.12 Scotland

3.5.12.1 Building Regulations

Energy standards within building regulations in Scotland were reviewed and improved in 2002, 2007, 2010 and, most recently, 2015. New buildings constructed to current standards produce approximately 75% less GHG emissions than those built to the standards applicable in 1990.

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[107] www.businesswales.gov.wales

The most recent improvements to energy standards within building regulations were introduced in October 2015[108]. These reduce emissions, on aggregate, from new homes by approximately 21% for new homes and 43% for new non-domestic buildings, when compared to standards introduced in October 2010.

Further review of these standards is planned to commence in early 2018.

3.5.12.2 Reducing emissions in existing non-domestic buildings

Action to improve the emission and energy performance of Scotland's non-domestic building stock has commenced. Regulations introduced in September 2016 require the assessment and, ultimately, improvement of larger non-domestic buildings[109]. These regulations apply to existing building in both the commercial and public sectors.

The Assessment of Energy Performance of Non-domestic Buildings (Scotland) Regulations 2016[110] apply to buildings over 1,000 m^2 and are triggered by sale of the building or rental to a new tenant. Assessment sets moderate improvement targets for both energy performance and greenhouse gas emissions. Owners then have 3.5 years to complete improvement or may defer completion where annual operational energy use is reported.

Review of these regulations, as part of broader action within Scotland's Energy Efficiency Programme (SEEP), is proposed for 2020.

3.5.12.3 Business carbon reduction support

The Scottish Government continued to invest in improving energy and resource efficiency across business and public sector and to continuing sustainable economic growth for Scotland. The 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 specialist assistance and loans to businesses of all sizes, but has a particular focus on SMEs.

3.5.12.4 Research and innovation for low carbon energy

Scotland has world-class research and innovation capacity and facilities to support the energy sector, including the Oil & Gas Technology Centre, European Marine Energy Centre and the Power Network Demonstration Centre.

Renewable energy plays a huge part in powering Scotland's homes and economy – provisional statistics for 2016 show 54% of Scotland's electricity needs met by renewables, more than three times higher than in 2006.

Scotland is home to the world's leading wave and tidal test centre, the world's largest planned tidal stream array and the world's largest tidal turbine. In October 2017, the First Minister of Scotland opened Statoil's Hywind Pilot Park – the world's largest floating windfarm – 25km off the Scottish coast.

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[108] http://www.gov.scot/S6-2015

[109] See www.gov.scot/section63

[110] http://www.legislation.gov.uk/ssi/2016/146/contents/made

Scotland is leading the rest of the UK in supporting innovative local energy solutions and community ownership and involvement in energy developments with over 600 mwMW of installed renewable energy capacity which is under community or local ownership.

3.5.12.5 Scottish Enterprise

Scottish Enterprise (SE) recognises low carbon as an important area of opportunity for driving greater innovation in Scotland in the positive shift towards a low carbon economy. Scotland already has competitive advantages in low carbon technologies and important strategic assets including our academic excellence and our expertise in oil and gas which will form the basis for long-term growth by companies. Even with the current uncertain economic conditions, the market opportunities relating to low carbon are continuing to grow, providing a platform for innovation for Scottish companies in energy, resource efficiency and renewables.

SE recognises opportunities for Scotland in emerging sectors such as low carbon energy transition, industrial biotechnology, sustainable construction and water and waste water, which SE helps companies to pursue.

In support of the Scottish Government's forthcoming Energy Strategy, SE will continue to work with companies to capitalise on new and emerging opportunities in the low carbon economy.

3.5.12.6 Highlands and Islands Enterprise

The Highlands and Islands region is home to some of Europe's best wind, wave and tidal resources and is internationally recognised for the advancement of offshore renewable technologies, not least due to the unique offering of the European Marine Energy Centre (EMEC). The region is also an exemplar in local, low carbon energy systems built upon a sustained focus on community ownership and revenue generation from renewable deployment. Significant employment and business opportunities remain in the planned build out of large scale offshore wind projects in the Moray Firth, and in continued testing and pilot array demonstration of marine technologies. Reflecting the changing UK and Scottish Government policy landscape, there will be an increasing focus on demand reduction and decentralised, low carbon energy systems providing increased opportunities for innovation in supply and demand-side activities, and wider dispersal of benefits throughout communities.

In further developing the renewable energy sector, HIE will focus efforts on 3 main areas of focus:

- Test and demonstration opportunities associated with further development of offshore renewables, primarily in wave, tidal and floating wind. This will include the continuing development and securing the long term sustainability of EMEC, capturing the international opportunities arising out of Wave Energy Scotland (WES), and support for demonstration of technologies at pre-commercial sites around the region;
- Securing supply chain opportunities from marine and offshore wind developments. As projects are built out around our coast, there will be significant and long term opportunities for ports and harbours and the local supply chain. The primary focus for this will be the offshore wind farms being developed in the Moray Firth and the build out of the MeyGen project in the Pentland Firth, with these two projects alone presenting the region with an opportunity to develop a real cluster of expertise, innovation and wider supply chain development;
- Development of local energy systems – as Scottish Government policy evolves to support creation of more localised energy systems there will be opportunities to both demonstrate the approach and integration of technologies across the region, but also to support the roll-out of such projects at both a community and business level.

3.5.13 Northern Ireland

3.5.13.1 Business Carbon Reduction Support

Invest Northern Ireland's technical consultancy support helps Northern Ireland businesses to determine areas of cost savings through energy and resource efficiencies. Through the Energy Efficiency Loan Fund, interest free loans of between £3,000 and £400,000 are available to assist businesses to install new energy saving equipment with the aim of identifying annual carbon savings in businesses of 10.10ktCO_2 per annum.

3.5.13.2 Buildings

The Building Regulations (Northern Ireland) 2012 came into operation on 31 October 2012. These included enhanced thermal standards for all new buildings and those undergoing renovation. Consideration is being given to further amendments in 2018-19 to enhance energy efficiency standards with a view to meeting the cost-optimal and nearly zero-energy building requirements of the Energy Performance of Buildings Directive 2010/31/EU.

3.6 Homes

3.6.1 Highlighted domestic policies and measures

Homes now account for 13%of the UK's emissions (rising to 22% once electricity use is taken into account). The average household's energy consumption has fallen by over 17% since 1990. This has been driven by a combination of: tighter building and products standards, in particular better boilers; the uptake of insulation and other energy efficiency measures, mainly delivered through obligations on energy suppliers; and greater awareness of potential energy savings.

While there are now approximately a quarter more homes than in 1990, the overall total of emissions from the sector has reduced by about a fifth over this period176.

Actions taken to tackle emissions have helped to reduce average energy bills for households as efficiency savings have more than offset the cost of financial support provided for developing low carbon technologies. The cost of policies delivering cleaner energy, support for vulnerable households and investing in upgrading our buildings accounts for around 12% of an average gas and electricity bill. However, these costs are on average more than offset by savings from improvements to the energy efficiency of people's homes, delivering a saving of £14 on average in 2016.

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), the vast majority of which have been delivered through government policies, saving between £25 to £270 on their annual energy bill.

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3.6.2 Policy framework

The government has put in place a range of policies to improve domestic (residential) energy efficiency. These include building regulations, a energy supplier energy efficiency schemes, minimum energy performance standards for the private rented sector, and advice to consumers. This broad approach aims to empower the consumer to make changes to behaviours and tackle rising energy demand.

3.6.3 Household energy efficiency

The government has already 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.

As set out in the Clean Growth Strategy published in October 2017, the government set out a number of new policies and proposals to go further.

The government is committed to upgrading all fuel poor homes to Energy Performance Certificate (EPC) C by 2030. In addition, the government set out in the Clean Growth Strategy an aspiration for as many homes as possible across the whole housing stock to reach a similar standard by 2035 where practical, cost-effective and affordable.

3.6.4 Minimum Energy Performance Standards

Since the publication of the previous National Communication, the government has introduced a requirement for privately rented homes that, from April 2018, landlords of the worst performing properties will need to improve those properties to a minimum of EPC E before they can be let, lowering bills for some of the most vulnerable private tenants while ensuring costs of improvements are reasonable and affordable. The government will consult shortly on amending these regulations so they can work as effectively as possible, maximising the benefits to tenants.

Building on this, the government also announced in the Clean Growth Strategy its intention to consult on setting a long term trajectory for energy performance standards across the private rented sector, with a view to reaching EPC C by 2030 for as many homes as possible, where practical, cost effective and affordable. The government also committed to consult on equivalent standards for social housing, subject to the independent public inquiry into the fire at Grenfell Tower in London in 2017, and the government's separate work looking at wider social housing policy issues.

3.6.5 Each Home Counts review

The government is also pressing ahead with the implementation of the Each Home Counts review which aims to look at issues around consumer advice, protection, standards and enforcement in relation to home energy efficiency and renewable energy measures.

3.6.6 The energy savings advice service

The Government has provided telephone based advice through the Energy Saving Advice Service since 2012, with over 930,000 calls received over this period. Development work on a digitally led service (with appropriate assistance for those unable to use a web based service). The new service is currently being prototyped with extensive user testing and is expected to be available to the public in Spring 2018.

3.6.7 The Green Deal

The last National Communication reported on the establishment of the Green Deal, which enables consumers to take out loans to pay for energy efficiency improvements in their properties, with repayments made through their energy bill. Repayments are made on a Pay-As-You-Save (PAYS) basis: after the improvement has been made, the consumer begins to save energy, their energy bills are less than they would have been without the improvement, and these savings are used to repay the loan.

The National Communication reported some early interest in the Green Deal. At that stage, there had been over 100,000 Green Deal Assessments in properties (the first step before taking out a Green Deal loan).

In the event, uptake across both sectors was significantly below expectations. In July 2015, the Government announced there would be no further public investment in the scheme. The Framework set up to support the programme, however, remained in place to service existing Green Deal Plans and for any private finance providers wishing to enter the market.

The Government is now considering options for the future of the Green Deal Framework in the light of a number of factors. There may be several reasons why the uptake of the Green Deal was below expectations, and the Government will learn from these. The Government believes, however, that the PAYS mechanism at the heart of the Green Deal could still play a valuable role, in both the domestic and non-domestic market. A key factor for optimism that PAYS can play a role is the interest from a number of finance providers, not least from the new owners of the Green Deal Finance Company, which was the vehicle originally created to finance Green Deal loans and in which the Government ended public investment during 2015. In 2017, private finance began operating through the framework on a limited scale.

In October 2017, the Government launched a "Call for Evidence on the reform of the Green Deal Framework". The outcomes of this call for evidence will help to inform Government decisions on the future of the Green Deal.

3.6.8 Energy Company Obligation

The Energy Company Obligation (ECO) funds 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.

ECO was reformed so that from 1 April 2017 a greater proportion (70%) is focussed on low income households with the remainder having a greater carbon-saving focus and open all households.

3.6.9 Building regulations

Around 22% 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. 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.

The Government has commissioned an independent review of Building Regulations and fire safety in England, being led by Dame Judith Hackitt. The review will report in Spring 2018. Following the outcome of the independent review, and subject to its conclusions, the Government intends to consult on improving requirements for new homes in England where the evidence suggests that there are cost-effective and affordable opportunities, and it is safe and practical to do so. This will look to ensure that new homes are futureproofed for the installation of lower carbon heating systems where this is cost-effective and affordable. This will help to phase out high carbon fossil fuels in the future, starting with homes off the gas grid.

New standards for domestic boiler installations, known as Boiler Plus, will keep England's UK's boiler standards higher than anywhere else in the world, and will save more than 5.2 $MtCO_2e$ over the next decade.

3.6.10 Raising product standards and encouraging consumer engagement

Policy on improving the performance of energy-using products is dominated by two pieces of European framework law 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 Eco-design of Energy Related Products Directive sets the framework for developing 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 a cost-effective way of saving consumers and businesses money on energy bills and reducing GHG emissions.

The EU Energy Labelling Framework Regulation (formerly a 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.

There are currently 28 Eco-design and 16 Energy Labelling Regulations, plus two industry voluntary agreements.

Currently agreed performance and labelling measures are estimated to lead to savings of 9 million tonnes of CO_2 in 2020, and to save the average dual-fuel household around £100 on their annual energy bills by 2020. These measures are estimated to have a net present value of around £23 billion to the UK for the period 2015–2030. They represent one of the most cost-effective ways to meet our carbon targets and reduce energy consumption. On the basis of emerging analysis from long-term work programme to improve the evidence base (which is still subject to quality assurance), it is expected these figures to be revised downward, although savings will still be sizable.

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.
- 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.

3.6.11 Billing and metering

Smart meters are the next generation of gas and electricity meters. They will offer a range of intelligent functions and provide consumers with more accurate information, bringing an end to estimated billing. Consumers will have near real-time information on their energy consumption to help them control and manage their energy use, save money and reduce emissions.

The Government is committed to ensuring that every home and smaller business in Great Britain is offered a smart meter by the end of 2020. The roll-out of smart meters is an important national modernisation programme that will bring major benefits to businesses and the nation as a whole.

The roll-out is making significant progress with nearly 7.7 million smart and advanced meters operating up to the end of June 2017. It is expected that investment by the energy industry in smart metering will yield a net benefit of around £5.7 billion over the lifetime of the Programme.

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 save the annual equivalent of about 1 million tonnes of EU ETS CO_2 allowances which the government would, otherwise, have needed to buy.

3.6.12 Tackling fuel poverty

The Government published a fuel poverty strategy for England in March 2015 which sets out how it intends to meet the fuel poverty target set in legislation since December 2014. The target states that as many fuel poor homes as reasonably practicable have to have an energy efficiency ranting of band C by 2030 with interim milestones of band E by 2020 and band D by 2025.

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

- The Warm Home Discount scheme provides £140 off energy bills to over 2 million low income and vulnerable households each winter. The scheme is due to continue until 2021 with spending of £320m per year (2015 prices).
- Since April 2017, around 70% of spending under the Energy Company Obligation (ECO) is directed towards low income and vulnerable households. ECO is due to continue until 2022 at £640m per year (2017 prices) and is due to be reformed further from October 2018.
- The government provides Cold Weather Payments of £25 to low income and vulnerable households on certain benefits for each seven day period of very cold weather. All pensioner households aged up to 79 years get a £200 Winter Fuel Payment each winter (£300 for those aged over 80). These payments help around 9 million households each winter.
- Each year, the government provides funding and support for 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.
- In 2015, the government provided £25m of funding to local authorities under the Central Heating Fund. Through the scheme, local authorities installed around 6,000 first time central heating systems in low income and vulnerable households.

3.6.13 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.

3.6.14 Fuel poverty and domestic energy efficiency in Scotland

The Scottish Government is currently developing a long term Fuel Poverty Strategy, including setting new statutory targets and putting in place a revised definition of fuel poverty that will help inform where action is most needed across the country. Further details on this are provided in section 3.8.12.2.

Whilst work to develop the new strategy is ongoing, the Scottish Government will continue to deliver support to householders through the Home Energy Efficiency Programmes for Scotland (HEEPS). HEEPS is designed to tackle fuel poverty, reduce carbon emissions and support jobs and has three strands:

- HEEPS: 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.
- HEEPS: Warmer Homes Scotland, offered to vulnerable households in receipt of certain benefits. Those receiving assistance must either be homeowners or tenants of private sector landlords. Warmer Homes Scotland (WHS) has a strong focus on fabric measures, such as heating and insulation, but also includes micro-generation to offer a wider range of heating options to off-gas households.
- HEEPS: Loans, available to all private sector households in Scotland (both owner occupiers and private sector landlords) who wish to install energy efficiency measures. The scheme offers an interest-free loan of up to £15,000 per household. The loans can be combined with ECO, and HEEPS: ABS.

The Scottish Government has designated energy efficiency as a National Infrastructure Priority, which in future will be delivered through Scotland's Energy Efficiency Programme (SEEP), a transformational and integrated approach to improving the energy efficiency and provision of heat to all types of buildings across Scotland. The Scottish Government is committed to ensuring that fuel poverty is prioritised and supported throughout SEEP.

3.6.15 Heat strategy

Heating our homes, businesses and industry accounts for nearly half of all energy use in the UK and a third of our carbon emissions. Nearly 70% of our heat is produced from natural gas. Meeting our target of reducing emissions by at least 80% by 2050 implies decarbonising nearly all heat in buildings and most industrial processes. Reducing the demand for heat through improved energy efficiency will have an important role to play but will not by itself suffice to meet our 2050 target.

There are a variety of fuels, technologies and distribution systems with potential to deliver the transformation necessary to meet 2050 targets – including heat networks, heat pumps, hydrogen and biogas, which can be used separately or in combination. But it is not yet clear which approach will work best at scale and offer the most cost-effective, long-term answer. Officials at The Department for Business, Energy and Industrial Strategy are currently conducting work to better understand the options and to lay the groundwork to support decisions in the first half of the 2020s on the long-term future of heat.

There are active measures in place to reduce our emissions from heat and are developing policies to address issues that aren't affected by complex decisions about decarbonisation of the gas network. The heating and cooling proposals set out in the *Clean Growth Strategy* to achieve the ambitious 5th carbon budget include action to phase out all oil-based heating systems off the gas grid, a sustainable market for heat networks, and strong action on new build and in the business and industrial sectors.

3.6.16 Domestic Renewable Heat Incentive

The Domestic RHI policy is set out along with the non-domestic policy on page 103 of this document.

3.6.17 Renewable Heat Premium Payment scheme

The Renewable Heat Premium Payment (RHPP) scheme opened in August 2011 and closed in March 2014. The scheme provided 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.

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

The scheme's purpose was to support the take-up of renewable heating technologies in the domestic sector prior to the introduction of the Domestic Renewable Heat Incentive in April 2014. The technologies supported by the RHPP were ground-, water- or air-source pumps, biomass boilers and solar thermal.

The RHPP scheme supported over 15,000 installations across England, Scotland and Wales and generated an estimated 232,959MWh of heat annually.

The scheme allowed the Government to learn more about what people thought of the technologies supported, and how these technologies performed in a variety of conditions.

Recipients of RHPP support were able to subsequently apply for support under the Domestic RHI scheme, but the level of their RHI payments was correspondingly reduced in order to avoid a double subsidy.

DECC (now BEIS) provided grant funding for the Energy Saving Trust (3.8.7) to deliver the Renewable Heat Premium Payment (RHPP) scheme.]

3.6.18 Heat networks

The CGS published in October 2017 makes it clear that heat networks will play a vital role in the long term decarbonisation of heating. In the Strategy's three illustrative pathways to 2050, heat networks are projected to meet around 17% of heat demand in homes and up to 24% of heat demand in industrial and public sector buildings (up from around 2% today).

To help deliver this, the 2015 Spending Review allocated £320m of capital funding out to 2021 to grow the UK heat networks market through the Heat Networks Investment Project (HNIP). This will help create the conditions necessary for a sustainable heat network market to emerge in the 2020s.

First payments for the pilot HNIP scheme were announced in April 2017, with 9 Local Authorities awarded some £24m of funding over two years across England: London and South East, Sheffield, Yorkshire and Greater Manchester. The nine successful bids are expected to leverage in over £50m of wider investment and provide heat to over 5000 domestic customers and 50 non-domestic buildings, saving over 200,000tCO_2e over the next 15 years.

The Heat Network Delivery Unit (HNDU) in BEIS continues to provide specialist support and guidance to local authorities. £14m of funding has now been provided since 2013/14 for feasibility and early stage project development for over 200 schemes across 131 local authorities. BEIS also ran a £7m Heat Network Innovation Small Business Research Initiative (SBRI) over 2013-16, to stimulate innovation to improve efficiency of heat networks and reduce costs of low carbon supply.

The government continues to take steps to ensure that heat network customers are treated fairly and to reduce risks for investors. Heat metering and billing regulations were passed into law in 2014 to ensure meters are fitted where it is cost effective and bills are transparent. BEIS is supporting industry-led initiatives to improve consumer protections and drive up technical standards, eg the Heat Trust consumer protection scheme and Code of Practice for Heat Networks. Further interventions will be necessary to create an effective long-term market framework to deliver sustainable and subsidy-free market growth after the HNIP funding ends in 2021. Following the publication of recommendations from an industry task force in January 2018 Government will examine the measures required to deliver this in more detail.

3.6.19 Supporting green skills

In the green paper 'Building our Industrial Strategy', the Government set out the importance of raising skills to support industries and consumers. The existing technical education system can be complex and confusing, which often does not deliver either for individuals, for the skills needs of employers, or for the wider economy.

Through the Sainsbury Review and the Skills Plan, the Government has set out its plan to radically simplify the thousands of vocational qualifications into a smaller number of high quality new routes.

The government have also made the following commitments:

- Creating a proper system of technical education, to benefit young people and provide better options for those already in the workforce.
- Committing £170m of capital funding to the creation of prestigious new Institutes of Technology to deliver higher technical education in STEM subjects.
- Exploring how to give technical education learners clear information, which could include a way of searching and applying for courses similar to the UCAS process.
- Working towards a joined-up, authoritative view of the sector specific skills gaps that the UK faces now and in the future.

3.6.20 Rural communities energy fund

DECC (now BEIS) and Defra have jointly funded 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. Communities have developed a range of power and heating solutions, many owned or part owned by the community which serve to reduce their carbon and provide an income. The scheme remains open and is currently being reviewed to include new technologies and storage.

The Government also ran an Urban Community Energy Fund from 2014-2016. This allocated just under £2m to community groups. This has been replaced by local authority schemes in Bristol, Manchester and London.

3.6.21 Future framework for heat in buildings

Beyond the RHI, the government intends to design a clear framework for domestic and non-domestic buildings through to the 2030s to:

- Reduce barriers to take up of low carbon heating and cooling with reduced reliance on subsidy;
- Sustain a viable supply chain for low carbon heating beyond the RHI whilst not closing off options on the longer term decarbonisation pathway.

The CGS has a very clear focus on the challenges and opportunities involved in decarbonising heat in buildings. It sets out the UK's ambition to phase out high carbon fossil fuel heating such as oil and coal during the 2020s in off gas grid buildings, starting with new build. The 850,000 households heated by oil in England resulted in 8MtCO_2e in 2013. More detail on how this might be achieved will be set during in 2018. The government will also set out its intention to consult on improving the energy efficiency of new and existing buildings (subject to the conclusions of the independent review of Building Regulations and fire safety).

Alongside the CGS, the government also published new standards for domestic boiler installations, known as Boiler Plus. These will keep the UK's boiler standards higher than anywhere else in the world, and will save more than 5.2 $MtCO_2e$ over the next decade.

3.6.22 Wales

Welsh Government Warm Homes is the Welsh Government's flagship energy efficiency and fuel poverty programme, made up of the *Warm Homes Nest* and *Warm Homes Arbed* schemes. The programme is designed to tackle fuel poverty and reduce carbon emissions by improving the energy efficiency of the homes of those on low income homes or living in the most deprived areas of Wales.

Since 2011, *Warm Homes* has improved the energy efficiency of over 45,000 homes, helping these households to save energy, reduce their fuel bills and reduce carbon emissions.

Warm Homes takes a 'whole-house' approach to energy efficiency improvements, taking account of the nature of the property, its occupancy, the potential impact of different measures and value for money. Potential measures can include insulation, heating system upgrades, renewable technologies, heating controls and energy efficiency advice.

Warm Homes Nest is a demand-led scheme, where households throughout Wales can contact the scheme for support. In 2016/17, Nest installed free energy efficiency improvements in over 45,500 of the most energy inefficient homes in Wales. This is estimated to deliver total lifetime savings of over 311,000 tCO_2.

In addition, *Nest* has provided advice and support to over 98,000 households since 2011, helping them to reduce their energy use, lower their energy bills, and reduce their carbon emissions.

Warm Homes Arbed is an area-based scheme which levers in and co-ordinates investment into the energy performance of Welsh homes, prioritising the most disadvantaged areas and low income areas with a high number of off-gas or hard to treat homes.

Welsh Government has announced investment of a further £104 million in the *Warm Homes Programme* over the next 4 years to improve the energy efficiency of up to a further 25,000 homes in Wales. This will include the delivery of a new *Nest* scheme and a new *Arbed ERDF* scheme, levering in up to £24 million of EU funding.

The Welsh Government requires all social homes to meet the Welsh Housing Quality Standard (WHQS) by 2020 and to be maintained afterwards.

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 2017) over 197,000 dwellings (88%) are fully compliant in achieving an EPC rating of 65 or above, and over 212,000 dwellings (95%) 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.

3.6.23 Northern Ireland

3.6.23.1 Energy Savings advice

In Northern Ireland the public can obtain information through the NI Direct website 'Energywise: Get in the know'[111]. The website contains advice and guidance on steps that can be taken to be more energy efficient, renewable technologies available and what may be most suitable for the home, grants available, tips on central heating and home insulation measures.

3.6.23.2 Fuel Poverty in NI

The Department for Communities (DfC) Affordable Warmth Scheme targets households most at risk of fuel poverty and provides a range of heating and insulation measures to improve the energy efficiency of households with an annual gross income of less than £20,000. The targeted scheme replaced the Warm Homes Scheme from April 2015. The Warm Homes Scheme was a self-referral scheme which relied on social security benefit entitlement as a passport and invested on average £1,400 per household on energy efficiency improvements. The new Affordable Warmth Scheme is finding and helping households which need more intensive help and is spending on average almost £4,000 per household on energy efficiency improvements. The Affordable Warmth Scheme aims to assist about 4,000 low income households each year.

The DfC's Boiler Replacement Scheme provides a grant towards the cost of replacing old and inefficient boilers over 15 years old. This continues to be a very popular scheme.

The DfC's fuel poverty strategy "Warmer Healthier Homes" was launched in 2011 and ran until 2016. The Department is committed to producing a new fuel poverty strategy and this will centre on the themes of "paying less, using less and wasting less energy". The strategy will include a commitment to continue with an area based and targeted approach to tackling fuel poverty by assisting those households most at risk.

3.6.23.3 Renewable Heat Incentive in NI

On 1 November 2012 a separate RHI scheme for business customers was introduced in Northern Ireland. The scheme was largely similar to the Great Britain RHI, however, had differing tariff levels designed specifically for the Northern Ireland market. The scheme was suspended on 29 February 2016.

3.6.23.4 RHPP in NI

On 24 May 2012 the Renewable Heat Premium Payment (RHPP) scheme was launched in Northern Ireland. The scheme closed on 24 November 2014 having received approximately 2168 applications requesting support, with 1220 receiving payments. 1162 of the RHPP recipients migrated to the Northern Ireland Domestic Renewable Heat Incentive Scheme following its introduction in December 2014. The scheme was suspended from 29 February 2016.

3.7 Transport

3.7.1 Sector Overview

The transport sector consists of emissions from domestic aviation, road transport, railways, shipping, fishing and aircraft support vehicles. This sector produced around 24% of UK

[111] https://www.nidirect.gov.uk/campaigns/energy-wise

greenhouse gas emissions in 2015, almost entirely through carbon dioxide. The main source of emissions from this sector is the use of petrol and diesel in road transport, in particular passenger cars.

Between 1990 and 2015, transport greenhouse gas emissions have reduced by around 2%. Given the importance of road transport to the sector, changes in this area have had the most impact over this time. New cars in the UK are up to 16% more efficient than they were in 2000. However, this improvement has been largely offset by a nine % increase in road traffic to 2015, with the number of registered vehicles increasing over the same period from 28.9 million to 36.5 million.

The continued move to a low carbon transport system will be central to meeting the targets set under the UK's Climate Change Act.

3.7.2 Reducing Emissions from Road Transport

Transport emissions in 2015 were down two % compared to 1990198,199. While new cars in the UK are up to 16% more efficient than they were in 2000200, this improvement has been largely offset by a nine % increase in road traffic to 2015201, with the number of registered vehicles increasing over the same period from 28.9 million to 36.5 million202. The transport sector now accounts for 24% of the UK's emissions203.

3.7.2.1 Accelerating Take up of Ultra Low Emission Vehicles (ULEVs)

Ambition:

- To meet the UK's 2050 target, almost every car and van will need to be zero emission by 2050.
- The Government has announced an end to the sale of all new conventional petrol and diesel cars and vans by 2040.
- The government want to have one of the best electric vehicle (EV) charging networks in the world.

The Government is spending nearly £1.5 billion in the period 2015-20 to drive the uptake of ULEVs. Support includes both supply side and demand side policy measures.

The UK now has over 120,000 ULEVs on the road. ULEV uptake has been driven through a combination of grants together with improved charging infrastructure and new approaches like the £40 million Go Ultra Low Cities scheme and Go Ultra Low public education campaign.

Key Policies:

The UK's **Plug in Grants** currently offset the upfront cost of buying a ULEV by up to £4,500 for cars, £1,500 for motorcycles, £8,000 for vans and £7,500 for taxis. If battery prices continue to fall there will be less need for Government subsidies for new vehicles in the future.

Central Government is leading the way with a commitment to electrify 25% of its fleet by 2022.

The Government provides financial support for the installation of charging infrastructure via the:

- **Electric Vehicle Homecharge Scheme** – up to £500 towards the cost of installing electric vehicle chargepoints at domestic properties.
- **Workplace Charging Scheme** – businesses, charities and public sector organisations can secure grants of £300 per socket for up to 20 charging sockets for their employees and fleets.

- **On-street Residential Chargepoint Scheme** – for local authorities towards the cost of installing on-street residential charge points for plug-in electric vehicles.
- **A £400m Charging Infrastructure Investment Fund** (£200m Government investment to be matched by private investors) to accelerate the roll out of charging infrastructure by providing access to finance to companies that deliver chargepoints.

In addition, £15 million from Highways England to ensure rapid charge points every 20 miles across 95% of England's Strategic Road Network.

New powers under the **Automated and Electric Vehicles Bill** will allow the Government to set specific requirements for the provision of EV charge points or hydrogen refuelling infrastructure at motorway service stations and large fuel retailers, as well as ensuring that charge points are convenient to access and work seamlessly right across the UK.

The Bill will also allow the Government to require all new charge points sold or installed in the UK to be 'smart' enabled. This will help shift charging away from peak times of the day, reducing demand on the electricity system and keeping costs lower for everyone.

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. A reformed VED system was implemented this year for cars first registered from April 2017. The reformed system strengthens environmental incentives to purchase the very cleanest cars. First year VED is clearly based on environmental standards, and evidence from car purchase decisions across Europe suggests this is when the environmental signals are most effective in influencing people's choice of car.

It creates five new First Year Rate bands in the 0–100 g/km of CO_2 range to distinguish between zero-emission cars, Plug-In and hybrid vehicles and efficient conventionally fuelled cars. The very cleanest zero-emission cars pay nothing while rates on the most polluting cars are significantly increased.

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. The Government is committed to maintaining a differential in rates for the lowest emitting cars – those that emit 75g/km of CO_2 or less. The Government announced at Autumn Statement 2016 that new, lower bands will be introduced for the lowest emitting cars in 2020–21. The new bands will provide stronger incentives for the purchase of ULEVs, in particular those with higher zero emission ranges. In the same year, the appropriate percentage for cars emitting more than 90g/km of CO_2 will rise by 1 percentage point.

The Government has provided £11 million through the **Hydrogen for Transport Advancement Programme** to create a network of 12 hydrogen refuelling stations, and support 50 hydrogen fuel cell electric vehicles on the UK's roads. A new £23 million fund was announced in March 2017 to boost the creation of hydrogen fuel infrastructure and encourage roll-out of hydrogen vehicles.

The **'Go Ultra Low'** communications campaign brings the Government and leading vehicle manufacturers together to explain the benefits of ULEVs to motorists and businesses, and its success has been internationally recognised. The Government will continue to work with industry on consumer communications on ULEVs until at least 2020.

The Government will set out further detail on a **long term strategy for the UK's transition to zero road vehicle emissions** by March 2018.

3.7.2.2 Improving the efficiency of conventional vehicles

Mandatory CO_2 emissions targets set at EU level are 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.

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 of CO_2. This represents a fall of 3.6% on the previous year and an overall 26.5% reduction since 2000.

As the UK leaves the EU, it should continue to be a world leader in low carbon transport, and Government will look for opportunities to strengthen further the controls on vehicle CO_2 emissions. The UK will pursue an approach which offers certainty to industry, and is at least as ambitious as current arrangements.

The fuel used in cars is also lower carbon, with the **Renewable Transport Fuel Obligation (RTFO)** driving the greater use of biofuels. Biofuels now account for around three % of fuel sales, with around half of that derived from wastes. Average greenhouse gas savings from biofuels are around 70% compared to petrol and diesel.

In September the Department for Transport published proposed amendments to the RTFO which will set a trajectory for the supply of renewable fuels in transport that will meet the 10% target for transport set under the Renewable Energy Directive target. The level will be increasing to 9.75% in 2020, rising to 12.4% in 2032.

The changes will approximately double the use of renewable fuels, reduce reliance on imported fossil diesel, and deliver greenhouse gas emissions savings equal to taking another one million cars off the road in the most cost effective way.

3.7.2.3 Developing a More Efficient and Low Carbon Freight System

Ambition:

- Emissions from heavy goods vehicles (HGVs) will also need to reduce significantly to make a meaningful contribution towards meeting the UK's overall 2050 target.

Ultra low emission vans and HGVs between 3.5 and 44 tonnes have been eligible since late 2016 for **plug-in grants** worth up to £20,000 for the first 200 vehicles bought using the grant. After the first 200, grants still apply in line with current Plug-in Van Grant levels; 20% off the price, up to a maximum of £8,000.

The Government has consulted on proposals to allow category B (car) licence holders to drive slightly heavier vans if they are powered by a low emission technology, effectively offsetting the additional weight of the powertrain. This may help achieve payload parity with conventionally fuelled vehicles and encourage further uptake of cleaner goods vehicles.

The Government's **Freight Carbon Review**, published in February 2017, identified a range of measures to help fleet operators reduce their emissions, including through improved fuel efficiency. The Energy Saving Trust is piloting a scheme to **advise HGV fleet operators on reducing fuel consumption**.

The Government is conducting an operational trial of longer semi-trailers, which is authorising up to 2,800 longer articulated goods vehicles to run on Great Britain's roads. Results from the trial to date suggest considerable benefits by way of improved efficiency and potential CO_2 savings.

Our 2016 **Rail Freight Strategy** highlighted the potential to reduce emissions by growing rail freight and reducing HGV journeys. As stated in the Clean Growth Strategy, the Government will accelerate activity to enable cost effective options for shifting more freight from road to rail, including using low emission rail freight for deliveries into urban areas, with zero emission last mile deliveries.

3.7.3 Encouraging Low Carbon Alternatives to Car Journeys

3.7.3.1 Cycling

Ambition:

- By 2040, the Government wants cycling and walking to be the natural choices for shorter journeys, or as part of a longer journey.

The Government will continue to invest in our public transport network, and help people to cycle, walk or travel by bus or train.

The **Cycling and Walking Investment Strategy** identifies £1.2 billion which may be invested in cycling and walking from 2016-21. Under this new strategic approach, **Local Cycling and Walking Infrastructure Plans** identify improvements required at the local level, and enable a long-term approach to developing local cycling and walking networks, ideally over a ten year period.

3.7.3.2 Buses

As announced in the 2016 Autumn Statement, the Government will provide £100 million for a national programme of support for **retrofitting and new low emission buses** in England and Wales, including hundreds of new low emission buses and retrofitting of thousands of older buses.

3.7.3.3 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. Rail passenger journeys are now at their highest level since the 1920s.

The Government will seek more use of electric, bi-mode (electric and diesel hybrid) and alternative fuel traction on the railway. The Government will continue to invest in **rail electrification** where it provides benefits to passengers. The industry is also developing trains powered by alternative fuels, for example using battery and hydrogen power.

3.7.4 Modernising the Aviation and Shipping Sectors

Ambition:

- Continued modernisation of aviation and shipping sectors, both through international action, such as standards and offsetting schemes, and domestically, for example through support for sustainable alternative fuels, improved efficiency and new technologies.

3.7.4.1 Aviation

It has long been the Government's position that strong action at a global level is the best means of addressing carbon emissions from aviation, given the international nature of the aviation sector.

For example, in October 2016, at its 39th Assembly, the 191 Member States of the International Civil Aviation Organisation (ICAO) agreed to implement a global market-based measure for international aviation. The Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) is the first worldwide scheme to address CO_2 emissions in any single sector.

Under the deal, airlines will offset their international aviation emissions with reductions from other sectors with the aim of delivering ICAO's goal of carbon-neutral growth of international aviation from 2020. The outcome is a success for the UK, which has long pushed to address aviation emissions at the global level.

The UK has volunteered to participate in the measure from the beginning in 2021. The focus now will be to ensure that this measure is implemented effectively both in the UK and around the world, and the UK is working with other States to achieve this.

In 2016, the UK was actively involved in ICAO's agreement of a CO_2 standard for civil aircraft. From 2020, the standard will set the technology level around the world to ensure only lower emission technology will be used on aircraft in future. Along with CORSIA, the standard forms part of ICAO's 'basket of measures' to tackle aviation's climate impacts.

At the European level, the European Commission published a proposal on the future of the aviation EU Emissions Trading System following agreement on the CORSIA at the 39th ICAO Assembly in October 2016. Following trilogue negotiations, agreement was reached that continues the current scope of the scheme until the end of 2023. The UK strongly supported the continuation of reduced scope to allow time for the implementation of CORSIA in the EU.

Domestically, industry and the Government have made a joint £3.9 billion commitment between 2013 and 2026 to the development of new aircraft technology with the Aerospace Technology Institute. The UK is also committed to making operational improvements in air traffic navigation services in order to increase fuel efficiency and reduce emissions. NATS has committed to reducing average CO_2 emissions per flight by 10% by 2020 compared to 2006.

On alternative fuels, it was announced that Government will extend the Renewable Transport Fuels Obligation (RTFO) to include incentives to use renewable fuels in aviation.

The Future Fuels for Flight and Freight Competition (F4C) is aimed at increasing domestic production of advanced low carbon fuels capable of tackling emissions from the hard-to-decarbonise aviation and heavy goods vehicle sectors in pursuit of long-term UK decarbonisation targets. The scheme will provide up to £20 million in capital grant funding over 3 years (2018-21) and up to £2 million of Project Development Funding in 2017-18 to support the development of proposals.

The industry is also working to reduce airport-related emissions through a range of measures including more efficient operation of aircraft, introducing efficient new technology, using landing charges to incentivise cleaner aircraft, reducing vehicle emissions within the airport boundary, and encouraging sustainable surface access.

The Government will set out its strategic approach to the aviation sector in a series of consultations over the next 18 months, including a paper on how to support growth while tackling the environmental impacts of aviation. This will culminate in a new Aviation Strategy for the UK which the Government intends to publish by the end of 2018.

3.7.4.2 Shipping

On international shipping, the UK continues to engage in the International Maritime Organisation (IMO) activities on the 'Roadmap for Developing a Comprehensive IMO Strategy on Reduction of GHG Emissions from Ships'. This process provides for the adoption of an Initial Strategy in spring 2018, and a Revised Strategy in spring 2023.

The Government is looking to deepen its technical expertise to further support the development of innovative technologies and fuels to reduce maritime emissions, ultimately helping create a zero-emissions maritime sector.

On domestic shipping, the Government will continue to work with industry to develop improved fuel efficiency technologies, including new propulsion systems, hull design and aerodynamic structures.

The Government will work with ship owners and ports to identify the barriers faced in supplying and using sustainable alternative fuels and cleaner emissions technologies, to explore possible solutions. In addition, it is expected that operational improvements will play a role, including better use of ship capacity.

3.7.5 Government Innovation Investment

The Government expects to invest around £841 million out to 2021 in innovation in low carbon transport technology and fuels, primarily through programmes run by DfT, OLEV, the Research Councils, Innovate UK, and BEIS.

The Government will build on this investment to make the UK one of the world's leading innovators in new low carbon technologies. Investments include:

- **Electric vehicle and battery technology**. Government investment will help bring down the cost of EVs and increase their range. Through the Industrial Strategy Challenge Fund (ISCF), the Government will invest £246 million over four years in the design, development and manufacture of batteries for the electrification of vehicles, as part of the 'Faraday Challenge'. The Government has also awarded £10 million to build UK capability in the development and commercialisation of automotive battery packs.
- **Innovative charging technologies**. Government announced in November 2017 £40m for R&D into innovative new charging technologies, supporting a low cost scalable solution for on-street charging, and wireless charging.
- **Smart energy**. Up to £70 million to 2021 to support innovation in energy storage, demand side response and other smart energy technologies. Other technologies include innovative electric vehicle-to-grid projects, up to £20 million for vehicle-to-grid products, services and knowledge, and non domestic smart energy management, innovative smart meter data led approaches to energy management tailored to three sectors: smaller hospitality, retail businesses and schools.
- **Advanced fuels**. There are fewer options for reducing emissions in the freight and aviation sectors, and here innovation in fuel technology can play an important role. The Government is providing £38 million out to 2021, to fund the development of advanced low carbon fuels derived from wastes or industrial and agricultural by-products. In August 2017 the Government relaunched the Future Fuels for Flight and Freight Competition – a £22 million industry competition to encourage development and deployment of low carbon HGV and aviation fuels.
- **Zero emission HGVs**. In January 2017, the winners of over £20 million for the Low Emission Freight and Logistics Trial were announced. Twenty different projects are

receiving funding to demonstrate and trial low and zero emission vehicles in UK fleets, for example using hydrogen, electric and biogas technologies. In the longer term, there is an opportunity to take forward projects to support innovative technologies such as 'dynamic charging' as a potential solution to decarbonising freight.

- **HGV platoons**. HGV platooning, using advanced vehicle technologies, enables lorries to move in a group and could deliver significant fuel and emissions savings. The Government will be delivering trials of HGV platoons, with joint funding from Highways England, to assess the feasibility and potential costs and benefits of this technology on UK roads. In August 2017, it was announced that a trial of HGV platoons, jointly funded with Highways England, will see up to three HGVs travelling in convoy, with acceleration and braking controlled by the lead vehicle, and with a driver ready to take control at any time in all the HGVs. Platooning trials have been conducted across Europe and the USA, and these trials will assess whether the technology is appropriate and beneficial on UK roads.
- Government has also established the **Centre for Connected and Autonomous Vehicles (CCAV)** and invested over £250 million, matched by industry, to position the UK at the forefront of research, development, and demonstration of automated vehicle technologies. These technologies have the potential to smooth traffic flows and increase efficiency of road transport, indirectly reducing emissions. CCAV is also coordinating engagement with the wider research base and industry, identifying and reducing barriers to innovation or business expansion.

3.7.6 Wales

The statutory *Wales Transport Strategy* includes clear objectives to reduce GHG emissions from transport and for climate change adaptation in the transport system. The Welsh Government is committed to supporting shift to more sustainable modes by continuing to invest in public transport, including bus grants and measures reflecting the Active Travel (Wales) Act. The Welsh Government is also committed to promoting the uptake of ultra low emission vehicles (ULEVs) in Wales. It will be providing £2 million to help secure a network of charging points throughout Wales, with the focus on infrastructure which will serve users of our strategic road network in order to alleviate range anxiety in respect of longer, through journeys. The Welsh Government is also looking to revise its statutory planning policy guidance to help support the uptake of ULEVs.

3.7.7 Scotland

The Scottish Government has published its draft emissions reductions strategy in 2017 with the final version due in early 2018. This contains a number of measures to address transport emissions including support to increase electric vehicle uptake and the creation of low emission zones in Scotland's 4 largest cities by 2020. The Scottish Government is also introducing measures to green commercial vehicles such as buses and HGVs by supporting fuel efficiency programmes, moving freight from road to rail and introducing low emission solutions at Scotland's airports and ports.

National Planning Framework 3 and Scottish Planning Policy (both published in 2014) strongly support patterns of development and land use that promote walking and cycling. Scottish Planning Policy states 'Plans should identify active travel networks and promote opportunities for travel by more sustainable modes in the following order of priority: walking, cycling, public transport, cars.' By law decisions on applications for planning permission must be made in accordance with the development plan for the area unless material considerations indicate otherwise.

3.7.7.1 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 £16.2 million of funding to support the introduction of 362 low carbon buses across Scotland. The Scottish Green Bus Fund is being extended and will start from 2019-20 to allow time for development and for the industry to ramp up in terms of demand and supply. In the meantime a further round of the existing Green Bus Fund is being considered.

3.7.7.2 Cycling

In Scotland, the Scottish Government has worked with local authorities, stakeholders and delivery partners to publish an updated Cycling Action Plan for Scotland (CAPS) in January 2017. This sets out actions to meet our vision of 10% of everyday journeys being by bicycle by 2020. Additionally, the Scottish Government has committed to doubling spend on active travel annually to £80 million from 2018/19.

3.7.8 Northern Ireland

The draft Northern Ireland Programme for Government (2016-2021) includes an indicator for the reduction in greenhouse gas emissions. In recognising the contribution which transport makes to greenhouse gas levels, the draft PfG includes an indicator to increase the percentage of all journeys made by walking, cycling and public transport. The following actions are focused on achieving this modal switch.

The Department for Infrastructure (Dfl) is working with local councils to ensure that Local Development Plans and planning decisions take account of existing regional strategic planning and transport policies and guidelines to encourage the use of walking, cycling and public transport. This includes building a safe and accessible cycling infrastructure by delivering a Belfast Bicycle Network, a bicycle network for other urban areas and a Strategic Plan for Greenways. Promoting the increased use of public transport is also progressing through projects such as the Belfast Rapid transit, development of the Belfast and Foyle Transport Hub and the creation of more Park & Ride facilities. The Translink companies have been set a target to increase passenger journeys to 81 million in 2017/18.

In addition, a charging network of 336 charging points for electric vehicles has already been established across Northern Ireland. Work is being taken forward to support the introduction of Ultra Low Emission Vehicles to the Northern Ireland market by adapting the broader UK Ultra Low Emission Vehicle Strategy, which is under development, to reflect the Northern Ireland context.

3.8 Power

Power sector emissions have fallen 49% since 1990 as there has been a switch from coal to gas and renewable power such as wind and solar, with biomass conversions also playing an important transitional role, alongside improvements in the efficiency of our economy242. Last year, 47% of our electricity came from low carbon sources, with the rest mainly coming from coal and gas243. Coal use fell to record low levels last year, and on 21 April 2017, for the first time since 1882,

coal was not used for a 24-hour period244. At the same time, the UK Government has ensured a secure supply of electricity.

The costs of low carbon and more efficient technologies have fallen significantly since 2010 through a series of innovations and growth in deployment. Solar photovoltaic modules are now almost 80% cheaper, LED lightbulbs over 80% cheaper, and batteries for electric vehicles (EVs) over 70% cheaper. Average household electricity bills in 2016 were around 10% lower than in 2008, when the Climate Change Act was introduced. While policy costs on bills have increased over this period, this has been more than offset by reduced electricity use, thanks in part to tightening standards on electrical products.

3.8.1 Carbon Price Floor

The carbon price support (CPS) is a tax on fossil fuels used to generate electricity. It came into effect on 1 April 2013. When the CPS is added to the EU Emissions Trading System (EU ETS) price, it sums to the Carbon Price Floor (CPF), a minimum carbon price for the power sector.

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 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 since 2013 the Budget has announce and the Finance Bill legislate for the rates two years ahead to provide certainty to the market and set out the provisional rates for the following two years to give an indication of the likely rates required to meet the floor.

3.8.2 Electricity Market Reform

Carbon price to provide a clear economic signal to drive the move towards a low carbon economy by adding a cost to emitting CO_2 to set a floor to the carbon price for electricity supply so as to (1) reduce the use of emissions intensive fossil fuels (2) increase in the proportion of electricity generation and supply from renewables

Table 13: Carbon price

	Confirmed rates							Indicative rates
CPS rates	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21
Carbon price equivalent (£ per tCO_2)	4.94	9.55	18.00	18.00	18.00	18.00	18.00	18.57

3.8.3 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 CHP is provided to improve the commercial case for investing in CHP because of its relatively long payback period and technical complexity. This is done through a range of measures including Enhanced Capital Allowances, CCAs and business rate exemptions. Modelling suggests that gas CHP will be higher carbon than the electricity it is displacing by 2032. Gas CHP is consequently supported as a transitional technology towards lower carbon emissions.

Support is also provided for renewable CHP, given its added decarbonisation benefits, including through the Renewable Heat Incentive and Contracts for Differences (CFD). The Renewables Obligation is used to support renewable electrical output, however was closed to new capacity in April 2017 as the UK transitioned to CFD becoming the main mechanism for supporting electrical outputs of CHP plants.

3.8.4 Renewables Obligation

The Renewables Obligation (RO) has been the main mechanism for supporting large-scale renewable electricity projects in the UK since 2002. It is a market-based support mechanism and works by placing an obligation on licensed electricity suppliers to produce a certain number of Renewables Obligation Certificates (ROCs) to Ofgem, the administrator of the scheme, in respect of each megawatt hour of electricity supplied each year.

Ofgem issue ROCs to generators in relation to the renewable electricity they generate. Generators sell those ROCs to suppliers or traders, with or without the electricity generated, as tradable commodities. This allows them to receive a premium in addition to the wholesale price of their electricity. The value of a ROC is a matter for negotiation between generator and supplier/trader.

Suppliers present ROCs to Ofgem to demonstrate their compliance with the Obligation or paying a buy-out price, set at £45.58 per ROC for 2017/18 (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 2017/18 in England, Wales and Scotland is 0.409 ROCs/MWh and 0.167 ROCs/MWh in Northern Ireland.

As part of the transition to the more cost effective and competitive Contract for Difference support mechanism, the RO closed to new capacity on 31 March 2017 (with some exceptions that extend the deadline for certain projects to January 2019 in Great Britain and March 2019 in Northern Ireland). Accredited capacity will usually receive support for 20 years or until the final closure of the scheme on 31 March 2037, whichever is the earlier.

Since its introduction in 2002, over 23,500 generating stations have been accredited under the Renewables Obligation, comprising 25GW of installed capacity. The scheme has played a key part in increasing the proportion of UK electricity generated from renewables from just above one percent in 2002 to 24.5% in 2016.

3.8.5 Carbon abatement technologies

The focus of the UK government's approach on carbon abatement technologies is the development of carbon capture usage and storage (CCUS). CCUS is a chain of technologies designed to remove the CO_2 from power and industrial sources and either use it as a feedstock, or 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 CCUS could play a significant role in low carbon electricity generation, low carbon hydrogen production, and decarbonising energy intensive industry. The Government has set out the approach to CCUS in the Clean Growth Strategy[112], including the ambition to have the option of deploying CCUS at scale during the 2030s, subject to global cost reductions.

The key components outlined in the Clean Growth Strategy are:

- To progress our commitment to deploying CCUS in the UK, subject to cost reduction. The Government will:
    - Establish a CCUS Cost Challenge Taskforce, reporting to Ministers in autumn 2018;

[112] https://www.gov.uk/government/publications/clean-growth-strategy

  - Produce a deployment pathway by the end of 2018, setting out the steps Government intends to take to realise its ambitions for deploying CCUS;
  - Review the delivery and investment models for CCUS in the UK, covering industry, power, and CO_2 infrastructure projects;
  - Test the development of CCUS industrial decarbonisation, working with ongoing initiatives in Teesside, Merseyside, South Wales, and Grangemouth; and
  - Establish a Ministerial-led CCUS Council to review our progress and priorities.
- The Government will convene and lead a new international working group to drive down the cost and accelerate deployment of CCUS, including by:
  - Continuing to participate in Mission Innovation and its Carbon Capture Challenge;
  - Working closely with private sector-led initiatives such as the Oil and Gas Climate Initiative;
  - Developing closer collaborative working with countries such as Norway, the US, Canada, and Australia, including joint working on CO_2 transport and storage solutions, and working multilaterally through the Carbon Sequestration Leadership Forum and North Sea Basin Task Force;
  - Continuing to be a global leader in CCUS investments through the UK's £60 million international CCUS programme which has been running since 2012, by investing a further £10 million in the programme; and
  - Organising a Global Carbon Capture Usage and Storage Conference in 2018, with international partners.
- The Government will spend up to £100 million from the BEIS Energy Innovation Programme to support industry and CCUS innovation and deployment in the UK, and support cost reductions. The Government will:
  - Provide £20 million of funding for a CCU demonstration programme;
  - Support next generation capture technologies, with an aim to lower the cost of capture;
  - Support small-scale industrial capture demonstrations to reduce the risks associated with CCUS on an industrial site;
  - Support the application of CCUS in low carbon hydrogen production;
  - Further our understanding of the role of Greenhouse Gas Removal (GGR) technologies, including BECCS (bio-energy with CCS); and
  - Support studies and technologies that reduce costs of transporting and storing CO_2.

Approaching 2050, remaining emissions are likely to be in sectors where it is most difficult to decarbonise – in industry, agriculture, aviation and shipping. Greenhouse Gas Removal (GGR) technologies are likely to play an important role in offsetting difficult-to-cut emissions. GGRs include afforestation, BECCS, and direct air capture. The Government's strategic approach to GGRs will include a programme of R&D, to help overcome uncertainties around costs, deployment potential, and impacts on the environment. The Government will also consider the scope for removing barriers and strengthening incentives to support the deployment of GGRs, to position the UK at the leading edge of GGR development.

The Government will work to realise the opportunities CCUS could provide in supporting decarbonisation across the economy, while maximising economic opportunities. The Government wants the UK to become a global technology leader in CCUS and work internationally with industry and Governments to bring about global cost reductions.

3.8.6 Ending Unabated Coal power generation

The Government has committed that there will be no unabated coal generation in Great Britain by 2025. While a combination of poor economics, age, the effects of a more intermitted electricity system and carbon pricing has meant that there now remain only nine coal power stations. Coal generation has fallen from 39% in 2012 to 9% in 2016 and in May 2017 there was the first 24 hour period of no coal generation. However, it is uncertain when the remaining coal generators will close, and so to improve the investment case for new, flexible, clean capacity and end date has been set for coal generators unless emissions can be abated to below 450gCO_2 per kWh of electricity generated.

Planning requirements mean that no new coal generator can be constructed without Carbon Capture and Storage technology being demonstrated on 300MWe of capacity. The Energy Act 2013 also introduced the Emissions Performance Standard on new fossil fuel capacity, at an equivalent rate of 450gCO_2 per kWh.

The UK is also working with other countries to support a movement away from a reliance on unabated coal.

3.8.7 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 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 900,000 installations (6 GW capacity) registered on either the Central Feed-in Tariff Register (CFR) or the Microgeneration Certification Scheme (MCS) by the end of August 2017. Of these, around 99% are solar PV installations.

3.8.8 Hydrogen

Hydrogen is an energy carrier which has the potential to decarbonise the electricity, heat and transport sectors and offer an option for, electricity grid balancing and energy storage. Improved energy system modelling is needed so that the potential benefits and costs can be properly evaluated.

UK activities on hydrogen include strengthening the evidence base on its potential use in the heat sector as part of wider work to assess heat decarbonisation options, support for innovation across the spectrum from basic research, through to development and demonstration (including a £25m project to establish the technical feasibility of using hydrogen for heat in homes), 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.

3.8.9 Electricity Market Reform

The UK government reformed 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** (CM) to ensure security of supply.
- **Carbon price floor** (CPF) 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.

Updated CFD contract terms and strike prices for renewable technologies, and the *EMR Delivery Plan* were published in December 2013. The first CFDs under the enduring regime were signed in 2014; and the first capacity auction was run in the same year, for delivery of capacity in winter 2018-2019. Both policies received state aid approval.

Since that time a further allocation round has been run for CFDs in 2017 and a further series of capacity auctions have been run.

3.8.10 Electricity Transmission

The innovative regulatory regime for offshore transmission, jointly developed by the government and Ofgem, has been established. There have now been 15 Offshore Transmission Owner licences granted by Ofgem under the regime, securing over £2.2 billion of investment in offshore transmission, with another £700m currently in the tender process.

To ensure the timely connection of new generation projects in the meantime, the Government introduced enduring 'connect and manage' grid access reforms in August 2010. These have proved successful, particularly in reducing the grid connection times for renewable projects by an average of five years. The regime now forms a standard part of the grid connection arrangements in Great Britain.

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.

In 2015 Ofgem approved over £26 billion of funding for the distribution network operators (DNOs) for the 2015–2023 RIIO ED1 price control. The DNO role is vital for the delivery of smaller-scale renewable projects, since 2012 generation connected to the distribution network has nearly doubled from 14GW to just under 28GW. [Source DUKES].

Further the regulator has taken steps to increase competition in electricity distribution connections which has brought cheaper and quicker connections for renewable generators. According to Ofgem in 2011, 14% of connections were provided by independent connection providers. By 2015 this had risen to 36%.

In July 2017 the Government and Ofgem published the paper *Upgrading our energy system: Smart Systems and Flexibility Plan*. This set out the guiding principles of our approach to enable the transition to a smarter, more flexible energy system in GB, followed by 29 actions that BEIS, Ofgem and others are undertaking across three broad themes:

- removing barriers to smart technologies including storage;
- smart homes and businesses; and
- markets which work for flexibility.

Government is also continuing to deliver the smart meter programme, which ensures that that every home and small business in the country is offered a smart meter by the end of 2020.

3.8.11 Wales

3.8.11.1 Energy Wales

The Welsh Government's energy policy is set out in *Energy Wales: A Low Carbon Transition.* The priorities for energy are; to use energy more efficiently, reduce our reliance on fossil fuels and ensure Wales benefits from this low carbon transition..

Energy Wales sets the Welsh Government priorities for leading the transition to a low carbon economy in a way that delivers long term benefit for the people of Wales. Energy Wales covers a range of actions to realise economic, social and environmental benefits from energy efficiency and renewable energy, and in the longer term from marine energy and the innovative initiatives that will deliver smart living.

The Welsh Government's intention is to maximise the role of renewable generation in delivering secure and affordable low carbon energy for Wales, which will form an important part of delivering carbon budgets. In order to achieve this, Wales will require a mix of different technologies and sizes, from community scale to major projects. In September 2017 the Welsh Government set stretching but realistic targets for renewable energy in Wales.

3.8.12 Scotland

3.8.12.1 The energy savings advice service

Scotland's Energy Efficiency Programme (SEEP) which will operate across Scotland will be launched in 2018 with substantial annual public funding drawing on the commitment to provide over half a billion pounds over the next four years and by the end of 2021 Scottish Government will have allocated over £1 billion since 2009 on tackling fuel poverty and energy efficiency

measures. It will be a co-ordinated programme to improve the energy efficiency of homes and buildings in the commercial, public and industrial sectors. Initial estimates suggest required overall investment of around £10bn from a range of public and private sources.

The Scottish Government's existing advice, support and loan services for residential (Home Energy Scotland) and the business and public sectors (Resource Efficient Scotland) will continue to deliver during the design phase of SEEP. As SEEP develops over the longer term, the future provision of advice and information to homes, businesses, and the public sector, to support them in improving the energy efficiency and decarbonising the heat supply of their buildings will be considered.

3.8.12.2 Fuel poverty and domestic energy efficiency in Scotland

Scottish Government has always prioritised tackling fuel poverty and has a clear aspiration to eradicate poor energy performance as a cause of it.

Scottish Government is delivering its commitment to make half a billion pounds available over the next 4 years and, by the end of 2021, will have allocated over £1 billion pounds since 2009 on tackling fuel poverty and improving energy efficiency.

In response to recommendations put forward by the Fuel Poverty Strategic Working Group and the Scottish Rural Fuel Poverty Task Force, which both reported in October 2016, the Scottish Government are consulting on a new draft fuel poverty strategy. In particular, the consultation asks for views on:

- a new definition of fuel poverty and indicators and sub-targets (launched 9 November 2017).
- Responses to the consultation will inform the new strategy and the development of a Warm Homes Bill, due to be introduced in 2018, and development of a new framework for tackling fuel poverty in Scotland.

The sub-targets being proposed in the consultation include setting a minimum energy efficiency rating. Further work is being done to set a long term direction for SEEP, including looking at minimum standards of energy efficiency across different tenures. Scottish Government will be engaging further on some of these issues in the coming months and will provide further details next year, publishing a SEEP Route Map in 2018 to set out its long-term ambition.

As part of the wider development of SEEP Scottish Government will continue to consult on proposals and will consider appropriate mechanisms to bring forward resulting new legislation and regulations as appropriate – a wider SEEP Bill in the third year of this Parliament.

3.8.13 Northern Ireland

3.8.13.1 NI Strategic Energy Framework

Northern Ireland's Strategic Energy Framework (SEF)[113] has set a target of 40% of electricity consumption to be met from renewables by 2020. An interim target of 20% was met in 2015 and, as of 31 March 2017, the figure stands at 27.1%[114]. It is anticipated that if all installations

[113] https://www.economy-ni.gov.uk/sites/default/files/publications/deti/sef%202010.pdf

[114] https://www.economy-ni.gov.uk/sites/default/files/publications/economy/Issue-7-Electricity-Consumption-and-Renewable Generation-in-Northern-Ireland-April-2016-to-March-2017.pdf

resulting from the Northern Ireland Renewables Obligation (now closed), together with two tidal energy projects[115] off the North Antrim coast come to fruition, the 40% target is likely to be achieved.

The SEF has been reviewed and is to be replaced by a new energy strategy which will (subject to Ministerial agreement) set out Northern Ireland's energy ambition for the period to 2050. This new strategy is expected to encompass future direction in relation to both renewables and energy efficiency policy which, in turn, will be informed by the changes brought about through the European Union's Clean Energy Package[116].

3.9 Agriculture, land use, forestry, waste and F-gases

The UK is generating more value from the use of our natural resources (covering livestock, crops, trees, land use and waste) while also cutting emissions. The UK has halved its emissions from these sectors since 1990 and they now only account for 15% of total UK emissions.

During this time emissions from the waste sector have decreased by 73%. This has been driven by taxing waste to landfill, increased recycling and more and better waste infrastructure. The UK has seen household recycling rates increase from 11% to 44% between 2000/1 and 2015/16269. At the same time, the UK waste sector has become an important contributor to electricity generation. Waste helped to generate 14% of UK renewable electricity in 2015, enough to power 2.3 million homes.

3.9.1 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 to in contributing to climate change mitigation. The Clean Growth Strategy (CGS), published in October 2017, affirms the UK government's ambition to play a significant role in low carbon growth, supported through a system of incentives to improve efficiency and improve the natural environment.

The UK's exit from the European Union and the Common Agricultural Policy will give the UK government the opportunity to address climate change more directly. A new system of support will be designed, with a strong focus on delivering better environmental outcomes, including climate change mitigation and adaptation.

The Greenhouse Gas Action Plan (GHGAP), is a voluntary, industry-led initiative to reduce the level of GHG emissions produced from agriculture in England. The Defra review of the GHGAP in 2016 concluded that progress has been made, with a reduction of 1MtCO_2e having been achieved. The review also recommended in order to achieve the GHGAP target of 3MtCO_2e by 2022, the GHGAP should focus on increasing uptake of mitigation measures already proving effective. The GHAP should also identify opportunities to encourage the take-up of new technology that will increase the potential for further emissions reductions. Transformative technologies also present opportunities for emissions reductions. The Government's ambition is for the UK to be at the forefront of land-based innovation, at the cutting edge of agricultural and bio-based technology development. This aspiration will be supported through the forthcoming bioeconomy strategy as well as through the existing £160 million Agri-Tech Strategy.

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[115] http://www.tidalventures.com/ and http://dpenergy.info/fht/

[116] https://ec.europa.eu/energy/en/news/commission-proposes-new-rules-consumer-centred-clean-energy-transition

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.

3.9.2 Agriculture in Scotland

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.

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. 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.

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.

3.9.2.1 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.

Scottish government launched the FFBC initiative in 2009. The programme is delivered by Scotland's Rural College (SRUC) and targeted at land managers to help them take action to mitigate 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.

3.9.2.2 The Farm Advisory Service (FAS).

Provides information and resources aimed at increasing the profitability and sustainability of farms and crofts.

Launched in 2016 as part of the SRDP FAS activities include providing events, case studies, guidance notes, carbon audits (including around 200 free audits per annum) and integrated land management plans which are designed to take a holistic approach to review of the whole farm business with increased emphasis on public good such as climate change and other environmental aspects. The FAS programme is made up of two components: the one to many advice service delivered by SAC consulting and the one to one advice service delivered by Ricardo.

3.9.2.3 The Beef Efficiency Scheme (BES)

A five-year SRDP climate change scheme that aims to help beef breeders improve their efficiency, sustainability and quality of their beef herd.

Launched in 2016 this scheme will help farmers increase their genetic value of their herd whilst reduce greenhouse gas emissions through improved efficiency. The scheme will deliver a range of improvements focusing on cattle genetics, management practices and giving members access a free advisory service to assist in developing the suckler herd. It is expected that the principal impacts will be reduction in GHG emissions through improved genetic selection in respect of growth rates, feed conversion, maternal behaviour, nutrition practice and disease resistance.

3.9.2.4 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.

3.9.2.5 Farm energy auditing and resource efficiency in Scotland (still active)

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.

3.9.3 Agriculture in Wales

The Environment Act (Wales) 2016 gives a clear legislative framework in which to set policy. The principles of Sustainable Natural Resource Management Policy are at the core of all future policy making and schemes implementation to ensure it achieves multiple benefits and delivers an array of public goods and services which is not at the expense of food production.

Following the review of the Land Use and Climate Change report 2013, the Welsh Government has actively been working with the industry to develop a robust evidence based action plan

which sets the pathway for agriculture to mitigate greenhouses gases and also adapt to the opportunities and challenges of tackling climate change. The focus on reducing carbon intensity in the livestock sector, Animal Health and Welfare and improving Soil Health are central to this activity.

3.9.4 Agriculture in Northern Ireland

The Department of Agriculture Environment and Rural Affairs (DAERA), working in partnership with key environmental, agri-food, forestry and governmental stakeholders through a Greenhouse Gas Implementation Partnership, launched Phase 2 of the 'Efficient Farming Cuts Greenhouse Gases Implementation Plan 2016 – 2020'[117] in September 2016. Building on Phase 1 (launched 2011), this plan focuses on supporting and promoting on-farm implementation of efficient technologies, best practice measures and knowledge transfer programmes that help reduce the carbon intensity of food production in Northern Ireland.

The Northern Ireland Rural Development Programme 2014–2020, through a range of schemes, provides financial and business development supports to incentivise on-farm adoption of measures that increase efficiency and build resilience to climate change. Key among these are: Farm Business Improvement Scheme - Capital, supporting investments in efficient and emission reducing technologies; Environmental Farming Scheme, supporting environmentally beneficial farming practices including carbon conservation and sequestration; and DAERA Forestry Schemes, supporting establishment of new woodlands and sustaining existing woodlands.

3.9.5 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. Defra has invested significant resources to reduce the uncertainties attendant on estimating emissions from soils. Our new inventory model will become operational this year (2017) and will improve the characterisation of this important emissions source. 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 AHDB has also recently 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. It is the Government's stated intention to ensure that mitigation and adaptation to climate change are key features of future agriculture policy. As part of this approach, the potential and viability of new technologies to improve nutrient use efficiency will be explored.

3.9.6 Reducing methane 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

[117] https://www.daera-ni.gov.uk/publications/efficient-farming-cuts-greenhouse-gases-implementation-plan-2016-2020

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 livestock systems, and research on beef and sheep breeding for better economic and environmental outcomes. This work is all part of our broader aim of achieving a thriving farming and food sector with an improving net environmental contribution.

3.9.7 Anaerobic Digestion and Action Plan

The UK Government recognises that Anaerobic Digestion (AD) can play a role in contributing to the UK's 2050 carbon reduction targets, as well as in the management of certain forms of waste.

To date, the focus of Government policy in relation to AD has been on the development of the technology as a distributed energy source. The UK produces about 100 million tonnes of food and farm waste per year that is suitable for treatment by anaerobic digestion. On that basis the majority of development has been at a sub 1MW scale, with a focus on "on-farm" AD. More recently larger facilities for treatment of industrial and municipal food waste have been developed, however the UK Government discourages the use of dedicated biofuel crops for AD, as the primary purpose of agricultural land is for food.

Building on the conclusions of the Anaerobic Digestion Strategy and Action Plan (2011), which estimated that AD has potential to deliver between 3 and 5 TWh of electricity by 2020, the Government has included AD within the various UK renewable and low carbon energy financial incentive schemes (i.e. the Feed in Tariff, the Renewables Obligation and Contracts for Difference).

The UK Feed-In-Tariff is the principal means of support for AD projects under 5MW and has helped the sector to continue development. In 2016, the Government also announced that payments under both the Renewable Heat Incentive and the Feed-In Tariff would be restricted in instances where anaerobic digestion (AD) installations are producing over 50% of heat or electricity from feedstocks other than wastes or residues. In February 2017, as part of a wider review of the operation of the FIT scheme, Government set out amendments to the scheme to ensure that only the most efficient installations receive support, ensuring that customers receive the best value for money.

AD projects over 5MW are eligible for support through the Contracts for Difference (CfD) scheme, implemented in 2015. AD sits in within the less established technologies part of scheme, known as "Pot II", competing against technologies such as offshore wind, advanced conversion technologies, energy from waste with CHP and others. Two CfD auction rounds have been carried out to date, in 2015 and 2017.

3.9.8 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 2014-2020, of which environmental stewardship is a key part. Addressing climate change is a cross cutting priority of these Programmes.

Actions under the Scottish Rural Development Programme (SRDP) that help address climate change includes the Farm Advisory Service and Beef Efficiency Scheme as discussed in section 3.9.3 and supports woodland creation as referred to in section 3.9.10.

In Wales, capital and revenue from the RDP provides significant investment in the farm modernisation sustainable production scheme, Glastir suite of land management programmes, Sustainable Land Management scheme, Agricultural Strategic Initiative, Climate Smart Agriculture (Wales) and Farming Connect advice service.

3.9.9 Non-food crops

The UK Government's bioenergy strategy, published in 2012, provides four key principles to inform bioenergy policy:

- 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.

Bioenergy is both cost-effective and versatile, with a significant role to play in meeting the UK's climate change and renewable energy obligations. As such, the Government has indicated in its Clean Growth Strategy its intention to invest and explore the potential of bioenergy in, for example, the decarbonisation of heat and transport.

Wheat and maize make up the bulk of bioenergy crops cultivated in the UK, with sugar beet, miscanthus, oilseed rape and short rotation coppice also grown. In 2016, bioenergy crops occupied 132 thousand hectares – just over 2% of the UK's arable land – 53% of which was for biofuel in the UK's road transport market.

The cultivation of purpose-grown crops for bioenergy must be balanced with the demand for food production. The primary purpose of agriculture remains the production of food. In light of this position, the UK Government has recently announced that it plans to introduce a cap of 4% on crop-based biofuels under the Renewable Transport Fuel Obligation (RFTO), decreasing year-on-year to 2% by 2032. As noted in 3.8.9, in 2016, the Government also announced that payments under the Renewable Heat Incentive and the Feed-In Tariff would be limited in instances where anaerobic digestion-installations are producing over 50% of heat or electricity from feedstocks other than wastes or residues.

While it is the UK Government's position that biomass production must not undermine either domestic or international food security, the Clean Growth Strategy sets out the UK government's intention to incentivise woodland creation and afforestation on marginal land, including where bioenergy is one potential end-use.

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, and 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.

3.9.10 Sustainable forestry policy

UK forestry policy is devolved in the UK. All four countries have established policies for woodland creation, currently 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), including Guidelines on Forests and Climate Change, was published in July 2017. 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. 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. In England, the Environmental Impact Assessment (Forestry) Regulations were revised in May 2017, requiring more information be provided by proposers of afforestation projects, while increasing the EIA threshold in areas mapped as low risk if a UKFS woodland creation plan is submitted. The objective of raising the threshold was to encourage the planting of larger woodlands, in part, to contribute to emissions reduction. The design of larger scale productive woodlands is supported through the Woodland Creation Planning Grant (from 2015), while their establishment is financed through the Woodland Carbon Fund (from 2016). 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.

The Clean Growth Strategy (CGS) was published in October 2017 and sets out broad aspirations to enhance the rate of afforestation and use of timber in construction in an illustrative pathway to meet the fifth carbon budget (2028-32) and longer term emissions reduction. The CGS also committed to 'set up a stronger and more attractive domestic carbon offset market that will encourage more businesses to support cost effective emissions reductions, such as through planting trees' and to 'We will unlock private finance to invest in forestry by establishing forestry investment zones to offer investors streamlined decision making and more certainty, within shorter timelines'.

In Scotland, forestry is recognised as having an important role in contributing to emissions reduction targets through carbon sequestration which is a specific objective of woodland creation. The Scottish Government is committed to expand this important carbon sink and the Programme for Government spells out the support to a growing forestry industry to contribute to climate change targets. The draft Climate Change Plan (third report on policies and proposals) sets out how the Scottish Government will meet its greenhouse gas emission reduction targets for the period.

2017-2032 and includes a policy on increasing the long term annual woodland creation target from the current 10,000 hectares of new woodland per year to 15,000 hectares per year from 2024/25. To complement woodland creation, a framework to better control woodland removal is also in place with a proposed policy to further increase emissions abatement through greater use of Scottish timber in building construction and refurbishment.

These targets will be taken forward in a sustainable way and require the creation of a range of different woodland types, on different sites, with different objectives. The Scottish Government is committed to supporting the creation of at least 3,000 hectares of new native woodland a year (Scottish Biodiversity Strategy: Route Map 2020).

To support the delivery of the draft Climate Change Plan, the Forestry Grant Scheme offers financial support for the creation of new woodland and the sustainable management of existing woodland. All applications are assessed against the UK Forestry Standard and associated guidelines.

The Scottish Government has recently introduced the Forestry and Land Management (Scotland) Bill to replace the 1967 Forestry Act in Scotland. The Bill includes duties on Ministers to promote sustainable forest management and to publish a forestry strategy which will set out the Government's priorities in relation to the economic, environmental and social benefits of forestry.

The Forestry (Environmental Impact Assessment) (Scotland) Regulations 2017 came into force in May 2017, driven by EU EIA Directive 2014 that aims to streamline aspects of the EIA process and improve transparency and consistency in EIA practice across a number of regimes. The main changes include an increase of the threshold for afforestation projects outside sensitive areas from 5 to 20 hectares to secure a more effective way in assessing woodland creation applications to contribute to emission reductions. The 2017 Regulations have been reflected in new guidance and training.

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.

To promote sustainable **land use**, "Woodlands for Wales" is the Welsh Government's fifty-year Strategy. The Welsh Government has set a new short term target over the life of the current action plan of 10,000 hectares of new woodland by 2020. This will require an average of 2,000 hectares of tree planting per annum.

3.10 Waste

3.10.1 Waste

In 2015 GHG emissions from waste contributed to 4% of total UK emissions; representing a decrease of 73% since 1990. Approximately 67% of emissions from this sector are attributable to landfill CH_4.

Consistent with the EU Waste Framework Directive, the government and the devolved administrations have published waste management and prevention plans aiming to reduce the quantity of waste produced and to increasingly recover value from it. In addition to these, the UK government has recently published its Clean Growth Strategy, where it set its long-term ambition to move towards zero avoidable waste by 2050 and a commitment to publish a renewed Resources and Waste Strategy in 2018.

In 2015 households in the UK produced 26.7 million tonnes of waste. This has remained relatively flat since 2010. The latest commercial and industrial arisings show a significant decrease in arisings, with 27.7 million tonnes in 2014 compared to 33.9 million tonnes in 2010. That is a decrease of 18%. The industrial sector accounts for 12.6 million tonnes and the commercial sector 15.1 million tonnes.

In 2015, 44.3% of UK household waste was recycled, having slightly fallen from 44.9% in 2014. The 2015 figure still represents the second the highest recycling rate value on record. In 2015/16 in England, local authorities recycled, composted or reused 111 million tonnes of the waste they collected, far outweighing the 5.1 million tonnes that were landfilled.

UK waste policy contributes to emission reductions via several routes: waste prevention efforts such as voluntary industry agreements; reductions in CH_4 emissions from landfill; emission reductions from efficient use of materials, waste prevention, reuse 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 32% of all UK CH_4 emissions (2015) and 2% of all UK GHG emissions (2015).

The EU Landfill Directive stipulates a reduction of biodegradable municipal waste (BMW) landfilled to 35% of the volume of BMW waste generated in 1995 by 2020 (with interim targets in 2010 and 2013 The UK comfortably met interim BMW targets for 2010 and 2013 and the value of BMW tonnages landfilled in 2015 was 22% of the 1995 baseline. The single most important driver for diverting waste from landfill is landfill tax. This is currently set at £86.10/tonne landfilled (non-inert) waste and is scheduled to increase in line with the Retail Price Index from April 2018 rounded to the nearest 5 pence. The landfill tax not only encourages diversion of wastes from landfill, but also encourages waste prevention through an increase in the cost of disposal.

Food waste has been identified as a priority under the Clean Growth Strategy, with the UK government committing to working towards no food waste entering landfill by 2030. 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 2025 Commitment.112

The UK continues to be seen as a leader in the EU on food waste prevention, having reduced food waste across households and the supply chain by 11% between 2007 and 2015. The UK government and devolved governments have worked successfully with industry to reduce foodwaste arising at manufacture by nearly 10% between 2011 and 2014 while household food waste is down by even more – 12% in 2015 since 2007. 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 2015 the UK government and devolved governments in Scotland, Wales and Northern Ireland launched the Courtauld Commitment 2025. 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. Courtauld 2025 is expected to result in a 20% reduction of food waste across households and the supply chain by 2025.

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 40 operational EFW plants with a capacity of nearly 10 million tonnes a year. In 2016 2.7 TWh of waste derived renewable electricity was produced from thermal combustion.

3.10.2 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 , commercial and industrial waste, and in some cases construction and demolition waste.

The Government wishs to align the RO with the RHI and not present additional barriers to participants already complying with the RO requirements. It 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.

3.10.3 Waste in Wales

Wales' recycling rate has increased from just under 5% to 64% – the third best in the world.

The final recycling figures for 2016/17 show the average combined reuse, recycling and composting rate across Wales' 22 Local Authorities was 64%, an increase of 4 percentage points on last year's final figure and 59 percentage points higher than the rate in 1998/99, when the data was first collected following devolution. It is also 6 percentage points higher then the current Statutory Recycling Target of 58%.

Wales leads the way in the UK when it comes to recycling, with these latest figures confirming Wales are exceeding their ambitious 58% target.

The Welsh Government intends to introduce regulations in 2019 under the Environment (Wales) Act – Part 4 that will substantially reduce the landfilling of biodegradable waste from businesses and the public sector, in order to help achieve the Towards Zero Waste goal of 'zero landfill' by 2025. Together with the statutory 70% recycling target for local authorities for 2024/25 and the residual waste treatment programme for local authority collected waste, this will almost eliminate the landfilling of biodegradable waste by 2025, significantly further reducing the emission of methane from landfill.

Wales is in the process of finalising an evaluation of its Waste Strategy, 'Towards Zero Waste'. Views on the update, a Route Map for a Resource Efficient Economy' will be sought during consultation in the summer of 2018.

A proposed reduction target to halve food waste by 2025 (from a 2006-07 baseline) has been proposed for Wales. The proposed target will be consulted upon as part of the update on Wales' Waste Strategy.

The Welsh Government has commissioned a study on options for extended producer responsibility for key types of food and drink packaging. This will include exploring the merits of introducing a deposit return scheme (DRS) in Wales. The project will scope out a trial for a DRS in Wales, which has budget provision in 2018/19.

The Welsh Government is providing support for alternative treatment of Local Authority Municipal Waste via the Waste Infrastructure Procurement Programme which was established to support groups of local authorities working together to develop sustainable long-term solutions for

- food waste treatment; and
- residual (black bag) waste treatment.

There are seven hubs formed of local authority partnerships involved in food waste treatment procurement using anaerobic digestion technologies. Six food waste contracts have been awarded to date, with five facilities built and operating across Wales. One further contract is due to be awarded in early 2018.

Three residual waste contracts have been awarded for long-term energy from waste solutions, diverting non-recyclable waste from landfill over a 25-year period. Eight local authorities in South East Wales are sending their residual waste to the Trident Park energy recovery facility in Cardiff. Five local authorities in North Wales will send their waste to Parc Adfer facility in Deeside which is due to start operating in 2019/20.

The food waste treatment solutions will provide an annual net benefit estimated carbon saving of up to 141,000 tonnes CO_2e in comparison to continued landfill. The overall environmental impact of the energy from waste solutions for residual waste will deliver a significant improvement on the former landfill-based disposal. Most notable is the reduced net carbon emission. It is estimated that annual carbon savings from energy from waste solutions will total up to 645,000 tonnes CO_2e when the Parc Adfer facility is operational.

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. Many local authorities have been assisted by the programme since its inception in late 2011.

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.

3.10.4 Waste in Scotland

3.10.4.1 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 , commercial and industrial waste, and in some cases construction and demolition waste.

The Scottish Government wishes to align the RO with the RHI and not present additional barriers to participants already complying with the RO requirements. The Scottish Government 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.

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.

3.10.4.2 Scottish government ambition for decarbonising waste

The Scottish government's Circular Economy Strategy "Making Things Last" (2016) sets out ambitions and priorities to keep products and materials in high value use for as long as possible.

The strategy has four priorities, where the biggest impact can be made: **food/bioeconomy**, **construction**, **remanufacture** and **energy infrastructure**.

Its targets include:

- 70% recycling/composting and preparing for re-use of all waste by 2025
- 70% recycling and reuse of construction & demolition waste. 2020
- No more than 5% of all waste to go to landfill. (Following ban
- On biodegradable municipal waste to landfill from 2021) 2025 **Reduce food waste by 33% by 2025**: the first such target in Europe, and will consult on whether the target should be statutory.

Measures cover waste prevention, design, reuse and repair, remanufacturing, recycling, producer responsibility, biological resources, energy recovery, landfill, communication, skills and measuring progress:

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.

3.10.5 Waste in Northern Ireland

The Northern Ireland Waste Prevention Programme "The Road to Zero Waste", published in September 2014, was one of a number of key policy interventions signposted in the NI Waste Management Strategy (2013). It encompasses a number of actions to assist in driving waste up the Waste Hierarchy and deliver resource efficiency, including targeting at-source waste production and extending a product's lifetime through re-use, repair or refurbishment.

Another policy intervention contained in the Strategy was the restriction on the landfilling of separately collected food waste. The Food Waste Regulations (Northern Ireland) 2015 came into operation in February 2015 and prohibited the landfill of separately collected food waste from 1 April 2015. From 1 April 2016 large producers of food waste have been required to take measures to ensure the separate collection of their food waste, and from 1 April 2017 district councils have been required to promote the separate collection of food waste and provide receptacles to householders for separate food waste collection.

Support has been provided to district councils for reuse and recycling projects through the Rethink Waste Capital Fund since 2010. For the most recent support to councils £2.3m was made available through the Rethink Waste Capital Waste Fund 2016-17 and in particular supported the new requirement for the separate collection of food waste by helping with the purchase of new refuse vehicles, additional recycling bins, food waste caddies and liners and promotional materials. Additional funding is also planned in 2017-18 to increase the rate of capture of non-food recyclates. The most recent official statistics show that in the year April 2015 to March 2016, 42.2% of household waste was recycled or composted, or prepared for reuse, against the Waste Framework Directive target of 50% by 2020.

The Department has initiated a review of the NI Waste Management Strategy and district council waste management plans, which will take account of the proposals for more challenging targets for the landfill and recycling of municipal waste proposed in the EU circular economy package.

3.11 Public Sector

Since 1990, the public sector – including central and local government, health, education and emergency services – has reduced its emissions by 40% as a result of energy efficiency and rationalisation of the central government estate.

Central government and its agencies have led by example through the Greening Government Commitments (GGC), which include a greenhouse gas reduction target. As of 2015/16, the UK

has succeeded in meeting the target by delivering a 27% emissions reduction and £127 million of savings against 2009/10 levels. The original target was a 25% reduction compared to the 2009/10 baseline so new targets were set in January 2017, with the aim of achieving a 32% reduction by 2019/20.

3.11.1 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.

The UK government continues to promote a number of tools to support sustainable procurement. These include a suite of Government Buying Standards for a range of products and services commonly purchased by the public sector which are mandatory for central government; the Flexible Framework and Prioritisation Tool, as well as product/sector specific guidance and training modules. Government also seeks to ensure its framework contracts embed sustainability considerations into their tenders and that departments do the same. Additionally, there is the 2012 Public Service (Social Value) Act which also requires all public bodies to consider, before entering into any service procurement over OJEU levels, the potential they have to leverage social, economic and environmental value in the design of the services and the procurement process.

The Government has also provided support to the RE:FIT programme which provides a national procurement framework for local authorities on energy efficiency. Local authorities and social housing providers are also developing and managing low carbon procurement frameworks to simplify delivery.

The Greening Government Commitments require departments to report annually on the processes they have in place to ensure sustainability is taken into account in all procurement activity, including embedding the Government Buying Standards and monitoring and reporting on the sustainability of their supply chain.

3.11.2 Central government (including the government estate)

The Greening Government Commitments deliver the estates and operations element of government's Vision for Sustainable Development. Updated in 2016, these targets require 22 central government departments to reduce GHG emissions, water consumption and waste by 2020, and to procure more sustainably and report transparently on their actions in relation to climate change adaptation; biodiversity; sustainable construction and sustainable food and catering. By 2020, compared to a 2009-10 baseline the government has committed to:

- Reduce GHG emissions by 32% from its estate and business-related transport
- Cut domestic business travel flights by 30% by 2020
- Reduce the amount of waste that government sends to landfill to 10% or less; increase recycling and reduce overall waste
- Reduce the amount of paper it consumes by 50%
- Reduce water consumption.

Work is currently under way to make sure the government-wide GHG reduction target is sufficiently stretching, with a view to raising the level of ambition of the 2020 target.

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, or take alternative measures to achieve an equivalent amount of energy savings. This requirement started in January 2014 and runs until 2020. The UK government is is using the Greening Government Commitments target to reduce GHG emissions from its estate as the mechanism by which it will comply with Article 5.

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The Greening Government Commitments require departments to report annually on the processes they have in place to ensure sustainability is taken into account in all procurement activity, including embedding the Government Buying Standards and monitoring and reporting on the sustainability of their supply chain.

3.11.4 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 are uniquely placed to bring together local partnerships of public and private sectors and to deliver integrated low carbon plans.

BEIS

The Government is committed to supporting local leadership and has already given additional powers and responsibilities through the Cities and Local Government Devolution Act 2016; many of the Local Devolution deals agreed to date include energy commitments. The Government will work with local areas to support delivery, develop partnerships, and enable access to low carbon procurement frameworks.

BEIS is currently consulting on a voluntary target for carbon emissions in the public and higher education sectors through a Call for Evidence associated with the Clean Growth Strategy. The intention is to produce a clear carbon emissions reporting framework for use by participating organisations by April 2018.

BEIS have funded Greater Manchester to develop a reporting mechanism on behalf of the Core Cities network, which will reflect Covenant of Mayors reporting requirements. This is in development and hopefully will be available to pilot cities in 2018.

Some 35 UK places have signed the international commitments on carbon reduction and almost 80 have signed a national pledge for 100% clean energy by 2050 under the UK100 partnership. All of the Local Enterprise Partnerships now have funding to develop an energy strategy. Government has also launched a new Local Energy Programme to support local areas in England to play a greater role in decarbonisation. This programme is will support regional hubs to increase local capacity and capability; provide a range of toolkits and guidance; provide some support and expertise to unlock local energy opportunities. The programme will start to support delivery of the Industrial Strategy and Smart Systems Plan, working with local areas to demonstrate that deep decarbonisation can be achieved through local system change in a way that keeps costs down and maximises economic benefit.

Local Authorities are now also looking at new financial models. Two UK cities have created arm's length energy supply companies and many have arm's length housing companies. This commercialisation of services allows the LAs to play a more direct role in designing and delivering low carbon projects which are integrated into local communities.

3.11.5 Planning

The statutory land use planning system is complemented by a framework of national planning policies issued by the government and the devolved administrations.

3.11.5.1 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.

3.11.5.2 Planning in Scotland

Scotland's third National Planning Framework and associated Scottish Planning Policy were published in June 2014 and represent the up to date suite of national planning policies for Scotland. Sustainable development remains at the heart of our policy approach which has a vision for Scotland as a successful, sustainable place, a low carbon place, a natural resilient place and a connected place.

This approach supports the continued decarbonisation of the energy system, principally through the development of renewable energy technologies (for heat and electricity) but also through other approaches such as carbon capture and storage. The approach to transport continues the long standing emphasis on non-motorised modes of travel allied with the creation of high quality, compact, walkable settlements.

The Scottish Government continues to:

- Include policy on managing and reducing flood risk, looking in the policy to landscape scale water management approaches.
- Implement Strategic Environmental Assessment and Environmental Impact Assessment as required by legislation for a range of plans and developments.

This ensures consideration of climatic factors at an appropriate level in decision making. The Spatial Planning Assessment for Climate Emissions (SPACE) tool remains available.

The Scottish Government has announced its intention to review National Planning Framework and Scottish Planning Policy from 2018. Scotland's Climate Change Plan will be used to shape the planning policy approach emerging from the review.

3.11.5.3 Planning in Wales

Planning Policy Wales (PPW), Wales' national land use planning policy document has always been written in the context of seeking to achieve sustainable development, including contributing to decarbonisation. PPW is kept under review and updated where evidence points to a need for amendments. PPW is currently being completely redrafted to align it with the goals and ways of working enshrined in the Well-being of Future Generations (Wales) Act 2015 and to embrace the concept of Placemaking as part of our overall vision to create Sustainable Places.

The Welsh Government is also in the process of developing the **National Development Framework**, a national land use plan which will address the continued need for decarbonisation.

3.11.5.4 Funding schemes for public sector organisations

The Welsh Government provides substantial decarbonisation and green growth support for the Welsh public sector, through the Green Growth Wales initiative, which supports the development of a significant pipeline of energy efficiency and renewable energy projects in the public sector.

Our support is provided through:

1. Technical, commercial, financial and procurement support that develops high quality projects, identifies commercial routes for delivery and removes barriers;
2. Re:fit Cymru – which enables the public sector to take an estate wide approach to energy efficiency and renewable energy. Crucially the energy savings are guaranteed, transferring the risk to the private sector. Paybacks are typically in the order of 6–8 years, though the assets installed typically have lives of over 20 years;
3. Finance – in the form of 0% interest loans or repayable grants that are repaid from the energy savings achieved. This finance is delivered in-house through Invest to Save Green Growth, and via Salix Finance, specialists in public sector energy efficiency loan funding.

The Green Growth Wales recycles funding repaid into future projects. The Welsh government expect to have approximately £70m invested in public sector energy projects by the end of the current government term, delivering £650m in cash savings to the public sector, avoiding 2.5 million tonnes of CO_2, and providing a substantial economic opportunity for the low carbon supply chain in Wales.

3.11.5.5 Welsh Government sustainable development – Well-being of the Future Generations Act 2015

Wales has had a longstanding commitment to taking action around sustainable development. The unique Well-being of the Future Generations (Wales) Act 2015 has allowed us to legislate on this important agenda and bring focus and coherence to our activity.

The Well-being of Future Generations (Wales) Act is about improving the social, economic, environmental and cultural well-being of Wales. It will make the public bodies listed in the Act think more about the long-term, work better with people and communities and each other, look to prevent problems and take a more joined-up approach.

To ensure visions are aligned, the Act puts in place seven well-being goals. The seven well-being goals show the kind of Wales the Welsh Government wants to see. Together they provide a shared vision for the public bodies listed in the Act to work towards. The Act makes it clear the listed public bodies must work to achieve all of the goals, not just one or two.

The Act puts in place a 'sustainable development principle' of 'Ways of Working' which tells organisations how to go about meeting their duty under the Act. Public bodies need to make sure when making their decisions they take into account the impact they could have on people living their lives in Wales in the future.

The 'Ways of Working' or 'Sustainable Development Principle' within the Well-being of the Future Generations Act ensures that Public Bodies are making decisions which:

- Think about the long-term;
- Take an integrated approach;
- Collaborate together with others;
- Involve people and communities affected by their decisions;
- Focus on taking preventative measures.

- The Well-being of the Futures Generations Act in at the heart of all work across the Welsh Government, including decarbonisation and is embedded throughout our carbon reduction work. The Well-being of the Future Generations Commissioner of Wales has identified climate change is one of her key priorities and the Welsh Government are working closely with her office to work together in this important area.
- CO_2 emissions from the Welsh Government's Administrative Estate have fallen 51% since 2010/11, including a 10% reduction in 2016/17. This substantially exceeds the 2020 target7.

3.11.5.6 Create Your Space

The Create Your Space programme is an £8.8m programme funded by the Big Lottery Fund (£6.6m) and Dormant Account funding £2.2m). Dormant Accounts contain money which has lain dormant in bank and building society accounts for at least 15 years and whose owners cannot be traced. Its use in Wales is subject to Directions issued by Welsh Ministers which state that 20% of the available funding must be used on projects relating to community-led action on climate change and sustainability.

The aim of Create Your Space is to make a real difference to people and communities:

- People are fully involved in shaping the transformation of their local outdoor spaces and genuinely strong partnerships formed between local people and organisations.
- By enabling people to transform the way they view and use outdoor spaces, they will:
  - Have the confidence and ability to influence and get involved in decisions about their communities with more control over their local environment.

  - Have a greater understanding and appreciation of the value of outdoor spaces, in particular their contribution to health and well-being, and the potential for creating sustainable business, jobs and leisure opportunities.

- As a result of the programme and what communities learn, organisations and communities will have the confidence and desire to take further action to get involved in activities to improve their local communities.

The six supported projects are:

- 'Welcome to our Woods' – led by Interlink, Upper Rhondda, RCT – £1,016,880
- 'The Vision for our Valley' – led by Ynysybwl Regeneration Partnership, RCT – £1,273,099
- 'Woodland Routes to Wellbeing' – led by Duffryn Community Partnership, Newport – £1,453,861
- 'Cwlwm Seiriol Bond' – led by Menter Môn, Anglesey – £1,098,000
- 'Roots to Shoots, Recasting Our Industrial Spaces' – led by Brymbo Heritage Trust, Wrexham – £1,996,479
- "Our Back Yard" led by Groundwork North Wales, Connah's Quay, Flintshire £649,941

The programme has a duration of seven years for delivery. The successful projects will bring about the large scale and long-term transformation of six community landscapes in Wales. Between them, the projects will connect people with their local environment through a wide range of activities including biodiversity enhancement through tree and flower planting, learning new skills, green health initiatives, community food growing on allotments and waste ground, renewable energy measures, the creation of cycling, walking and pony paths, clearance of former industrial areas and facilitating access to local green spaces.

3.11.5.7 Renew Wales

The aim of the Renew Wales programme is to support communities across Wales to design and deliver their own adaptation and mitigation projects to tackle climate change and promote sustainability. Dormant account funding administered by the Big Lottery Fund enables the programme to provide a range of free advice, training, mentoring and peer and technical support to community groups. Experts in the field (Co-ordinators) provide skills, knowledge and experience. Role models from projects which have already delivered successful projects act as Mentors. As each project is community-based, local people are empowered to make lasting changes through their own efforts.

The Renew Wales programme has been highly successful and has been extended to 31 March 2020. It has engaged with and provided advice to over 600 community organisations on climate change and sustainability projects. Around half of these bodies had not previously taken any action in these areas – this focus on dealing with bodies new to taking climate change action will continue.

Not all the contacts with the community bodies resulted in a fully worked-up project intervention. However, over 100 projects have been completed and many more are ongoing. They cover a wide range of activities including renewable energy schemes (hydro, wind and solar), energy efficiency retro-fitting of local halls and social hubs, energy saving advice, community woodlands and food growing, electric car clubs and flood prevention.

These projects have delivered energy savings and ongoing income to many hard-pressed voluntary and community groups and levered in over £3.5m of additional capital through community share offers. They have enhanced local woodland habitats and food growing projects have cut carbon emissions by reducing "food miles". Social cohesion has been improved by involving hundreds of local volunteers.

3.11.6 Funding schemes for public sector organisations

In 2004 the public sector energy efficiency loan scheme, manged by Salix Finance Ltd. was established to accelerate public sector investment in energy efficiency technologies through interest-free loans. It established a zero-interest, recycling loan fund 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 5 years (8 years for schools). To date, the loan scheme has funded over 16,000 projects, improving public sector and higher education buildings for its users and is projected to save the sector around £55 million on energy bills this year (2017).

The scheme delivers good value for money and catalysing markets in energy efficiency by implementing measures at scale.

3.11.7 Schools

3.11.7.1 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.

3.11.7.2 Schools in Northern Ireland

Northern Ireland has 100% of schools registered on the Eco-Schools Programme.

The Eco-Schools Green Flag, awarded to schools with high achievement in their programme, is a recognised and respected eco-label for environmental education and performance. In Northern Ireland, the Eco-Schools Programme is operated by Keep Northern Ireland Beautiful, an environmental charity, and is supported by the Department of Agriculture, Environment & Rural Affairs and other organisations.

Northern Ireland is ranked ninth out of the sixty-four participating countries for number of Green Flag Status Schools and was also the first country in the world to award a Green Flag to one of its schools.

3.11.8 Higher education (HE)

3.11.8.1 Students' Green Fund

The Students' Green Fund provided £5 million for student led sustainability projects between 2013 and 2015. In addition to engaging over 121,700 HE students and 7,600 staff, a saving of 4608.6 tCO_2e was achieved across the 25 projects.

3.11.8.2 Revolving green fund (RGF)

A fourth round of the HE revolving green fund was introduced in 2014, providing recoverable grants to universities for projects investing in energy-efficiency and low-carbon technologies. Projects at 41 universities are estimated to deliver an annual carbon saving of 14,111 tCO_2e.

HE institutions can also access the Salix interest-free loan scheme (as mentioned above).

3.11.8.3 Guidance on sustainable development and the HE curriculum

In 2014 the Quality Assurance Agency (QAA), in conjunction with the Higher Education Academy, guidance was published for HE providers on the inclusion of education for sustainable development as part of the student academic experience.

Further information, including the targets of the project, can be found in Chapter 8.

3.11.9 The NHS in England

The National Health Service (NHS) in England, Europe's largest employer, is responsible for around a third[118] of public sector carbon emissions and is a leader in local communities across the country. Work in carbon reduction and sustainable development across the sector is supported and coordinated by the Public Health England and NHS England co-funded Sustainable Development Unit (SDU). In 2014 the SDU launched a Sustainable Development Strategy[119] running to 2020 – aimed at the creation of social value, improvement of health and working towards reducing the carbon footprint of the NHS by 80% by 2050.

Emissions from energy and travel alone have an annual carbon footprint of 7.4 million tonnes[120] demonstrating the important role of the NHS and the health supply chain in reducing the UK's emissions. By 2015 from a 2007/08 baseline, the data suggests the NHS has achieved already an 11% reduction in emissions[121] achieving the 2015/16 interim Climate Change Act target. Despite the challenges in the sector, over the last ten years the health system has reduced its annual carbon emissions by 3.6 million tonnes and saved almost £2 billion in energy costs alone[122].

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[118] Sustainable Development Unit (2016) Carbon Footprint update for NHS in England http://www.sduhealth.org.uk/policy-strategy/reporting/nhs-carbon-footprint.aspx

[119] Sustainable Development Unit (2014) Sustainable Development Strategy http://www.sduhealth.org.uk/policy-strategy/engagement-resources.aspx

[120] Sustainable Development Unit (2016) Carbon Footprint update for NHS in England http://www.sduhealth.org.uk/policy-strategy/reporting/nhs-carbon-footprint.aspx

[121] Sustainable Development Unit (2016) Carbon Footprint update for NHS in England http://www.sduhealth.org.uk/policy-strategy/reporting/nhs-carbon-footprint.aspx

[122] Sustainable Development Unit (2016) Securing Healthy Returns http://www.sduhealth.org.uk/policy-strategy/engagement-resources/fnancial-value-of-sustainabledevelopment.aspx

Health organisations have in place mandatory Sustainable Development Management Plans which include recommendations on the health co-benefits of sustainable development, promoting health and reducing health impacts through reducing carbon emissions and reducing air pollution arising from NHS travel[123]. Health organisations are encouraged to build their Management Plans using the NHS Sustainable Development Assessment Tool[124], ensuring that they are aligned with the UN SD goals as well as contributing to carbon reduction, resource efficiency, health and social value.

NHS organisations are required to report annually on sustainability activity with 85% of providers and Clinical Commissioning Groups meeting minimum standards. Health organisations are also strongly encouraged to adopt and report on progress against a carbon reduction target of 34% in line with the Climate Change Act with an NHS baseline of 2007/08[125]. Thirty-nine%[126] of trusts already report they are on track to meet the 34% target by 2020/21.

The NHS national 5 year strategy the '5YFV Next Steps'[127] encourages commissioners and those designing local health and care systems to 'take account of wider social, economic and environmental benefits of the sort referenced in the Social Value Act' 'As they think about how to develop their local health and care systems'.

The SDU is working with the National Institute of Clinical Excellence on embedding carbon emissions and resource use alongside costs in new clinical guidance.[128]

The NHS along with higher Education have been highlighted for focus in terms of the importance of their contribution to achieving UK carbon targets, through their direct and supply chain impacts, in the DBEIS Clean Growth Strategy.[129]

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.

3.11.10 The NHS in Wales

The NHS continues to act as an exemplar for the rest of the public sector in Wales in terms of reducing greenhouse gas emissions. NHS Wales generates approximately 20% of its electricity demand through on-site combined heat and power which is lower carbon as it is co-generating heat and electricity. A number of biomass woodchip installations have also been set up across NHS hospital sites.

Health Boards and NHS Trusts have progressed a number of schemes that have helped to improve energy efficiency and reduce greenhouse gas emissions. Hywel Dda University Health Board entered into an energy performance contract with British Gas in 2012/13. The Welsh Government funded four of the key projects at a capital cost of £9.3m as phase 1 of the project. Year 2 of the contract delivered savings of £634,701 and of 4,567 tonnes of carbon.

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[123] Sustainable Development Unit (2017) Health Outcomes Travel Tool http://www.sduhealth.org.uk/delivery/measure/health-outcomes-travel-tool.aspx

[124] https://www.sduhealth.org.uk/sdat/

[125] Sustainable Development Unit (2014) Sustainable Development Strategy http://www.sduhealth.org.uk/policy-strategy/engagement-resources.aspx

[126] 5 Hospital Estates and Facilities Statistics 5 Hospital Estates and Facilities Statistics http://hefs.hscic.gov.uk/ReportFilterConfirm.asp?FilterOpen=&Year=2015%2F2016+01&Level=T&Section=S&SHA=&Org_

[127] https://www.england.nhs.uk/publication/next-steps-on-the-nhs-five-year-forward-view/

[128] https://www.nice.org.uk/About/What-we-do/Into-practice/resource-impact-assessment

[129] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/651916/BEIS_The_Clean_Growth_online_12.10.17.pdf

Electricity generated by solar power is a growing area across the NHS estate. Aneurin Bevan University Health Board have recently completed installation of four 50kW solar arrays on four sites in Gwent. At Llandough Hospital in Cardiff there is a 70kW installation on the new Mental Health Unit currently the largest installation of its type in NHS Wales. Two of the health boards are also currently investigating the feasibility of larger scale solar farm developments.

All health boards and NHS Trusts have the internationally recognised environment management standard ISO 14001 accreditation across all their sites. A number of the health boards with the largest emissions were included in Phase 2 of the Carbon Reduction Energy Efficiency Scheme but this scheme is due to come to an end in 2018-19. Cardiff and Vale University Health Board report under the EU-ETS scheme in respect of the level of emissions at the University Hospital of Wales.

3.12 Leaving the European Union

Leaving the EU will not change any of the UK's statutory commitments to reducing greenhouse gas emissions under the 2008 Climate Change Act. Detailed future policies will emerge as negotiations between the EU and the UK proceed, but whilst the UK is a member of the EU, existing rules and regulations still apply, and will continue to engage constructively on new and existing legislation.

As highlighted in the government's Clean Growth Strategy, the UK remains committed to the Paris Agreement.

3.13 Policies to promote sustainable development in developing countries and emerging economies

3.13.1 International Sustainable Development from Wales

Wales has a history of leadership at the international level. Its is the World's First Fair Trade Nation and one of the first nations in the World to have duty on sustainable development at the heart of our constitution.

In 2011 Wales committed to introducing legislation to make sustainable development the central organising principle of the Welsh Government and the devolved public sector in Wales and establishing an independent sustainable development body for Wales.

The Well-being of Future Generations (Wales) Act was introduced in 2015 and will ensure that doing things in a sustainable way becomes the core principle that guides how public bodies in Wales make decisions that affect our society, our economy and our environment and culture. For the first time, public bodies listed in the Act (such as local councils, health boards and the National Library) will be under a legal duty to work towards achieving a set of shared goals which define the Wales people want to see in the future.

The main parts of the Act clarify what organisations are aiming to achieve and explain how they should work differently to achieve this; this is what is meant by sustainable development as a central organising principle.

The Well-being of Future Generations Act put in place 7 well-being goals, including a goal where a Wales is globally responsible.

The United Nation's Sustainable Development Goals fed into the development of the well-being goals, which are a statement of what well-being looks like for Wales. The Act puts in place a framework for taking action and measuring progress. The Act required Welsh Ministers to set national indicators to assess progress towards achieving the well-being goals. Wales is the

first country in the UK to map our national indicators of progress against the UN goals, putting our own well-being ambitions in a global context. As well as ensuring the driving of sustainable development through legislative framework, the Government is also:

- Take part at the international stage showing leadership, driving action and highlighting the important role of States and Regions in tackling the global challenges of sustainable development and climate change.
- Work with international partners through Programmes such as our Wales for Africa.

Wales over the years has attended the United Nations Conference of Parties on sustainable development, climate change and biological diversity.

The Welsh Government currently holds the Vice Presidency of the international Network of Regional Governments for Sustainable Development (nrg4SD) and is on the Steering Group for The Climate Groups States and Regions network. The Welsh Government has also been and a founding signatories of key agreements like the Climate Group's Compact of States and Regions and Future Fund.

3.13.2 10 Million Trees

In partnership with Welsh charity the Size of Wales, the Welsh Government's 10 Million Tree project aims to alleviate the harmful effects of climate change in a highly deforested region of Eastern Uganda through planting trees. Heavier than usual rain fall accompanied by severe flooding has already caused a number of deadly landslides on Mt Elgon, the worst of which killed over 300 people including 100 school children sheltering from the storm. Crops regularly fail due to increasingly unpredictable and changing weather conditions. The project has planted 6 million trees to date, including a fruit tree for every child born or adopted in Wales since 2014 through Welsh Government's Plant! scheme. The project was recognised by the UN as one of the first 'Momentum for Change Lighthouse Projects' at COP17 in Durban. and to date more than 500,000 people have benefited from the project.

3.14 3.14 Monitoring and evaluation

3.14.1 United Kingdom

The United Kingdom has a rigorous monitoring and reporting framework to track progress against its domestic and international targets. Each year the UK Government published its Greenhouse Gas Inventory, and Energy and Emissions Projections.

The Climate Change Act (2008) requires the UK Government to set five yearly carbon budgets, and then produce a plan to meet these budgets. The most recent was the Clean Growth Strategy, published in October 2017. The Committee on Climate Change (CCC), the UK's independent advisory body, provide an assessment of this plan.

The CCC also produces an annual progress report, with the UK Government laying a response before Parliament. From 2018, the UK Government will use its response to the CCC's annual progress report to bring together reporting against the Clean Growth on the emission intensity ratio, metrics and actions. The UK publish our performance against the Emissions Intensity Ratio on an annual basis. UK Government will also update key elements of the Strategy in line with our annual statutory responses to the CCC's reports on progress, ahead of setting the sixth carbon budget by 30 June 2021.

3.14.2 Wales

The 2010 Climate Change Strategy had a monitoring and reporting framework in place to provide a robust mechanism for effectively tracking progress. Each year progress on the 3%

and 40% target is reported through various mechanisms such as Annual Reports or updates through the Welsh Government website. Alongside the tracking of the overall targets, a set of emission reduction performance indicators have been developed to provide a measure of progress against the Climate Change Strategy Delivery Plan for Emission Reduction.

The Environment (Wales) Act 2016, sets out a new regulatory framework It also puts in place a robust reporting and monitoring framework for tracking progress against our interim targets and carbon budgets. Progress will be provided after each budgetary period and interim target. Alongside this progress reports will also be provided from the UK Committee on Climate Change.

3.14.3 Scotland

3.14.3.1 Public Sector Reporting in Scotland

The Climate Change (Scotland) Act 2009 places duties on public bodies relating to climate change. Further to the Act, the Scottish Government introduced the Climate Change (Duties of Public Bodies: Reporting Requirements) (Scotland) Order 2015 requiring all named public sector organisations to submit reports on their compliance with their climate change duties under the Climate Change Act. Currently, 180 public sector organisations report annually under this legislation.

The Scottish Government supports and encourages climate action from all public bodies in Scotland and recognises the key leadership role they have to play in tackling climate change and adapting to the impacts of climate change. A wide range of support is available to the Scottish public sector, and the Sustainable Scotland Network act as a central gateway, providing support, resources and facilitating collaborative working.

3.14.3.2 Progress report – Scottish Climate Change Act

Progress in reducing emissions is reported by the Scottish Government and its independent adviser, the Committee on Climate Change. A statutory annual target report is published by the Scottish Government setting out whether each annual emissions reduction target has been met. In 2015, emissions in Scotland have fallen by 41% from the 1990/1995 baseline period, well on track to meeting the interim 2020 target of a 42% emissions reduction.

The Committee on Climate Change publish an annual report on progress towards meeting Scottish climate change targets. The Committee published its sixth report in September 2017 and advised that Scotland has made good progress in reducing its emissions and is performing well compared to other parts of the UK.

Chapter 4: Projections of GHG Emissions, scenarios with measures

4.1 Key developments

In 2015, emissions of the basket of seven greenhouse gases (GHGs) covered by the Kyoto Protocol[130] are estimated to be 499 million tonnes of carbon dioxide equivalent (MtCO2e), 37.8% lower than the 1990 level of 803 MtCO2e. Emissions from this basket of GHGs are projected to fall to 414 MtCO2e (48% below the 1990 level) by 2020 and 382 MtCO2e by 2030 (52% below the 1990 level).

- Emissions of carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) are projected to be 44%, 65% and 57% 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 6th National Communication, the UK has implemented further policies to help meet its EU effort sharing, renewable energy and energy efficiency targets, and the Carbon Budgets[131] set under the 2008 Climate Change Act[132].

Unlike the National Communication report, the Energy and Emissions Projections (EEP)[133] also includes planned policies (this scenario is known as 'with additional measures' or WAM). According to the 2017 edition of the EEP (Due to be published January 2018), the UK met the first carbon budget with headroom of 36 $MtCO_2e$, and is projected to meet the second and third carbon budgets with headroom of 125 and 143 $MtCO_2e$, respectively. There are projected shortfalls against the fourth and fifth carbon budgets of 94 $MtCO_2e$ and 196 $MtCO_2e$, respectively. As policies and proposals in the Clean Growth Strategy[134] are developed more fully, their impacts will be included as appropriate in future projections.

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[130] The basket of greenhouse gases covered by the Kyoto Protocol consists of seven gases: carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, sulphur hexafluoride and nitrogen trifluoride

[131] http://www.legislation.gov.uk/uksi/2009/1259/article/1/made

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

[133] Figures available in Energy and Emission Projection report due to be published in January 2018

[134] BEIS Clean Growth Strategy, published in October 2017, available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/651916/BEIS_The_Clean_Growth_online_12.10.17.pdf

4.2 Overall projections of GHG emissions

This chapter presents the UK's GHG emissions projections, in a scenario 'with existing measures' (or 'WEM'), along with assumptions and methodology. The UK projections are due to be published in January 2018 and provide the basis for this National Communication. 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, 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 1 sets out the UK's historic emissions to 2015 and *with existing measures* projections from 2020 to 2035, by GHG. The historic emissions set out in this chapter are based on the UK GHG inventory 1990 – 2015 published and submitted to the UNFCCC in 2017. The current emissions projections up to 2035 are consistent with this inventory. The UK's GHG inventory and National System are discussed in Chapter 1.

The tables of emissions in this chapter are reported on the basis of UNFCCC coverage. 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 0.7% of the total emissions in 2015 based on the latest (1990 – 2015) inventory. Therefore, whilst the projected emissions are based upon the national projections published in December 2017[135] the UK has added new projections for those overseas territories not covered in its published national projections to make due allowance for this difference.

The projections include the impact of implemented and adopted measures, but exclude any use of flexible mechanisms such as EU Emissions Trading System (EU ETS) emissions trading or Joint Implementation (JI)/ Clean Development Mechanism (CDM) credits. They show that UK GHG emissions including LULUCF are projected to be 48% below 1990 levels in 2020 and 52% below in 2030. For estimates excluding Land Use, Land Use Change and Forestry (LULUCF), the percentages are very similar. LULUCF emissions are reported in full, consistent with the Inventory Convention reporting and are not restricted to just those allowed under Articles 3.3 and 3.4 of the Kyoto Protocol.

[135] Figures available in Energy and Emission Projection report due to be published in January 2018

Table 1: UK Greenhouse gas emissions by gas (UNFCCC coverage)

$MtCO_2e$	Inventory						Projections			
GHG excluding LULUCF	**1990**	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**
CO_2	595.3	559.8	560.6	563.6	507.5	415.7	346.5	318.1	322.9	326.4
CH_4	135.3	128.8	111.0	89.3	68.2	52.6	46.8	43.7	41.2	40.3
N_2O	48.9	39.5	29.2	25.4	22.5	21.7	20.5	20.1	20.0	20.0
HFCs	14.4	19.1	9.9	13.2	16.5	16.0	11.1	7.3	4.3	2.7
PFCs	1.7	0.6	0.6	0.4	0.3	0.3	0.3	0.3	0.3	0.3
SF_6	1.3	1.3	1.8	1.1	0.7	0.5	0.4	0.4	0.4	0.5
NF_3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	**796.8**	**749.1**	**713.1**	**692.9**	**615.7**	**506.8**	**425.5**	**389.9**	**389.1**	**390.1**
Change from 1990 (%)	**0%**	**-6%**	**-11%**	**-13%**	**-23%**	**-36%**	**-47%**	**-51%**	**-51%**	**-51%**
GHG including LULUCF										
CO_2	598.5	560.4	558.8	558.4	499.9	406.8	333.8	307.4	314.2	319.3
CH_4	135.3	128.8	111.1	89.4	68.3	52.6	46.8	43.7	41.2	40.3
N_2O	51.3	41.9	31.4	27.3	24.2	23.2	22.1	21.9	21.9	22.0
HFCs	14.4	19.1	9.9	13.2	16.5	16.0	11.1	7.3	4.3	2.7
PFCs	1.7	0.6	0.6	0.4	0.3	0.3	0.3	0.3	0.3	0.3
SF_6	1.3	1.3	1.8	1.1	0.7	0.5	0.4	0.4	0.4	0.5
NF_3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	**802.5**	**752.1**	**713.6**	**689.7**	**609.9**	**499.4**	**414.4**	**381.0**	**382.4**	**385.0**
Change from 1990 (%)	**0%**	**-6%**	**-11%**	**-14%**	**-24%**	**-38%**	**-48%**	**-53%**	**-52%**	**-52%**
Net LULUCF emissions										
CO_2	3.2	0.6	-1.8	-5.2	-7.5	-8.9	-12.7	-10.7	-8.6	-7.1
CH_4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
N_2O	2.5	2.4	2.3	1.9	1.7	1.5	1.6	1.8	1.9	2.0
Total	**5.7**	**3.0**	**0.5**	**-3.2**	**-5.8**	**-7.4**	**-11.1**	**-8.9**	**-6.7**	**-5.1**

Source: Final Emissions Statistics 2017, Energy and Emissions Projections, 2017

4.3 Sectoral emissions by source

Table 2 shows how historical and projected GHG emissions are distributed across sectors of the UK economy.

Table 2: GHG emissions by source (UNFCCC coverage), $MtCO_2e$

	Inventory						Projections			
Sector	**1990**	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**
Agriculture	59.3	58.7	55.2	51.5	48.9	49.4	46.9	45.0	44.6	44.4
Business	114.6	112.5	116.5	110.1	95.1	84.9	76.2	66.7	60.0	57.5
Energy Supply	279.1	239.2	222.2	232.3	208.1	145.5	87.6	69.3	75.6	77.7
Industrial processes	60.0	50.9	27.1	20.6	12.7	12.7	10.0	9.4	9.0	8.8
Land use, land use change and forestry	5.7	3.0	0.5	-3.2	-5.8	-7.4	-11.1	-8.9	-6.7	-5.1
Public	13.5	13.3	12.1	11.2	9.7	8.1	7.0	6.9	7.5	7.9
Residential	80.4	82.0	89.1	86.1	87.9	66.7	66.8	67.7	71.7	75.4
Transport	123.0	123.3	127.8	131.7	121.3	121.0	117.1	112.8	109.4	107.7
Waste Management	66.9	69.3	63.0	49.4	31.9	18.4	13.9	12.2	11.2	10.7
Total net GHG emissions	**802.5**	**752.1**	**713.6**	**689.7**	**609.9**	**499.4**	**414.4**	**381.0**	**382.4**	**385.0**

Source: Final Emissions Statistics 2017, Energy and Emissions Projections, 2017

4.3.1 Energy supply

The 'with existing measures' projections of emissions from the energy supply sector show that emissions are projected to be 69% lower than 1990 levels by 2020 and 73% below by 2030.

Table 3: Energy supply sector emissions by GHG, UNFCCC coverage ($MtCO_2e$)

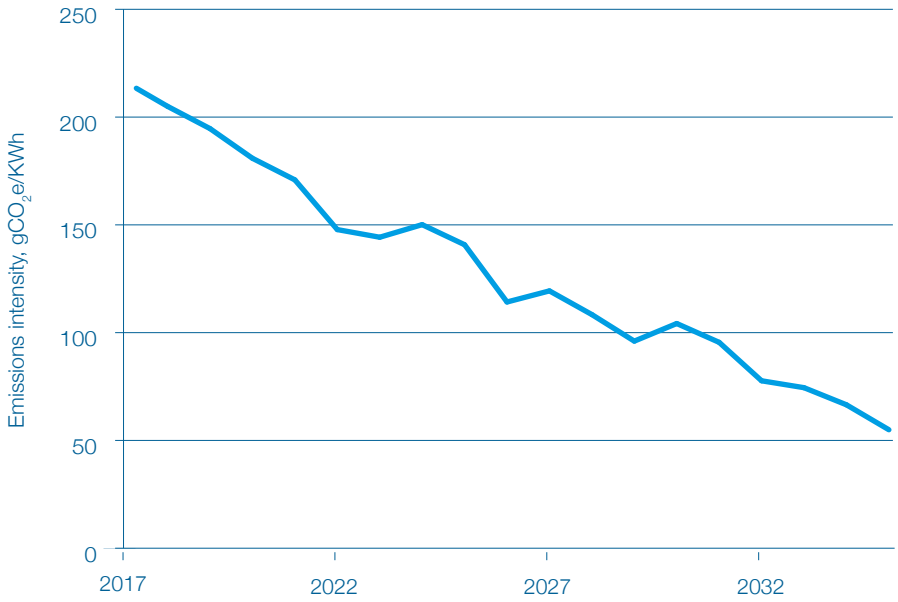
	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035
CO_2	243.3	211.4	204.6	219.9	198.0	137.8	79.9	62.1	70.1	72.5
CH_4	34.4	26.5	16.4	11.1	9.1	6.7	6.8	6.3	4.7	4.5
N_2O	1.4	1.3	1.1	1.2	1.0	1.0	0.9	0.9	0.8	0.7
HFCs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PFCs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SF_6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NF_3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	**279.1**	**239.2**	**222.2**	**232.3**	**208.1**	**145.5**	**87.6**	**69.3**	**75.6**	**77.7**
Change from 1990 (%)		-14%	-20%	-17%	-25%	-48%	-69%	-75%	-73%	-72%

Source: Final Emissions Statistics 2017, Energy and Emissions Projections, 2017.

Following a sharp fall in coal fired generation in 2016, a further gradual decline in fossil fuel based generation out to 2035 is projected. This is displaced by more renewables and eventually nuclear based generation with increased imports (via interconnectors) until new nuclear capacity reduces the need for this in the 2030s.

As a consequence, emissions from electricity production are projected to fall steadily over the full period to 2035.

Figure 38: Emissions intensity of electricity supply (UK coverage, with additional measures), gCO_2e/KWh



Source: 2017 Energy and Emissions Projections

4.3.2 Residential

The principal long-term driver of emissions in UK households is household numbers. These are projected to increase over the whole period both due to population growth in the UK as a whole and due to the disproportionate increase in smaller households.

Table 4:Residential sector emissions by GHG, UNFCCC coverage($MtCO_2e$)

	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035
CO_2	78.6	80.0	86.0	82.9	84.9	63.8	64.7	65.5	69.5	73.2
CH_4	1.5	1.1	0.9	0.6	0.8	0.9	0.9	0.9	0.9	0.9
N_2O	0.3	0.2	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.2
HFCs	0.0	0.7	2.0	2.4	2.0	1.8	1.1	1.1	1.1	1.1
PFCs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SF_6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NF_3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	**80.4**	**82.0**	**89.1**	**86.1**	**87.9**	**66.7**	**66.8**	**67.7**	**71.7**	**75.4**
Change from 1990 (%)		2%	11%	7%	9%	-17%	-17%	-16%	-11%	-6%

Up to 2020 the impact of increases in population and housing are offset by the impact of existing energy and emission reduction policies, for example, through the improved insulation of homes.

The overall impact of these factors has driven a projected rise in domestic emissions by 9 $MtCO_2e$ (13%) by 2035 compared to 2015.

4.3.3 Public

Public services include central and local government, defence, education, health and social work.

Table 5: Public sector emissions by GHG, UNFCCC coverage ($MtCO_2e$)

	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035
CO_2	13.4	13.2	12.1	11.1	9.7	8.1	6.9	6.9	7.5	7.8
CH_4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
N_2O	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HFCs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PFCs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SF_6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NF_3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	**13.5**	**13.3**	**12.1**	**11.2**	**9.7**	**8.1**	**7.0**	**6.9**	**7.5**	**7.9**
Change from 1990 (%)		-2%	-10%	-17%	-28%	-40%	-48%	-49%	-44%	-42%

Total GHG emissions from public services are projected to remain broadly constant until the mid-2020s before rising slightly in the late 2020s and 30s.

4.3.4 Business

Energy emissions from CO_2 (and related CH_4 and N_2O emissions) in commerce are attributable to combustion, both to heat buildings and in manufacturing.

Table 6: Business sector emissions by GHG, UNFCCC coverage ($MtCO_2e$)

	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035
CO_2	111.8	108.9	109.1	97.2	78.6	68.7	64.1	58.4	54.7	53.8
CH_4	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
N_2O	1.6	1.6	1.6	1.6	1.4	1.3	1.4	1.4	1.4	1.4
HFCs	0.0	0.8	4.6	10.2	14.4	14.2	10.0	6.2	3.2	1.6
PFCs	0.1	0.1	0.3	0.1	0.1	0.2	0.2	0.2	0.2	0.2
SF_6	0.9	0.9	0.8	0.8	0.5	0.4	0.3	0.4	0.4	0.4
NF_3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	**114.6**	**112.5**	**116.5**	**110.1**	**95.1**	**84.9**	**76.2**	**66.7**	**60.0**	**57.5**
Change from 1990 (%)		-2%	2%	-4%	-17%	-26%	-34%	-42%	-48%	-50%

Emissions in this area are projected to fall to 34% below 1990 levels by 2020, and to 48% below by 2030. Improvements over time are attributable to the impact of policies that encourage energy efficiency, such as Building Regulations, minimum energy efficiency standards for new products and economic measures such as the Carbon Reduction Commitment and the Renewable Heat Incentive. These are discussed in Chapter 3: Policies and Measures.

4.3.5 Transport

In 2015, 121 $MtCO_2e$ was emitted in the transport sector, representing around a quarter of all GHG emissions. It is projected that as we move into the 2030s transport will comprise around 30% of the emissions. Transport emissions are projected to be 5% lower than 1990 levels by 2020 and 11% lower by 2030.

Table 7: Transport sector emissions by GHG, UNFCCC coverage ($MtCO_2e$)

	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035
CO_2	120.3	120.4	125.6	130.1	120.1	119.8	115.7	111.3	107.9	106.2
CH_4	1.3	0.9	0.6	0.4	0.2	0.1	0.1	0.1	0.1	0.1
N_2O	1.4	1.9	1.6	1.3	1.0	1.1	1.3	1.4	1.4	1.4
HFCs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PFCs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SF_6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NF_3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	**123.0**	**123.3**	**127.8**	**131.7**	**121.3**	**121.0**	**117.1**	**112.8**	**109.4**	**107.7**
Change from 1990 (%)		0%	4%	7%	-1%	-2%	-5%	-8%	-11%	-12%

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 now and 2030.

CH_4 and N_2O emissions from road transport have been impacted by changing in European vehicle standards and increasing diesel cars over petrol. N_2O emissions had been falling since the mid-1990s due to reducing N_2O emissions from petrol vehicles with higher emission standards. However, since 2010 they have increased and are projected to continue to do so due to increased diesel activity with associated higher emission factors.

Emissions from commercial aviation from flights within the UK's UNFCCC coverage are projected to increase by 23% in 2020 and by 35% in 2030 compared to 2015 emissions,

4.3.6 Industrial processes

Emissions from industrial processes, which include process emissions from cement and lime production, glass manufacture, steel production, and chemicals manufacture, have fallen sharply in the period up to 2015 compared to 1990, by 79%. Emissions are then projected to fall to 83% below 1990 levels by 2020 and 85% below by 2030.

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

	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035
CO_2	19.4	17.7	17.0	16.4	10.6	12.1	9.5	8.9	8.6	8.3
CH_4	0.3	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1
N_2O	23.9	14.4	5.4	3.1	1.5	0.3	0.3	0.3	0.3	0.3
HFCs	14.4	17.7	3.3	0.5	0.1	0.0	0.0	0.0	0.0	0.0
PFCs	1.6	0.4	0.3	0.3	0.2	0.2	0.1	0.1	0.1	0.1
SF_6	0.4	0.4	1.0	0.2	0.2	0.1	0.0	0.0	0.0	0.0
NF_3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	**60.0**	**50.9**	**27.1**	**20.6**	**12.7**	**12.7**	**10.0**	**9.4**	**9.0**	**8.8**
Change from 1990 (%)		-15%	-55%	-66%	-79%	-79%	-83%	-84%	-85%	-85%

The large historical reductions in emissions of N_2O 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 in the late 1990's led to a large reduction in emissions of HFC-23 emissions from HCFC-22 manufacture.

4.3.7 Land use change, land use and forestry

From 1990, the amount of carbon stored in UK trees has been increasing, with the accumulation rate reaching a net sink of 7.4 $MtCO_2$/year in 2015. However, the UK's experts expect this balance to change in future as forests mature (in mature forests carbon uptake is reduced) and more are felled. By2030 the accumulation rate is projected to have fallen substantially.

Table 9: LULUCF sector emissions by GHG, UNFCCC coverage ($MtCO_2e$)

	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035
CO_2	3.2	0.6	-1.8	-5.2	-7.5	-8.9	-12.7	-10.7	-8.6	-7.1
CH_4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
N_2O	2.5	2.4	2.3	1.9	1.7	1.5	1.6	1.8	1.9	2.0
HFCs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PFCs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SF_6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NF_3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	**5.7**	**3.0**	**0.5**	**-3.2**	**-5.8**	**-7.4**	**-11.1**	**-8.9**	**-6.7**	**-5.1**
Change from 1990 (%)		-47%	-91%	-157%	-202%	-229%	-294%	-256%	-218%	-190%

Further information on non-CO_2 emissions from LULUCF can be found in Annex N of the Energy and Emissions Projections report[136].

4.3.8 Waste

Annual GHG emissions from waste management were 72% lower than 1990 levels in 2015 and are projected to fall to 79% below 1990 levels by 2020 and by 83% by 2030. The historic fall can

[136] Add link to Annex N of the Energy and Emissions Projections report

largely be attributed to a reduction in CH_4 emissions from landfill sites due to the introduction of the Landfill Directive in 2000 and associated measures. These had the aim of reducing the amount of waste going to landfill and improving the collection of methane for energy recovery from landfill sites.

Table 10: Waste sector emissions by GHG, UNFCCC coverage ($MtCO_2e$)

	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035
CO_2	1.3	0.9	0.5	0.4	0.3	0.3	0.3	0.3	0.3	0.3
CH_4	64.8	67.5	61.5	48.0	30.4	16.8	12.2	10.4	9.5	8.9
N_2O	0.8	0.8	1.0	1.1	1.3	1.4	1.5	1.5	1.5	1.5
HFCs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PFCs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SF_6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NF_3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	**66.9**	**69.3**	**63.0**	**49.4**	**31.9**	**18.4**	**13.9**	**12.2**	**11.2**	**10.7**
Change from 1990 (%)		4%	-6%	-26%	-52%	-72%	-79%	-82%	-83%	-84%

The continuing reduction in waste emissions is caused by the continuing decrease in landfill emissions as more waste is preferentially sent to alternative disposal routes (incineration, biological waste treatment (BWT) and recycling) and small further improvements in landfill efficiency are made. The policy which partially drives this, the Landfill Directive, expires in 2020. Therefore the proportion of waste going to landfill is projected to stop decreasing post 2020, although emissions reductions should continue as landfill emissions lag behind disposal. Partially counteracting the decrease in landfill emissions are projected increases in BWT emissions and domestic wastewater emissions.

4.3.9 Agriculture

Emissions from the agriculture sector showed reductions of 17% on 1990 levels in 2015 which reflects declining livestock numbers and a reduction in the amount of synthetic fertiliser used. The historical fall in CO_2 emission is largely related to fewer emissions from mobile machinery.

Emissions are projected to be fairly stable through the 2020s and 2030s.

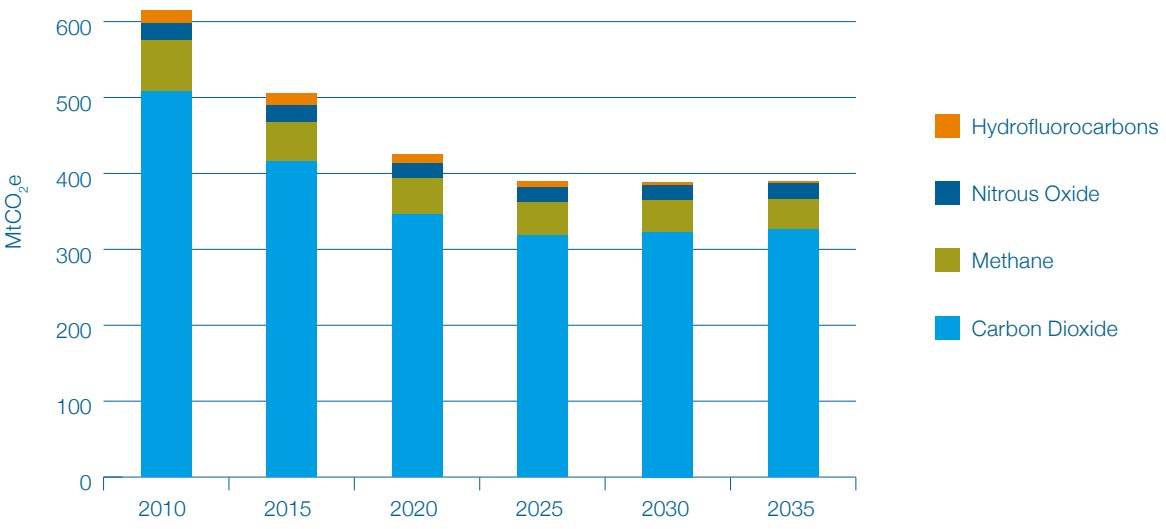
Table 11: Agriculture sector emissions by GHG, UNFCCC coverage ($MtCO_2e$)

	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035
CO_2	7.0	7.2	5.8	5.6	5.2	5.2	5.3	4.7	4.3	4.2
CH_4	33.0	32.4	31.2	29.0	27.5	27.8	26.6	25.8	25.8	25.7
N_2O	19.4	19.2	18.2	16.9	16.2	16.4	15.0	14.5	14.5	14.5
HFCs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PFCs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SF_6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NF_3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	**59.3**	**58.7**	**55.2**	**51.5**	**48.9**	**49.4**	**46.9**	**45.0**	**44.6**	**44.4**
Change from 1990 (%)		-1%	-7%	-13%	-17%	-17%	-21%	-24%	-25%	-25%

4.4 Projections by gas

Each of the sector tables in previous chapters provided information about projected emissions both by sector and by greenhouse gas. This section describes the projected emissions trends by greenhouse gas.

Figure 39: GHG projected emissions by gas, UNFCCC coverage ($MtCO_2e$)



Source: UK GHG Inventory, 2017 Energy and Emissions Projections

4.4.1 Carbon dioxide

Carbon dioxide emissions are projected to decline as trends in energy efficiency, alternative fuels and decline in heavy industry are likely to offset increasing population, transport demand and renewed economic growth.

The largest change expected is the continued decline in CO_2 from energy supply as the power sector is decarbonised. This is driven by the Government's *Electricity Market Reform (EMR)* policies which incentivise investment in secure, low-carbon electricity – in particular nuclear and renewables-based generation.

4.4.2 Methane

Methane emissions have already fallen significantly, by 61%, between 1990 and 2015 and are projected to continue to decline more modestly, by a further 8% by 2030, compared to 1990 levels. This is largely as a result of expected reductions in landfill waste, with some contribution from decreasing natural gas leakage due to pipe replacement and reducing coal mining.

Waste disposal on land was the largest source of CH_4 in 1990, and it is projected to fall further due to the policy-driven diversion of solid wastes to recycling and combustion for energy. Wastewater treatment CH_4 emissions reduced slightly from 1990 to 2015 and are projected to remain fairly constant.

Agriculture, which was the third largest source of CH_4 in 1990, is now by far the largest and is projected to stay so.

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 is projected to 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.

4.4.3 Nitrous oxide

The largest source of N_2O in 2015 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 agriculture is projected to remain the largest source in 2030.

In other sectors, waste N_2O emissions are projected to increase due to increased biological waste processes and sewage sludge decomposition. Transport N_2O emissions are also projected to increase due to increased diesel vehicle activity. Growth in the economy will also lead to some increased emissions.

4.4.4 Fluorinated gases (hydrofluorocarbons, perfluorocarbons, sulphur hexafluoride and nitrogen trifluoride)

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.

Use of HFCs has increased, replacing HCFCs phased out as propellants and refrigerants from 1995 onwards. This increase is expected to peak presently and then HFC emissions are projected to reduce by 73% between 2015 and 2030. This significant reduction is caused by the various requirements of the 2014 EU F-gas regulation which specify details of phasing out f-gases.

Historically the largest source of PFCs has been as a by-product of carbon anodes in primary aluminium manufacture.

The major uses of SF6 are as a magnesium cover gas, in high-voltage electrical switch gear, as an insulator in semiconductor manufacture and in military Airborne Warning and Control Systems (AWACs).

Emissions, though small, have declined throughout the period 1990 – 2015 for use as a cover gas due to declining industrial demand. SF_6 use in the UK is now projected to roughly stabilise at its current level.

4.5 Total effect of policies and measures

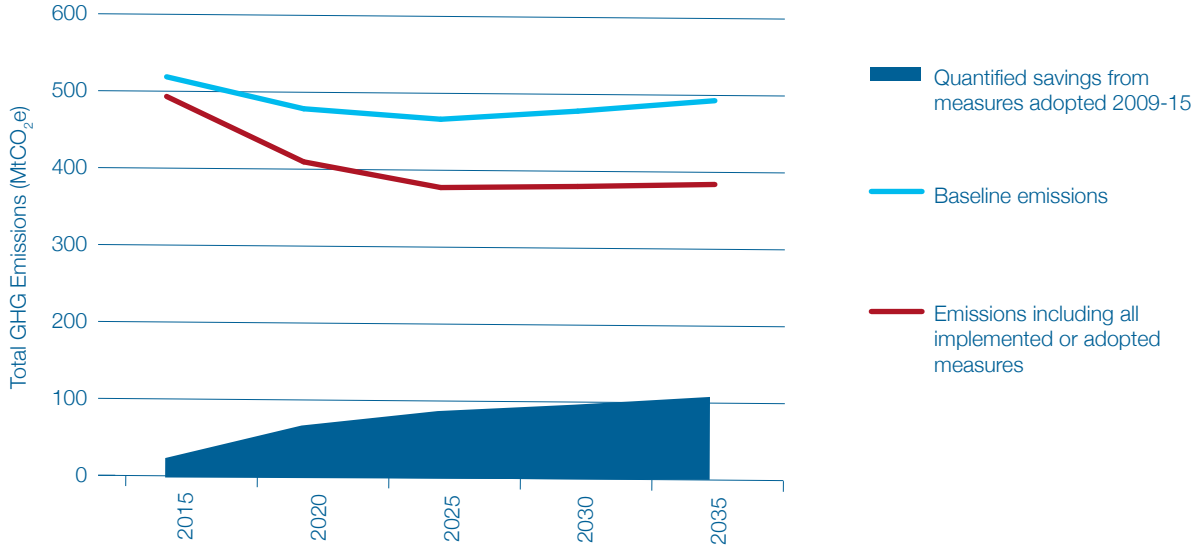
The projections presented here (the 'with existing measures' scenario) include the impact of all the UK's implemented and adopted policies and measures. These policies and measures and their projected CO_2e savings are detailed in the Annex. It does not include policies which are classed as planned, so these figures differ from those quoted in the Energy and Emissions Projections.

Since the last National Communication, the UK has continued to provide updated analysis of policies and measures expected to help meet its EU effort sharing and renewable energy targets, and the targets for the carbon budgets set under the 2008 Climate Change Act. Details of these policies are in Chapter 3.

The UK treat the policies adopted before 2009, when carbon budgets were set at the time of the 2009 Budget and the Low Carbon Transition Plan (LCTP)[137], as part of the baseline. Figure 40 and Table 12 below show the estimated emissions savings and the effect on projected emissions attributable to policies adopted between April 2009 and July 2017, as published in the 2017 UK EEP. For example, in 2020 we project that UK policies will deliver emissions reductions of almost 50 $MtCO_2e$.

[137] https://www.gov.uk/government/publications/the-uk-low-carbon-transition-plan-national-strategy-for-climate-and-energy

Figure 40: Projected impact of adopted and implemented policies, UK coverage



Source: 2017 Energy and Emissions Projections

Table 12: Projections of total net GHG emissions in the 'with measures' scenario, $MtCO_2e$

	2015	2020	2025	2030	2035
Emissions excluding the impact of measures adopted between 2009-15 (baseline)	525	483	470	480	494
Savings from measures adopted 2009-15 (excluding planned policies)	26	69	89	98	109
Emissions including all implemented or adopted measures (excluding planned policies)	499	414	381	382	385

4.6 Projections methodology

Projections of the UK's emissions of CO2 and combustion-related emissions of other greenhouses gases (CH4 and nitrous oxide) have been largely derived from the BEIS Energy and Emissions Projections (EEP) model suite. This models the UK energy market including final sector energy use and the electricity supply sector. It includes a mixed (top down/bottom up) econometric model of energy demand and combustion related greenhouse gas (GHG) emissions for the UK economy 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).

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. Industrial process emissions are calibrated by relating inventory emission to production.

The EEP model projects emissions using prospects for fossil fuel prices, carbon prices, economic growth and demographics. Sources for these assumptions are given in the Key assumptions chapter.

These projections included scenarios for high and low fossil fuel price assumptions, high and low GDP growth rates and a baseline excluding post-2009 climate change policies and measures. The projections in the UK are typically presented 'with existing measures' and 'with additional measures', though these are on a UK-only basis and do not include emissions from crown dependencies and overseas territories. The projections reported in this chapter are

based on the 'with existing measures' scenario which have been scaled up to include crown dependencies and overseas territories emissions in order to meet UNFCCC requirements.

Projections of energy demand by fuel and sector 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 for this National Communication we do not include those that only have planned status.

The overall modelling approach is similar to that used in the previous National Communication, although there have been improvements in each sector.

4.6.1 Energy supply

BEIS use the "Dynamic Dispatch Model" (DDM) to project investment and generation in the electricity supply sector. The DDM 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 incorporating the effect of government policies such as 'Contracts for Difference' which incentivise low-carbon generation through market mechanisms.

From this year, the DDM now also models investment in the supply of heat and electricity from Combined Heat and Power (CHP) plants, mostly in industry.

Emissions from oil refining are calculated from the latest energy consumption statistics from DUKES.

4.6.2 Residential

Emissions projections from energy use in the residential sector are produced separately for gas, oil and solid fuels. An assumption is made about the percentage of households using each of these fuels as a main source for heating. The primary drivers of residential energy demand are household numbers, fuel prices, temperature and income.

4.6.3 Business

The primary driver of total energy demand in Business is sectoral gross value added (GVA). There are also fuel price and seasonal temperature effects. Fuel share models are then used to decompose this into demands for the individual fuels.

4.6.4 Public

When modelling public services, the primary driver of electricity and heating fuel demand is sectoral employment. Similar to commercial services, demand is also influenced by seasonal temperatures and a trend in improved energy intensity per employee. As with commercial services a fuels share model is then used to decompose this heating energy into demand for the individual fuels. In both public and business sectors additional energy efficiency improvements are policy driven.

4.6.5 Land use change, land use and forestry

LULUCF emissions projections are produced by the Centre for Ecology & Hydrology (CEH) and Forest Research on the basis of assumptions applied to the current inventory methodology. Four scenarios (Baseline, Central, High and Low) are produced and the assumptions cover afforestation, wildfires, peat extraction, land use change and deforestation. The scenarios were developed by a policy maker stakeholder group and have been updated in 2016 following discussions with all of the UK devolved administrations. Broadly, the Central scenario is

a continuation of current policies and activity rates and is the scenario used in generating emissions projections for the purpose of this report.

4.6.6 Industrial processes

Projected 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 gross value added (GVA), tonnages, reported energy use and the inventory.

Industry energy demand and process emissions are projected on a final use sub-sectoral basis. The sub-sectors are defined based on those used in DUKES, with some aggregation for the non-energy intensive sub-sectors. The sub-sectors used 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.

4.6.7 Transport

The CO_2 road transport model is an econometric response surface model integrated into the economy-wide Energy Demand Model and calibrated against the Department for Transport's (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 HGVs 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. Unlike in other demand sectors, the impacts of policies and measures in road transport on fuel demand are modelled within the economy-wide Energy Demand Model. Road vehicle efficiencies, motor spirit/diesel engine shares and biofuel use under different policy scenarios are fed into the model and mitigation impacts calculated from the differences in demand between scenarios.

Non-CO_2 road transport emissions projections follow a bottom up calculation methodology in line with that used to calculate the historical time-series of emissions. The activity data - vehicle distance travelled - is projected using 2015 DfT traffic forecasts[138].

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 High Speed 2 (HS2). Projected emissions mitigation from electrification of existing track is reported in CTF3.

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[138] https://www.gov.uk/government/publications/road-traffic-forecasts-2015

Emissions projections for UK commercial aviation are produced by DfT using projections of UK GDP, consumer expenditure, population and oil prices. Efficiency improvements are modelled using the Fleet Mix Model and assumptions of increasing use of biofuels are included. DfT provide more detailed information on methodology and assumptions alongside the aviation forecast [139]. Aviation emissions projections are extended to UNFCCC coverage by extrapolating historical trends in the Greenhouse Gas Inventory.

National navigation is projected to remain largely static.

4.6.8 Agriculture

Agriculture is a small use of energy in the UK, therefore simple trend models are used to project emissions from energy consumption in agriculture.

For non-energy agriculture emissions, activity data projections (livestock numbers, crop production, fertiliser nitrogen use) to 2030 (note that we flat line post 2030), were provided by DEFRA using the Food and Agricultural Policy Research Institute (FAPRI) methodology.[140] The FAPRI projections are based on an economic model assuming a specific set of international prices for agricultural commodities and a particular path for the sterling exchange rate. Together these factors are important determinants of the returns to farmers and hence total agricultural production. The FAPRI activity projections are converted to agriculture emissions projections using the latest agriculture GHGI model.

4.6.9 Waste

Projections of CH_4 from landfill are based on projections of tonnages of waste to landfill provided by DEFRA (municipal waste) and HMRC (commercial and industrial waste). We project composition from the changes to BWT processes and Defra projections of waste arising. These projections of waste to landfill are then run through MELMod[141], the landfill emissions calculation model. MELMod is based on the first-order decay Intergovernmental Panel on Climate Change (IPCC) methodology, and is summarised in the 2014 GHGI report[142]. CH_4 and N_2O from domestic wastewater and sewage and sludge decomposition are driven by ONS population projections. Industrial wastewater emissions are projected to be constant. Emissions projections from BWT are combined from multiple sources, some of which are projected to be constant and some of which are extrapolated from the latest year based on sector experts' estimates of expected BWT capacity in 2020.

4.6.10 Estimation of emissions in Crown Dependencies and Overseas Territories

The UK's dependant crown dependencies and overseas territories are not included in the projections the UK produces annually to monitor progress against its own carbon budgets. For this National Communication the UK has supplemented its annual projection with projections for these areas consistent with the UK 1990 – 2015 GHG Inventory (see chapter 1).

Emissions in these territories are only a small proportion of UK emissions, making up around 0.7% of the UK's UNFCCC coverage emissions in 2015.

The UK has produced simple trend projections for GHGs within each National Communication sector, assuming a continuation of the linear trends observed in the period 2007 – 2015.

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139 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/223839/aviation-forecasts.pdf

140 https://www.afbini.gov.uk/publications/fapri-uk-greenhouse-gas-emission-modelling-system-england-wales-scotland-and-northern

141 http://sciencesearch.defra.gov.uk/Document.aspx?Document=9887_WR1124Finalreportincludingappendices.pdf

142 http://naei.beis.gov.uk/reports/reports?report_id=932

4.6.11 Strengths and weaknesses of the projection methodology

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 2015 Inventory and 2016 energy statistics, both published in 2017. These are well established sources of information.
- Projections 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.
- There is a rolling programme of review and update of the projection methodologies and econometric models. Models are tested by back-casting 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 uses 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 short-run fuel switching and long-term investment strategies.

The UK's modelling methodology has the following weaknesses:

- The modelling generally assumes that historical 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.

4.7 Key assumptions

The UK's energy and emissions projections are based on a set of key assumptions about UK economic growth, demographic changes in the UK and future fuel price trajectories. The main sources of the projections are the forecasts made by the UK's Office for Budget Responsibility and Office for National Statistics, supplemented by IMF projections of world growth. Fuel prices are those produced by BEIS. The key parameters and assumptions are documented in CTF Table 5 in Annex 1.

Updated Energy and Emissions Projections are published annually. This uses the economic assumptions and projections produced for the UK government by the Office of Budget Responsibility (OBR).

UK GDP up to 2021 is based on the March 2017 Economic and Fiscal Outlook[143] and beyond 2021 is based on the January 2017 Fiscal Sustainability Report[144].

Population projections were produced in 2014 by the UK's Office for National Statistics (ONS)[145] alongside a supporting methodology description[146].

Household projections are based on those produced by the Department for Communities and Local Government which combine ONS population projections with household formation propensities[147]. Projections were produced separately for England (2014), Scotland (2012), Wales (2011) and Northern Ireland (2012) and combined to produce UK figures.

Updated socio- economic growth assumptions are shown in Table 13.

Table 14: Growth Assumptions

	Actual		Projection			
% per annum	2013	2014	2020	2025	2030	2035
UK GDP	1.9%	3.1%	1.9%	2.1%	2.3%	2.3%
UK Population	0.6%	0.8%	0.6%	0.6%	0.5%	0.4%
UK Households	0.9%	1.0%	0.9%	0.8%	0.7%	0.6%

Source: 2017 Energy and Emissions Projections

The fossil fuel price projections[148] and carbon prices projections[149] are updated annually by BEIS and are subject to peer review. They are also used more widely across government.

Key fossil fuel and carbon price values are set out below in

Table 15, and exchange rates are shown in Table 16.

Table 15: Central Fossil Fuel and Carbon Prices

		Actual		Projection			
2017 prices	Units	2015	2016	2020	2025	2030	2035
Crude oil (Brent 1 month)	$/bbl	55.9	45.8	57.0	69.0	80.0	80.0
Gas (NBP)	p/therm	44.5	35.6	43.0	55.0	67.0	67.0
Coal (CIF ARA)	$/tonne	58.0	57.0	65.0	77.0	88.0	88.0
EU ETS carbon price	£/tCO2	5.8	4.5	4.6	13.2	39.4	39.4

Source: 2017 Energy and Emissions Projections

143 http://budgetresponsibility.org.uk/efo/economic-fiscal-outlook-march-2017/

144 http://budgetresponsibility.org.uk/fsr/fiscal-sustainability-report-january-2017/

145 https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationprojections/bulletins/nationalpopulationprojections/2015-10-29

146 https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationprojections/methodologies/nationalpopulationprojectionsqmi

147 https://www.gov.uk/government/statistical-data-sets/live-tables-on-household-projections

148 https://www.gov.uk/government/publications/fossil-fuel-price-assumptions-2017

149 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/360323/20141001_Supporting_Tables_for_DECC-HMT_Supplementary_Appraisal_Guidance.xlsx

Table 16: Exchange rates against Sterling

		Actual					
	Units	2015	2016	2020	2025	2030	2035
US Dollars	$ per £	1.5	1.4	1.3	1.3	1.3	1.3
Euros	€ per £	1.4	1.2	1.1	1.1	1.1	1.1
Coal (CIF ARA)	$/tonne	58.0	57.0	65.0	77.0	88.0	88.0
EU ETS carbon price	£/tCO2	5.8	4.5	4.6	13.2	39.4	39.4

Source: 2017 Energy and Emissions Projections

4.8 Quality Assurance/Quality Control

Quality assurance of modelling undertaken by government departments has taken on a greater emphasis following the publication of the Macpherson Review in 2013[150].

Energy projections and the energy-related emission projections are produced in BEIS by a small team (the 'EEP modelling team') whose key 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 BEIS within the Science division.

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 normally 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.

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.

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 Committee on Climate Change (CCC).

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150 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/206946/review_of_qa_of_govt_analytical_models_final_report_040313.pdf

4.9 Uncertainty

The published annexes for the UK's Energy and Emissions Projections, published in December 2017 projections included the following variant scenarios/sensitivities:

- Low and high fossil fuel prices.
- Low and high UK GDP rates.

4.9.1 Fossil fuel prices

The fossil fuel prices scenarios used assumptions as follows:

Table 17: Variant Fossil Fuel Price Scenarios

	Actual		Projection			
Fossil fuel	2017 Prices	2016	2020	2025	2030	2035
Low Fossil Fuel Prices						
Crude oil (Brent 1 month)	$/bbl	45.8	36.0	45.0	55.0	55.0
Gas (NBP)	p/therm	35.6	34.0	36.0	39.0	39.0
Coal (CIF ARA)	$/tonne	57.0	43.0	52.0	61.0	61.0
High Fossil Fuel Prices						
Crude oil (Brent 1 month)	$/bbl	45.8	77.0	98.0	120.0	120.0
Gas (NBP)	p/therm	35.6	62.0	72.0	83.0	83.0
Coal (CIF ARA)	$/tonne	57.0	89.0	102.0	115.0	115.0

Source: 2017 Energy and Emissions Projections

These scenarios were produced by 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[151]. They are not sensitivities to the overall level of fossil fuel prices and do not maintain fuel cross-price ratios.

4.9.2 Growth sensitivities

The UK GDP growth sensitivities, set at +/- 25 basis points per annum with respect to the reference scenario, were:

Table 18: Variant UK GDP growth sensitivities

	Actual		Projection			
	Units	2016	2020	2025	2030	2035
Low UK GDP Growth	%pa	1.8%	1.6%	1.8%	2.1%	2.1%
High UK GDP Growth	%pa	1.8%	2.1%	2.3%	2.6%	2.6%

Source: 2017 Energy and Emissions Projections

[151] https://www.gov.uk/government/publications/fossil-fuel-price-assumptions-2017

4.9.3 Total GHG emissions using variant assumptions

These parameter variants give us four variant emissions projections:

Table 19: Total 'with additional measures' GHG emissions in variant scenarios, including LULUCF

	Projection				
	2016	2020	2025	2030	2035
Reference scenario	444.7	403.1	369.5	358.3	348.1
Variant scenarios					
Low Fossil Fuel Prices	444.7	410.5	375.1	369.2	358.3
High Fossil Fuel Prices	444.7	406.9	368.1	350.6	340.6
Low UK GDP Growth	444.8	402.0	366.8	354.2	343.7
High UK GDP Growth	444.7	404.4	372.0	362.6	352.7

Source: 2017 Energy and Emissions Projections

4.9.4 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.

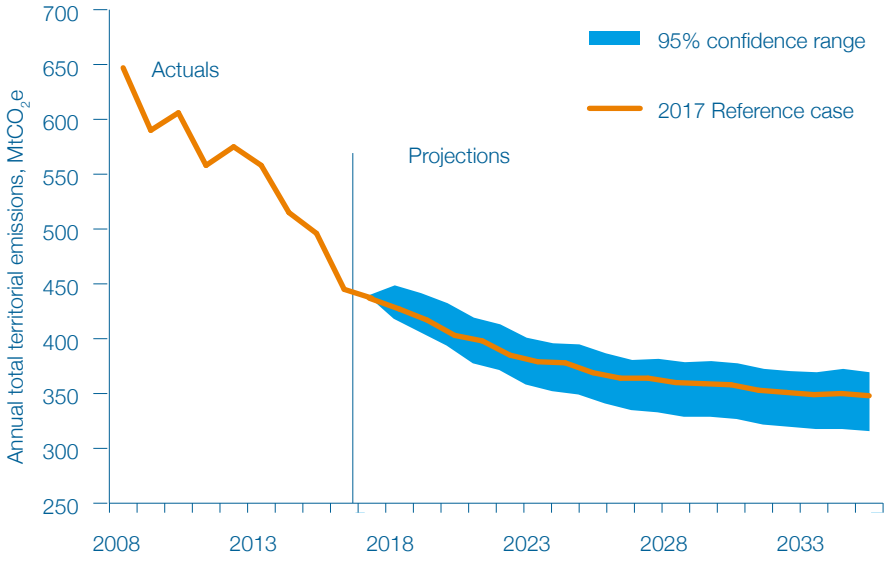
In order to model this, randomly selected trajectories of values drawn from the uncertainty ranges for 36 key parameters, including GDP, population, fossil fuel prices, annual temperatures and policy savings were combined in a 10000 run Monte Carlo simulation to assess the overall uncertainty range for the UK's emissions projections. Figure 41 shows the results of this probabilistic analysis.

Table 20: Ninety five per cent confidence interval for total 'with additional measures' GHG emissions from Monte Carlo simulation including LULUCF

	Inventory		Projection		
	1990	2015	2020	2025	2030
Upper 95% confidence interval	799	496	384	348	334
Reference projection [1]	799	496	403	369	358
Lower 95% confidence interval	799	496	425	393	384
Upper 95% confidence interval, % difference from reference	-	-	-5%	-6%	-7%
Lower 95% confidence interval, % difference from reference	-	-	6%	6%	7%
Upper 95% confidence interval, % change on 1990 values	-	-38%	-52%	-56%	-58%
Reference, % change on 1990 values	-	-38%	-50%	-54%	-55%
Lower 95% confidence interval, % change on 1990 values	-	-38%	-47%	-51%	-52%

It is projected that in 2020, UK emissions on GHGs will be between 47% and 52% below 1990 levels, with the central estimate 50% below.

Figure 41: Uncertainty in UK projected emissions, with additional measure, UK coverage



Source: 2017 Energy and Emissions Projections[29]

4.10 Differences from the last National Communication

The table below summarises the differences between the projections in this and the last National Communication, which was based on projections produced in 2015.

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 and economic growth assumptions.

The projections have also been updated to take into account improvements to the historical inventory and other improvements to methods, emission factors and activity data. The effect of changes to the inventory are summarised in Chapter 1.

The net effect of these changes is to reduce projected emissions in 2020 from 43% below 1990 levels in the Sixth National Communication to 48% below 1990 levels in the Seventh National Communication. The projected reduction of 24 $MtCO_2$ between the two projections is mostly due to projected reductions in CO_2 and N2O emissions.

Table 21: Comparison with last National Communication

$MtCO_2e$	Sixth National Communication			Seventh National Communication		
GHG including LULUCF	1990	2020	Projected change	1990	2020	Projected change
Carbon Dioxide	593.5	359.8	-39%	598.5	333.8	-44%
Methane	99.2	36.3	-63%	135.3	46.8	-65%
Nitrous Oxide	68.3	33.0	-52%	51.3	22.1	-57%
Hydrofluorocarbons	11.4	8.6	-25%	14.4	11.1	-23%
Perfluorocarbons	1.4	0.2	-84%	1.7	0.3	-84%
Sulphur Hexafluoride	1.0	0.6	-43%	1.3	0.4	-70%
Nitrogen Trifluoride	-	-	na	0.0	0.0	-100%
Total GHG	774.8	438.5	-43%	802.5	414.4	-48%

Source: 2017 Energy and Emissions Projections

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

5.1 Key developments

Government Action – Since the publication of the 6th National Communication (2013), the UK has passed a number of further significant milestones, including the publication of the country's second Climate Change Risk Assessment (2017) and two statutory assessments of progress (2015 and 2017) on the first National Adaptation Programme.

UK Climate Projections – The UK's climate projections were released in summer 2009 (UKCP09) and relate to current and future climate change up to 2100. They were used in both the first and second UK Climate Change Risk Assessments published in January 2012 and 2017. We have been working towards updating these projections in 2018 (UKCP18). Work builds upon the current set of projections to provide the most up-to date assessment of how the climate of the UK may change over the 21st century. UKCP18 will update the probabilistic projections over land and provide a set of high-resolution spatially-coherent future climate projections for the globe at 60km scale and for the UK at 12km scale. Projections will be further downscaled to a level previously only used for short-term meteorological modelling allowing realistic simulation of high impact events such as localised heavy rainfall in summer. The marine projections will also be updated for sea-level rise and storm surge.

UK Climate Change Risk Assessment – The Climate Change Act 2008 requires a Climate Change Risk Assessment (CCRA) to be completed every five years. The first UK CCRA was published in January 2012 and identified over 700 risks to the UK from a changing climate. The second CCRA was published in January 2017 and outlines the UK and Devolved Governments' views on the key climate change risks and opportunities that the UK faces. Six priority risk areas have been identified where further action is needed in the next five years.

The National Adaptation Programme –The first National Adaptation Programme (NAP) was published in July 2013 covering England and non-devolved climate adaptation matters, as required by the Climate Change Act 2008. Assessments of progress in implementing the NAP, also required every two years by the Climate Change Act, were completed in June 2015 and 2017 by the independent Adaptation Sub-Committee of the Committee on Climate Change. The 2017 assessment concluded that actions in the NAP have largely been completed, identifying where progress is being made or where further efforts are needed to reduce vulnerability.

5.2 Adaptation in the UK

Climate adaptation policy is a devolved matter. Scotland, Wales and Northern Ireland have established their own adaptation programmes while the UK Government leads on 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.

5.2.1 UK Government programme

Building on the UK's strong start on adapting to climate change reported in the sixth communication, the UK continues to make progress in equipping ourselves to cope with a broad range of potential changes in our climate. This chapter describes the ways in which the UK continues to develop its 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[152] ("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;
- that a National Adaptation Programme (NAP) must be put in place and reviewed every five years to address the most pressing climate change risks;
- a power for the government to require public authorities and public and private companies that provide our infrastructure and related services (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 those risks;
- the Adaptation Sub-Committee of the Committee on Climate Change to oversee progress on the government's climate change adaptation programme, advising on the CCRA and evaluating progress on implementing the NAP.

On 1 July 2013 the first NAP was published covering England and non-devolved climate adaptation matters, as required by the Climate Change Act 2008. 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. 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 NAP provides an overview of UK government's policies and programmes on adapting to climate change and describes over 370 actions to be taken over the five year period of the first NAP. The NAP sets 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.

Assessments of progress in implementing the NAP, also required every two years by the Climate Change Act, were completed in June 2015 and 2017 by the independent Adaptation Sub-Committee (ASC) of the Committee on Climate Change. In the 2017 assessment by the ASC, 51% of actions are assessed as complete and an additional 35% are considered on track or ongoing by those responsible for their delivery.

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

Since the ASC's first statutory report new measures have been introduced in some priority areas, in part prompted by events such as the severe storms and flooding in 2015 and 2016. Measures include more funding for flood and coastal defence projects, and steps to encourage flood resilient repairs to be made to affected properties as standard practice.

UK government's approach is to integrate consideration of climate risks and adaptation across all policies, programmes and activities within government and beyond. This means that as understanding of and action on climate risks develops during the period of the NAP, further actions and activities are put in place that build upon and extend those already outlined in the NAP.

5.2.2 Scottish Government programme

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 Climate Change (S) Act 2009 placed a duty on Ministers to lay a programme for climate change adaptation before the Scottish Parliament as soon as reasonably practicable after they receive the Climate Change Risk Assessment (CCRA) for Scotland.

The Scottish Government launched Scotland's first Climate Change Adaptation Programme (SCCAP) in 2014. It is funded by SG but delivered by Sniffer via Adaptation Scotland. The gateway website showcases case studies and provides supporting resources.

The SCCAP aimed "to increase the resilience of Scotland's people, environment and economy to the impacts of a changing climate". It has around 150 individual policies and proposals spanning three themes (Natural Environment, Buildings and Infrastructure, and Society) and six objectives. It was developed by extensive public consultation and Parliamentary scrutiny.

The act also requires an annual report on progress and the advisory body (ASC) to prepare a report within 2 years setting out its independent assessment of the progress made on objectives, proposals and policies set out in the programme. The first, second and third annual progress reports were produced in 2015, 2016 and 2017, setting out progress in detailed tables and key case studies.

An independent assessment was undertaken in Sept 2016, where the SCCAP was recognised by the Adaptation sub Committee (ASC) as a positive start in taking steps to prepare for climate change. This took into account the Evidence Report for CCRA2 prepared in 2016, which comprised a synthesis report for the UK as a whole, technical chapters and national summaries, including one for Scotland. The Evidence Report was published in July 2016 and used the concept of urgency to summarise the findings of the analysis, variously identifying 'more action needed', 'research priority', 'sustain current action' and 'watching brief' categories. It highlighted:- The need for more action to address flood risks / The potential for water scarcity / Heat related impacts on health and wellbeing / Risks to the natural environment / Risks of food price volatility; and New and emerging pest and disease risks, especially for Scotland's forestry. (Notably many of the actions identified as priorities for other parts of the UK were shown to be less critical for Scotland at this stage.)

The independent assessment confirmed that steps were being taken to prepare Scotland for climate change, the SCCAP was a positive start with almost all of its 148 policies and proposals reported as being on track and it acknowledged that it provided a solid foundation for further progress. However, the assessment highlighted a number of evidence gaps that meant it was difficult to determine whether key vulnerabilities are being suitably addressed and there was

insufficient evidence to judge progress.' Additionally, there is a need for more adaptation action: specific, effective steps to directly confront and tackle the risks highlighted. Also, more could be done to make sure Scotland is ready to realise the opportunities that milder winters and warmer summers will bring.

5.2.3 Welsh Government programme

Wales has strengthened its legislative requirements to build resilience to the impacts of climate change through the Wellbeing of Future Generations (Wales) Act 2015 and the Environment (Wales) Act 2016. Climate change is integral to all of the Well-being Goals and there is specific reference to a resilient Wales, which includes resilience to the effects of climate change. Climate change is also a key element of the Future Generations Commissioner for Wales' role and the Future Trends Report and Public Service Board well-being assessments will need to take into account the latest Climate Change Risk Assessment (CCRA).

In light of this new legislation and the emerging evidence, such as the Climate Change Risk Assessment Evidence Report prepared by the Committee on Climate Change , the Welsh Government are now developing a new Climate Change Adaptation Plan for Wales, to be delivered in 2018.

We anticipate the Plan will focus on:

- Tackling the key risks identified in the Climate Change Risk Assessment 2017.
- Supporting disadvantaged groups and vulnerable communities to build resilience to climate change impacts.
- Establishing mechanisms and timescales for addressing research priorities.
- Clearly define the actions to be taken at an all Wales level, and those for which local delivery partners (such as Public Service Boards) are responsible.

We recognise that the latest CCRA evidence findings have implications across all sectors of Welsh Government including Health, Communities, Transport, Housing, Economy, Agriculture, Food and Environment. These implications are important considerations for our key decisions and major projects.

In the meantime, we continue to deliver on the actions in the current Climate Change Strategy for Wales and to invest in our work programme in key areas, such as Flood and Coastal Risk Management and delivering on the priorities identified in our National Natural Resources Policy.

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.

The Strategy 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.

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.

The Natural Resources Policy was published on 21 August 2017. Its publication marked the second major milestone in the implementation of the Environment (Wales) Act 2016. The Natural Resources Policy sets out the national priorities we will take forward to address the challenges our natural resources face and realise the significant opportunities that they provide for our well-being and prosperity. The Natural Resources Policy will drive delivery across all of the Well-being Goals, delivering win-wins for our communities and our economy whilst also improving our environment.

There are three national priorities which were welcomed by stakeholders on which we need to take action, namely:

- The delivery of nature-based solutions
- Increasing renewable energy and resource efficiency, and
- Taking a place-based approach.

The Natural Resources Policy will drive action across the whole of the Welsh Government and will require partnership working with stakeholders across sectors.

Natural Resources Wales will now develop Area Statements to support delivery of the Natural Resources Policy in a local context, for example by providing evidence for Local Development Plans, Well-being Assessments and by encouraging local, collaborative action.

5.2.4 Northern Ireland Government programme

In Northern Ireland, the Department of Agriculture, Environment and Rural Affairs (DAERA) takes the lead on climate change issues.[153] It works closely with Defra and the Devolved Administrations of Scotland and Wales.

The current NI Climate Change Adaptation Programme, produced in 2014, focuses 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;
- Natural environment;
- Agriculture and forestry.

A second 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 NI Summary of the UK Climate Change Risk Assessment, which was produced in 2017.

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[153] https://www.daera-ni.gov.uk/topics/protect-environment/climate-change

Climate NI was established in 2008 to help fulfil the NI Executive's obligations to address climate change impacts. It is funded by the Department of Agriculture, Environment and Rural Affairs (DAERA) and is governed by a Steering Group composed of organisations from a wide range of sectors. These include central and local government, the business and voluntary communities and academia. Its aims are to share best practice, increase the understanding of the impacts of climate change in Northern Ireland, to share knowledge, promote action and provide independent advice to all Government Departments. Climate NI provides a vital link between the environmental NGOs, business sectors, and government.

5.3 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.

5.3.1 Climate Projections

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 underpinned evidence used in the first and second UK CCRA..

The UKCP09 projections suggest that the most likely increase in 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 for a central estimate (i.e.50% probability, while 10% and 90% probability levels show 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.

UKCP09 has informed key policies and programmes including:

- The Environment Agency's Long Term Investment Scenarios for Flood and Coastal Erosion Risk Management.
- Water Companies' five-yearly water resource plans
- The National planning policy framework and local planning decisions

UK Government has commissioned an updated set of climate projections for the UK that will be prepared by the Met Office and will be available in 2018. The projections – called UKCP18 – will provide information on how the climate of the UK may change over the rest of this century. UKCP18 will inform the Government's third and fourth Climate Change Risk Assessments (due for completion in 2022 and 2027) and subsequent revisions to the National Adaptation Programme. UKCP18 will be an important source of information for other UK organisations that have to manage climate impacts on their assets and operations.

5.3.2 Risk Assessment

The first UK climate change risk assessment was published in January 2012. It 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 first CCRA assessed climate risks for the UK using the UKCP09 for three time periods – 30year 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 were 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 second CCRA was published in January 2017 and identifies six priority risk areas where action is needed in the next five years. To underpin both the first and second UK Climate Change Risk Assessments, the Government commissioned independent expert studies of the available evidence which have been published in the form of supporting evidence reports.

The UK Climate Change Risk Assessment 2017 Evidence Report for the second CCRA was prepared by the Adaptation Sub-Committee, which was asked to address the question: 'Based on the latest understanding of current, and future, climate risks/opportunities, vulnerability and adaptation, what should the priorities be for the next UK National Adaptation Programme and adaptation programmes of the devolved administrations?'

In order to assess climate risks in a consistent way, and to facilitate action being focused on the most pressing risks, the Adaptation Sub-Committee took a three-step approach to assess the urgency of additional action for each climate risk and opportunity:

- considering the magnitude of the risk now and in the future;
- taking into account policies and adaptation plans already in place to manage the risks;
- considering the potential benefits of further action.

The UK Climate Change Risk Assessment 2017 Evidence Report also goes further than the first in considering international climate risks that could have consequences for the UK, as well as the interdependencies between the various climate risks. The Adaptation Sub-Committee's full Evidence Report comprises an overarching Synthesis Report, which summarises the conclusions of eight technical chapters and highlights six groups of priority risks where additional action is recommended in the next five years. The six priority risk areas encompass most of the individual risks that are identified as needing 'more action'.

The risks and opportunities from climate change will vary across the UK because of geography and the policy frameworks that exist in the different countries. In addition to summarising the priorities for the UK, the *UK Climate Change Risk Assessment 2017 Evidence Report* identifies the priorities for each of the countries in the UK in separate national summaries. These are based on the UK-wide assessment, but take account of the particular risks to each country and where urgent action is required.

The six priority risk areas identified in the second CCRA, where action is needed in the next five years, are summarised below.

i) *Flooding and coastal change risks to communities, businesses and infrastructure*

The *Evidence Report* presents compelling evidence that climate change may lead to increases in heavy rainfall and significantly increased risks from fluvial and surface flooding by mid-century. Rising sea levels may further increase the risk of flooding and erosion along our coastline. The *Evidence Report* recommends more ambitious approaches to adaptation, working with communities, businesses and other partners to meet this challenge by:

- ensuring there are long-term strategies in place to address projected risks to people, communities and buildings;
- delivering more natural flood management and developing a more integrated approach in high-risk catchments, especially where there are likely to be co-benefits such as carbon storage, water quality and biodiversity benefits.

ii) *Risks to health, well-being and productivity from high temperatures*

Warming UK temperatures, combined with demographic change, may lead to an increased risk of overheating. The evidence report projects that the number of heat-related deaths in the UK could more than double by the 2050s from a current baseline of around 2,000 per year. It states that urgent action is needed in the next five years across a range of policy areas to address overheating in homes and public buildings and to reduce the impacts of the urban heat island effect through urban design and planning. Further information is needed on impacts

of overheating on employee productivity and further research is needed to understand the influence of climate change on ground-level ozone and other outdoor air pollutants (especially particulates), and how climate, temperature and other factors (eg individual behaviour) affect indoor air quality.

The *Evidence Report* also notes some potential opportunities associated with higher temperatures. Outdoor activities may become more attractive, with perhaps an increase in active transport, such as cycling, and walking leading to benefits for health and wellbeing, as well as climate change mitigation from reductions in car use. However, these benefits need to be set against the potential for greater exposure to the risks from sunlight, ultraviolet radiation and air pollution. Warmer winters could also lead to fewer cold-related deaths, which currently account for a greater number of excess deaths than periods of very hot weather. Cold spells and snow storms interrupt travel for patients and staff. Fewer cold events in future will benefit health system management. Several estimates of the reduction in cold-related mortality exist. Hajat et al (2014) estimated that cold-related mortality would decline by 2% in 2050 from a baseline of around 41,000 deaths. The benefit from climate warming will not be sufficient to reduce the need for public health interventions for cold.

iii) *Risks of shortages in the public water supply, and for agriculture, energy generation and industry, with impacts on freshwater ecology*

Climate change combined with population growth may put greater pressure on water availability. By the 2050s, many catchments across the UK will need to manage water deficits and competing demands for water for public supply, industry, agriculture and the environment. The Evidence Report recognises that the policy framework for managing these long-term risks exists. Continued action will be needed that is flexible enough to take account of the high degree of uncertainty about future projections of seasonal rainfall and therefore the frequency and intensity of water shortages and drought.

iv) *Risks to natural capital, including terrestrial, coastal, marine and freshwater ecosystems, soils and biodiversity*

There are significant threats to our natural capital and the goods and services it provides, from timber, food and clean water to pollination, carbon storage and the cultural benefits of landscapes and wildlife. The Evidence Report shows that direct impacts on the distribution of UK species and the composition of terrestrial, coastal, marine and freshwater ecosystems are already being observed. There is clear evidence of northwards shifts in species distributions and the timing of seasonal events due to climate change.

The Evidence Report highlights important links between climate change impacts on natural capital and the other risk areas. For example, the natural environment plays an integral role in the quality and availability of our water and on the magnitude of flood events. It provides the backdrop to the movement of pests and diseases, and can play a role in addressing overheating through urban trees and green spaces.

The report also identifies potential opportunities for agriculture and forestry in the form of extended growing seasons, increased productivity and new crop varieties that would have potential benefits for domestic food production. In order for these opportunities to be realised, however, there is a need to manage the negative impacts from reduced soil quality and water availability and the increase in flooding and pests and diseases.

The Evidence Report concludes that, while good progress is being made, strengthened action is needed over the next five years to reduce existing pressures on the environment. More

flexible and integrated approaches to managing natural capital need to be adopted and priority research undertaken into the changing suitability of land for different uses and the climate risks to marine ecosystems.

v) *Risks to domestic and international food production and trade*

Extreme weather can affect international food production, trade and supply chains. Longer-term incremental changes in climate will affect agricultural productivity in regions that are important for food production. At the same time, climate change will present risks and opportunities for domestic production, with the resilience of UK food systems dependent on the stewardship of natural resources including soils and responses to international markets. The resilience of food supply chains is regularly tested by severe weather and other events, and consistently performs well. However, food production and security is still a clear research priority.

vi) *New and emerging pests and diseases, and invasive non-native species, affecting people, plants and animals*

New and emerging pests and diseases – including invasive non-native species – have the potential to cause severe impacts on people, animals and plants. The evidence report concludes that there is an urgent need for research in the next five years to improve our understanding of how climate change will affect the threat of pests and diseases and the best approaches to monitor, detect and manage outbreaks and develop resilience to disease (eg through developing new crop varieties and breeding techniques). It finds that the evidence is not yet clear as to what extent surveillance is effective in identifying risks, or whether resources are prioritised towards those vectors and pathogens that pose the biggest challenge in the changing climate. Research is also needed to improve the evidence about the impact of endemic diseases in a changing environment.

5.3.3 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, we continue to develop the 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.

Living with environmental change (LWEC) was a network of 20 UK public-sector organisations that funded, carried out and used environmental research. The LWEC Network enhanced the impact of the UK's publicly-funded environmental change research, evidence and innovation by enabling members to co-ordinate strategic activities. By leveraging resources and avoiding duplication, network members could be more efficient in their use of public funds to give decision-makers the knowledge they need to make informed responses to environmental change. UK Government supported LWEC to develop Climate Change Impact Report Cards. There are report cards on Biodiversity, Water, Agriculture & Forestry, Health and Infrastructure, with more in development. The cards provide a summary of the latest scientific research on the impacts of climate change on the UK. Some of this work is now taken forward by LWEC's successor, the Research and Innovation for our Dynamic Environment (RIDE) Forum. This forum includes 19 public sector organisations which enhances the impact of the UK's publicly-funded environmental change research, evidence and innovation by enabling members to coordinate strategic activities.

The UK Met Office provides world-leading weather forecasting and climate modelling and shares this expertise with countries around the world. The UK Met Office works in partnership

for sustainable development through worldwide delivery of weather and climate services. These services aid planning to protect against disasters, underpin socioeconomic growth, inform policy and help societies prepare for and adapt to the impacts of climate change.

UK government funds the Met Office Hadley Centre Climate Programme that provides world-leading climate science that supports the UK's contribution to international initiatives, including the Intergovernmental Panel on Climate Change and country capacity building projects funded through the UK Government's Newton Fund. Met Office science is integrated into European and international science initiatives such as the European Commission Horizon 2020 projects and the Grand Challenges of the World Climate Research Programme, and through the expanding agenda of climate services being supported by the Copernicus programme and the World Meteorological Organisation's Global Framework for Climate Services.

5.4 Examples of adaptation in the UK

There are many examples of adaptation in practice in the UK. The first NAP alone sets out over 370 actions focusing on the highest order risks from the CCRA. The sixth communication set out an extensive range of policy approaches, examples and case studies on adaptation to climate change across the whole of the UK organised by each of the thematic areas covered by the first UK NAP. Following are some further examples of adaptation actions and approaches across the UK administrations which add to those reported in the sixth national communication.

This is far from an exhaustive list. 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 an overview of UK adaptation actions. Assessments of progress by the Adaptation Sub- Committee provide a comprehensive oversight of adaptation actions and progress in the UK. Many more assessments and progress reports across the range of UK administrations' activities outline the ways in which climate risks and the need to adapt to a changing climate are integrated within the UK's broader policies and programmes.

5.4.1 The climate ready support service

The Climate Ready Support Service for England, established in October 2011 and provided by the Environment Agency, completed its work programme in March 2016. The service provided advice and support to businesses, the public sector and other organisations to enable them to adapt to the changing climate. The service helped organisations build their own capacity to adapt by incorporating climate risk management into their plans and decision making. The Service covered England only, but the products generated are available for use across the UK and elsewhere and continue to support organisations in identifying and addressing the risks that they face.

The support service complemented the 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.

The service was 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 EA worked with local authorities, other government bodies, business sectors and civil society, and partners such as the Local Government Association and the Climate Change Partnerships across England. Support was tailored to key themes which mirror those in the NAP.

By 2016 the majority of NAP actions to which the CRSS Service was contributing were either complete or ongoing without the need for support from the service. The CRSS produced or supported a range of tools and products to help organisations in preparing for climate change which remain available to support UK businesses and communities adapt to climate change. For example:

- Guidance on resilient local highways, business continuity, a resilient built environment, making the case for adapting the built environment, tackling overheating, adaptation for health and social care, the paper and pulp sector, chemicals businesses, and the food and drink sector, resilient supply chains, farm business resilience, business opportunities, and climate-proofing health and wellbeing strategies, adaptation in the natural environment, and a quick guide for small and medium-sized businesses.
- Tools to better understand social vulnerability and climate change, monitor impacts of severe weather, assess climate impacts on businesses, business resilience and farm business resilience, analyse the costs and benefits of adaptation, project climate change impacts on wetlands, assess the climate resilience of catchment management methods, and develop a practical action plan to increase resilience.
- A series of case studies on Nestle, Greencore, North Somerset and Lostwithiel flooding, health impacts, use of the SHAPE tool, and how Kent, Newcastle, Hull, Bristol, and East Sussex councils and the Greater London Authority are adapting to climate change.
- Qualifications in business resilience.
- Support for local councils through the Climate Local initiative, with associated resources and publications.
- Information on future flows and groundwater levels.
- Information on resilient growth for local economic growth investment and a review of good practice for Local Enterprise Partnerships.
- Natural England and the RSPB, in partnership with the Environment Agency's climate ready support service and the Forestry Commission published the 'Climate change adaptation manual: evidence to support nature conservation in a changing climate' to support conservation practitioners in adapting to climate change.

5.4.2 Adaptation Reporting

The Climate Change Act enables UK government to direct relevant organisations, such as public bodies and infrastructure providers, to report on the progress being made in adapting to climate change. Since the Climate Change Act 2008 entered into force the adaptation reporting process has been through two cycles. First, in 2009, reporting focused on major infrastructure providers from the energy, transport and water sectors and 91 organisations were directed to report with a number of other organisations also invited to report. Statutory guidance was published to guide reporting organisations on the content of their submissions and a formal evaluation of reports was carried out. In total, 105 organisations took part.

The second cycle of adaptation reporting started in 2013, taking a voluntary, light touch and flexible approach to reporting, which was supported by stakeholders who responded to the consultation. This, contrary to the first cycle of reporting, was a 'bottom-up' approach and no formal guidance was offered to reporting organisations. In total, 86 organisations took part.

Evaluation of both reporting rounds found that the reporting process made a significant contribution to driving adaptation. It helped organisations identify and appreciate climate risks to services, assets, and functions, thereby supporting the creation of programmes of activity to improve their understanding of risk. Reporting was considered important in driving the planning of adaptation work and in gaining organisational, senior level and external engagement. It also gave legitimacy to climate adaptation issues within sectors and demonstrated action/resilience to stakeholders. It provided a catalyst for discussion and, ultimately, action on climate change. The reports were considered a useful communication tool to gain strategic buy-in and presented opportunities for partnership and sector engagement. Reporting gave coherence to policy frameworks across different areas and assisted the mapping of new policy proposals, such as in the financial sector. It also demonstrated that organisations were already adapting to climate change and mitigating their specific climate change risks. Some sectors were particularly advanced and were running their own research programmes on adaptation.

5.4.3 Natural environment and biodiversity

As with climate change, the protection of biodiversity and the natural environment is a devolved matter in the UK. Each of the four countries of the UK has developed plans or strategies for implementing the UK's commitments under the Convention on Biological Diversity. These commitments include taking action for species and habitats as well us for protecting and enhancing the 'services' or benefits we gain from our natural world such as food, clean water, clean air, improved health and wellbeing. UK action is coordinated through the UK Biodiversity Framework and the UK Marine Strategy.

In England, the UK Government is committed to publishing a 25 year environment plan. The Plan will set out the Government's vision for cleaner air and water, richer habitats for more wildlife and an approach to agriculture and land use which puts the environment first.

The UK government approach to conserving and enhancing biodiversity in England is set out in Biodiversity 2020, our strategy for England's Wildlife and Ecosystem Services and is supplemented by our National Pollinator Strategy. Marine biodiversity is conserved and enhanced through the UK Marine Strategy.

For biodiversity on land, we have two main approaches to strengthening resilience to climate change, alongside strengthening of the evidence base. First, we are taking action to reduce wildlife's vulnerability to climate change by protecting, managing, restoring and creating priority habitats. We do this primarily through the designation and management of protected sites on land and at sea, through our agri-environment schemes, or by supporting voluntary action. Second, we are taking action to reduce other sources of pressure on our priority species and habitats such as water quality or air quality.

There has been progress with protecting and enhancing important wildlife habitats. For example, the total extent of land and sea protected in England through national and international protected areas increased from 1.2 million to 2.3 million hectares between 1999 and 2016;

an increase of 94%, the bulk of which has been through designation at sea with the area of protected marine sites within the 12 nautical mile limit increasing from 295,000 to over 1.3 million hectares between 2011 and 2017 (based on data up to the end of 2016)[154].

On land and in our freshwaters we have continued to take action to put the right management in place on over 1 million hectares of protected sites to restore and maintain their condition or value for wildlife. Across the country there has been an overall increase of around 5,000 hectares of SSSIs achieving 'favourable' condition in the year between April 2016 and April 2017.

Various policies are already in place to address climate risks to natural capital. For example, increased efforts to restore the hydrology of wetland habitats are under way as part of Countryside Stewardship, and the Forestry Commission is working to protect, improve and expand woodlands on the Public Forest Estate.

The UK government has undertaken investigations into the impacts of climate change on plant health and the potential for climate change to increase the risk from pests. This work will lead to improvements in our risk assessments to ensure that we target the pests and diseases that pose the greatest risks.

The UK Plant Health Risk Register, accessible through the new UK Plant Health Information Portal, compares risks posed by different plant pests and pathogens and prioritises actions. We carry out collaborative horizon-scanning and information-sharing activities with international organisations, such as the European and Mediterranean Plant Protection Organisation, to provide early warning of new pest threats.

The approach in the marine environment has been to improve its resilience by reducing pressures from human activities, for example moving towards fishing mortality maximum sustainable yield (FMSY) and setting up marine protected areas. We have already made considerable progress towards sustainable fishing. For 2017, 29 stocks that are of interest to the UK and that are maximum sustainable yield (MSY) assessed will be fished at or below their MSY compared to 25 in 2016. Over the same period the number of stocks with full analytical MSY assessments has also increased, from 35 to 45.

The Scottish Biodiversity Strategy: 2020 Challenge for Scotland's Biodiversity recognises the need to help nature adapt to climate change, for example through reducing pressures on ecosystems, habitats and species, and making space for natural processes. Ecosystem restoration priorities include peatlands, coastal sand dunes, native woodlands and establishment of saltmarsh to improve resilience to climate change. The Route Map to 2020 sets out large-scale, cooperative actions that will improve ecosystem health so helping nature to adapt to climate change. Progress will be reported to the Scottish Parliament in 2017. Future priorities for action will take account of biodiversity pressures including climate change.

Scotland's Climate Change Plan committed to supporting 10,000 hectares of restoration rising to 20,000 hectares pa in future years, which will be supported by a monitoring strategy which will ensure that restoration delivery is monitored, recorded and reported.

The Environment (Wales) Act 2016 puts in place the legislation needed to plan and manage Wales' natural resources in a more proactive, sustainable and joined-up way. It delivers against

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[154] Source: https://www.gov.uk/government/statistics/england-biodiversity-indicators. Note that this areas is increasing rapidly in the marine environment, and is likely to have increased significantly since this latest statistical publication. The area designated in UK waters, beyond the 12 mile limit is significantly higher. UK figures are published here: http://jncc.defra.gov.uk/page-4241

our Programme for Government commitment to introduce new legislation for the environment. This positions Wales as a low carbon, green economy, ready to adapt to the impacts of climate change.

It will mean significant economic, social and environmental benefits for Wales. It has been carefully designed to support and complement our work to help secure Wales' long-term well-being, so that current and future generations benefit from a prosperous economy, a healthy and resilient environment and vibrant, cohesive communities. Part 1 of the Act addresses the sustainable management of natural resources, focussing on enabling Wales' resources to be managed in a more proactive, sustainable and joined-up way. It also helps to tackle the challenges we face, including climate change, and is focused on the opportunities our resources provide.

5.4.4 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.

Following formal consultation in January 2016 Government published a range of approaches to address the challenges of climate change, population growth and which will better protect the environment. We are now preparing to launch a water abstraction plan in 2017, explaining how reform will be implemented over the coming years.

The Water Abstraction plan outlines three main approaches to address existing issues. We intend to make full use of existing regulatory powers and tools to address unsustainable abstraction and meet environmental objectives. A stronger catchment focus that brings together the Environment Agency, abstractors and catchment partnerships to develop local solutions that address current pressures and prepare for the future will be at the heart. These local solutions will protect the environment by changing licences to better reflect water availability in catchments and reduce the impact of abstraction. Access to water for abstractors will also be improved by introducing more flexible conditions that support water storage and water trading.

To support these reforms we will modernise the abstraction service, ensuring all significant abstraction is regulated through the removal of exemptions and bringing regulations in line with other environmental permitting regimes.

Defra invests over £1M per year on breeding programmes to undertake targeted genetic improvement in livestock and major UK crops. These programmes are specifically designed to improve resource use efficiency, enhance sustainability and build resilience to biotic and abiotic stresses.

Beyond water management, Defra invests over £1M per year on breeding programmes to undertake targeted genetic improvement in livestock and major UK crops. These programmes are specifically designed to improve resource use efficiency, enhance sustainability and build resilience to biotic and abiotic stresses.

The Sustainable Intensification Research Platform (SIP, launched in 2014) aims to provide robust evidence to inform the farming industry's drive for sustainable intensification. The three SIP's linked and transdisciplinary research projects comprise: 1. Integrated Farm Management for improved economic, environmental and social performance, 2. Opportunities and risks for farming and the environment at landscape scales, and 3. A scoping study on 'The influence of external drivers and actors on the sustainability and productivity of English and Welsh farming'.

The Rural Development Programme for England 2014-2020 embeds climate resilience, whereas the Payments for Ecosystem Services provides a means of rewarding farmers for delivering important services, including adaptation measures, which benefit wider society.

Other activities include the UK Agri-tech strategy (launched in 2013). Agri-tech strategy investments include research and knowledge exchange in crop and livestock genomic, agri-engineering, genetics, health in crops and livestock and energy generation from waste, amongst other topics.

Forestry

Forestry research and international policy are reserved issues while domestic forestry policy is devolved to country administrations.

The UK Forestry Standard was revised in 2017 and underpins forestry incentives (including for woodland creation), regulations and management planning and its Forests and Climate Change Guidelines include requirements that aim to promote climate adaptation:

- When selecting trees and shrubs for new woodlands and restocking, consider the risks and opportunities of climate change and vulnerability to pests and diseases for particular species to decide if alternative species or increased species diversity are merited.
- Plan for forest resilience using a variety of ages, species and stand structure; consider the risks to the forest from wind, fire, and pest and disease outbreaks.
- Review forest rotation lengths in response to changing productivity and wind risks, and review planting seasons in response to changing conditions and establishment success.
- Review species suitability and diversity over time as forest management plans are renewed.
- Where timber production is an important objective, consider a wider range of tree species than has been typical of past planting, and consider the use of planting material from more southerly origins. Consider suitability under both current climate and 2050s High emissions projections inform the choice.

In 2015 the Forestry Sector Climate Change Working Group published a survey[155] of progress in complying with the adaptation measures in the UK Forestry Standard's Forests and Climate Change Guideline, alongside a Climate Change Accord[156], and the Forestry Climate Change Working Group (FCCWG) aims to publish an Action Plan for Forestry and Climate Change Adaptation in early 2018.

Government continues to advocate and support woodland expansion with objectives including increased resilience of the woodland resource and, through strategic targeting, helping society to adapt to the impacts of climate change. In England, Rural Development Programme woodland creation grants have supported the planting of 7,400 hectares of new woodland during the past five years. The Woodland Creation Planning Grant and Woodland Carbon Fund have also been introduced to support the planting of large scale, productive woodlands.

There is currently an active programme (advocacy and grant support) to increase the level of management in England's woodlands, particularly broadleaf woodland, providing opportunities

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[155] https://www.sylva.org.uk/downloads/BWS2015report.pdf

[156] http://sylva.org.uk/forestryhorizons/downloads/Climate_Change_Accord_2015.pdf

for adaptation measures to be implemented. The percentage of woodland in active management increased from 53% at 31st March 2013 to 58% at 31st March 2017. The long-term target for woodland in active management (80%) will be reviewed in 2018.

The Science and Innovation Strategy for Forestry in Great Britain was reviewed and revised in 2014, with three of the research programmes providing a focus on resilience.

The Forestry Commission reviewed its Adaptation Reporting Power report[157] in 2016, including the Climate Change Action Plan for the Public Forest Estate and identified three key risks to be addressed over the next five years: lack of species diversity, low level of woodland management and tree health.

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 Scotland, the Scottish Forestry Strategy (2006)23 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.
- Early in 2013 Forestry Commission Scotland published a Climate Change Programme24.

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.

Forestry Commission Scotland latest actions include:

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[157] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/596766/climate-adrep-forestry-commission.pdf

- The launch of a stand-alone Forestry Grant Scheme, as part of Scotland's Rural Development Programme, in 2015. The scheme contributes towards the Scottish Government target of 10,000 hectares of new woodlands per year; and the sustainable management of existing woodlands and includes funding for new woodland creation and the management of existing forests.
- The revision of the UK Forestry Standard and the associated Climate Change Guidelines that sets out legal and good practice requirements on dealing with both risks and opportunities presented by climate change.
- Ongoing funding for tree health research and collaborative action.
- New guidance for forest management on how to prepare long-term forest plans.
- The launch of work to improve the condition and connectivity of native woodlands, for new native woodland planting, bracken control and protection with fencing.

Forestry and Woodland Strategies aim to encourage a move towards planning and managing well-structured and diverse forests that can better withstand change and extreme events. Forestry and Woodland Strategies are updated by local authorities in order to reflect current National and local forestry policy. Climate Change considerations therefore need to be considered when developing Forest Plans and Woodland Creation projects. In addition we promote the benefits of habitat connectivity and habitat networks, including integrating forest and open habitat networks for biodiversity. In priority native woodland habitats

FCS continues to promote actions to facilitate adaptation including encouraging natural regeneration, increasing native woodland creation and developing forest habitat networks. FCS also work to halt the loss and fragmentation of existing priority habitats. FCS continues to support research, trials and demonstration sites to identify appropriate species and provenance choices which take account of projected changes in climate.

In Wales, responding to climate change is one of the key themes in the forestry strategy, Woodlands for Wales.25 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 accompanying Action Plan, which runs to 2020, includes action for the creation 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.

5.4.5 Healthy and resilient communities

The CCRA Evidence Report (2017) states that increasing temperatures, rising sea levels and modified rainfall patterns will change the climate-related risks in the UK. Climate Change will create new challenges for those working in planning, community development, the health and social care system, flood and water management, and emergency preparedness. Flooding and extreme hot weather pose the highest magnitude risks and the greatest need for action in the next five years. There are some potential benefits from reduced cold and opportunities from warmer weather.

The health sector including the Department of Health, Public Health England, NHS England, the Sustainable Development Unit and local partners responsible for the delivery of health and social

care 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.

Public Health England publishes the *Heatwave Plan for England* to manage the risks of hot weather to public health. This is a key component of emergency planning that provides advice for professionals, organisations and individuals to enable them to plan for and respond to hot weather. Both the Heatwave and Cold Weather Plans for England are accompanied by public and professional supporting material and resources (e.g. a checklist for identifying and managing overheating in care homes). The Cold Weather Plan for England was independently evaluated in 2012-13. An evaluation of the Heatwave Plan for England is currently underway and a report is due in 2019.

Local risk assessments overseen by the local health and wellbeing boards across England provide an important vehicle to highlight climate risks to health, for example the mental health impacts of flooding or the risks from overheating.

The UK has a proven system in place for monitoring international disease threats to human and animal health. As an example, Public Health England undertakes invasive mosquito surveillance with 30 seaports and airports and at key goods importers and motorway service stations leading away from ports of entry in south-east England. Work is undertaken collaboratively with industry to assess and manage pest risk, such as on Bluetongue disease and the Schmallenberg virus. An international forward look also improves forecasting of outbreaks by seeking to identify links between meteorological data and geophysical impacts, and public and animal health threats.

Public Health England also has a role in providing advice and guidance on the building of healthy sustainable housing, neighbourhoods and communities, which can contribute both to the mitigation of and adaptation to climate change. This includes working with other government departments, for example in influencing the National Planning Policy Framework and the 25 Year Environment Plan to achieve health and climate change co-benefits and providing guidance for planners and developers through the Spatial Planning for Health guidance as well as joint work with the Town and Country Planning Association. In addition PHE is supporting the NHS Healthy New Towns programme, which is working with 10 sites across the country to explore how sustainable and healthier development principles can be embedded into an area from the outset and how these can contribute, not only to improve the health outcomes of the community, but also its resilience.

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. It 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.

Using funding from the National Centre for Resilience, Scottish Government has commissioned Health Protection Scotland to conduct a study into the link (or absence thereof) between hot and cold ambient temperature and mortality and morbidity. This will enable the design of evidence based interventions in response to extreme weather events related to climate change. SG are also working with HPS to scope proportionate research into the climate change related risks to public health from vector borne disease.

Scotland has a strong focus on healthy and resilient communities and within this policy agenda, domestic climate justice, because climate change impacts most severely on poor people and vulnerable communities. The report Mapping Flood Disadvantage in Scotland 2015 assesses social vulnerability for the key risk of flooding to help people working in flood risk management, resilience, emergency services, public health, social care, housing, and the environment.

5.4.6 Flooding

The National Flood and Coastal Risk Management Strategy for England provides an overaching framework for future action by all risk management authorities to tackle flooding and coastal erosion in England, within which communities have a greater role in local risk management decisions. 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.

Under the Flood and Water Management Act 2010 Lead Local Flood Authorities (LLFAs) have responsibility for local flood risk management ensuring flooding from local sources, which includes surface run-off, is identified and managed as part of a local flood risk management strategy. LLFAs have to consult the public and other Risk Management Authorities (RMAs) in their area on the strategy. The strategy must for example include an assessment of the local risk, the objectives for managing the risk, and the measures proposed to achieve the objectives. In addition to managing local sources of flood risk effectively LLFAs have to work in partnership with other RMAs and have the flexibility to form informal partnerships. The act also requires RMAs to co-operate and exchange information.

The UK's flood risk investment programme is driving down the overall risk of flooding and coastal erosion to ensure that we will better protect over 300,000 homes from flooding by 2021. Investments are based on a well-developed national flood risk assessment and long-term investment scenario modelling developed by the Environment Agency, which already factors in climate change predictions and continually evolves to take account of new climate change evidence and risks. The long-term investment scenario modelling considers differing investment scenarios in the face of pressures such as climate change and asset deterioration and takes into account total levels of investment, not just government investment.

The National Flood Resilience Review was published in September 2016 and sets out actions to improve our readiness for flooding in the short term, to reduce the impacts and the consequent costs and disruption to communities, businesses and our economy. This includes working with infrastructure operators to improve the resilience of locally important assets at risk of flooding. It also set out a new stress test of the risk of flooding from rivers and the sea in England so that for the first time, Met Office forecasts of extreme rainfall scenarios have been linked with EA modelling to provide a new assessment of flood risk. The review is also informing our consideration of long-term investment needs and funding options..

Climate change means Wales faces an increased risk of flooding, not only through sea level rise but also from all sources of flooding, particularly due to more frequent and intense storms. Flood and coastal risk management remains a priority for the Welsh Government. During 2017/18 we will be investing over £54 million across Wales. The 4 year capital funding allocation for flood risk management will allow us to plan more effectively, providing certainty of funding from one year to the next.

Wales are planning for future coastal risk by working alongside local authorities to develop a programme of capital investment in coastal risk management commencing in 2018/19. The Coastal Risk Management Programme provides the opportunity for local authorities to invest up to £150 million in the coastal infrastructure protecting our coastal communities, adapting to the challenge of climate change and sea level rise and achieving wider benefits. Work across government departments includes regeneration and tourism to achieve wider wellbeing goals through the schemes. £5 million funding has been allocated to continue the preparatory work in 2017/18.

Wales are currently reviewing the National Strategy for Flood and Coastal Risk Management with an update planned for 2017/18. This provides an opportunity to set out longer-term objectives and underline the approach to managing risk. In carrying out this review we will be working alongside risk management authorities as well as other government departments.

A new Development Advice Map, aligned with the NRW Flood Map was launched in spring 2017 providing a single site for all flood risk mapping advice to public, developers and local authorities alike.

The Welsh Government publishes climate change adaption guidance for use by Risk Management Authorities when developing Flood Risk Management Schemes and Strategies. The current guidance note will be refreshed in 2017 to ensure that it aligns with corresponding Planning guidance and reflects the most up to date assessment of UKCP09 data.

In Scotland, the National Flood Risk Assessment published in December 2011 provided the first 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.

The first set of Scotland's flood risk strategies based on the National Flood Risk Assessment were published in December 2015. The second National Flood Risk Assessment is being developed and will be published in 2018.

Guidance supporting the building standards in Scotland now 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.

This means that the capacity to adapt to changes in climate is considered in more detail during the building design and construction process.

5.4.7 nfrastructure

Infrastructure operators are vulnerable to a range of climate impacts, as set out in the CCRA and outlined from recent weather events, such as the National Flood Resilience review of events following the storms and floods of 2015-2016, and the Transport Resilience Review following the weather events of 2013-2014.

The National Risk Assessment (NRA) and Sector Resilience Plans (SRPs) identify key risks and vulnerabilities facing our Critical National Infrastructure (CNI). Climate Change is addressed as part of these processes, as a key driver of some of the risks. A number of different mechanisms are in place to assess and address risks and implications from climate change, from price review processes overseen by the regulators to Sector Security Resilience Plans. The Adaptation Reporting Power (ARP) also plays a role in helping reporting organisations understand and take action to address climate related risks. The National Risk Assessment and Sector Resilience Plans should contribute to proportionate approaches to increasing resilience over time. Reporting under the Adaptation Reporting Power should make transparent the actions economically regulated sectors are taking towards this goal.

Nationally significant infrastructure projects (NSIPs) are consented through the nationally significant infrastructure regime. Planning policies for NSIPs are set out in National Policy Statements, which includes policies on adapting to climate change, and are informed by an appraisal of sustainability. Where National Policy Statements have a spatial element, for example on Nuclear Power and Waste Water Treatment these spatial choices are strongly influenced by climate change considerations and, as with other national policy statements, are subject to Strategic Environmental Assessment as part of the appraisal of sustainability. Cumulative environmental impacts are considered as part of the appraisal of sustainability and environment impact assessment of individual projects.

5.4.8 Water resources

The UK Climate Change Risk Assessment Evidence Report sets out how climate change combined with population growth may put greater pressure on water availability. By the 2050s, many catchments across the UK will need to manage water deficits and competing demands for water for public supply, industry, agriculture and the environment. The Evidence Report recognises that the policy framework for managing these long-term risks is in place.

In 2016 the Government published “Enabling resilience in the water sector”, our policy framework to meet the demands of climate change and a growing population on the water sector. It sets out plans to enhance resilience in the sector. In March 2017, the Government announced that a national policy statement for water resources will be developed. This will support the timely delivery of large water resources infrastructure, including reservoirs and water transfers, which are expected to be required alongside demand management, to ensure future resilience in the sector. The need for these schemes is identified in water companies water resources management plans.

Water companies are required to prepare statutory plans to ensure a secure supply of water. This includes long-term (25 years at least) strategic water resources management plans and tactical drought plans. Water companies must update their plans at least every five years. The plans must take account of the latest evidence on the impacts pressures such as climate change will have the supply and demand of water in the future.

The Water Strategy for Wales sets out our strategic direction for water policy over the next 20 years and beyond. Water is one of our greatest natural assets and an integral part of Wales’ culture, heritage and national identity.

The strategy highlights the Welsh Government's vision to ensure that Wales continues to have a thriving water environment which is sustainably managed to support healthy communities, flourishing businesses and the environment. We want the people of Wales to receive first class, value for money, water services with water used efficiently, safely and respectfully by all.

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.

The 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 March 2016, the Northern Irish Department of Agriculture, Environment and Rural Affairs launched Sustainable Water – A Long Term Water Strategy for Northern Ireland (2015-2040). This cross-Departmental strategy contains a long-term vision to manage flood risk and drainage in a sustainable manner, which will help to address the future risks from climate change

5.4.9 Local government

The impacts of climate change and severe weather conditions will vary from location to location and are thus often most effectively managed at a local level. Local authorities are key partners in delivering many aspects of the National Adaptation Programme. They are responsible for a significant number of risks and areas relating to climate change including flood management, civil contingencies and planning.

Local government responsibilities should be considered in the context of the Localism Act 2011 and the Cities and Local Government Devolution Act 2016 which gives local government functions, freedoms and flexibilities as well as responsibilities and governance. UK government engages on adaptation with local government, including the availability of tools and guidance, via different forums, or groups such as the Local Adaptation Advisory Panel, the Core Cities group and the Local Government Association.

Online tools and best practice for councils are available through the sites of delivery agents, such as Climate UK/London Climate Change Partnership, to enable councils to improve and develop their ability to adapt to climate change. For instance, there is a template business case available for councils.

Planning policy and legislation already sets a clear expectation that local planning authorities will take account of climate change and seek to mitigate and adapt to its impacts. There is a statutory requirement under section 19(1A) of the Planning and Compulsory Purchase Act 2004 for local planning authorities to include policies in their local plan designed to contribute to the mitigation of, and adaptation to, climate change.

The National Planning Policy Framework sets out how, through both local plan-making and decision taking, planning authorities should support the transition to a low carbon future in a changing climate and minimise vulnerability to the impacts of climate change. These are considerations when a local plan is examined and before it can be adopted. Once adopted, the local plan provides the primary basis (subject to other material planning considerations) for planning decisions in the local authority's area.

Beyond this in England, there is still an ongoing and wider (voluntary) area of collaboration at a local and sub-national level. The Core Cities collaborate, share best practice and support each other to further action on adaptation via the Core Cities group. Officer level efforts on adaptation

feeds up via policy hubs into wider Core City action and influence as well as supporting areas around adaptation such as risk and vulnerability assessment and direct adaptive measures. This complements and adds to the spatial planning work above. This is also linked more widely with the wider local government ask and offer around adaptation via the Local Adaptation Advisory Panel which directly links with and reports up to and central government via Defra as lead department. Through this way a wider picture of the landscape and activity is understood and will influence the ambition and content of things like the next NAP. However, in the absence of a more formal reporting arrangement as exists for the devolved administrations outlined below, this is scaled to reflect the available resource.

In Wales, specific environmental grants are provided to local authorities for delivery against Ministerial priorities and multiple benefits in support of the Well-being of Future Generations (Wales) Act 2015. Local Authorities are required to submit a detailed spending proposal annually, clearly outlining how their proposals align to these goals.

Local Authorities are each issued with a formula based grant allocation and they are able to use this funding to deliver against the key priorities of the Directorate:

- Better Management of our Natural Resources, including Biodiversity and Floods
- Waste and Resource Efficiency
- Local Environment Quality

Local Authorities are key partners in the Public Service Boards (PSBs), which are required to consider climate change in their assessment of local well-being.

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.

The Climate Ready Clyde Partnership is a collaborative partnership initiative aimed at developing a regional structure for adapting to climate change, to accelerate work on adaptation within the Glasgow City Region. 10 partners from the City Region, comprising 6 local Councils, NHS Greater Glasgow and Clyde, SPT, University of Glasgow and University of Strathclyde have formally agreed to pool their resources, alongside Scottish Government, to fund a regional secretariat, delivered by Sniffer.

The secretariat will assess the risks and opportunities presented by climate change, and work with partners to develop a strategy and action plan for the City Region.

The Scottish Government provided £100,000 seed funding to get Climate Ready Clyde up and running and has enabled the City Region to be a demonstrator for research, with £4.5m of NERC-funded research being undertaken on climate adaptation as a result.

Climate ready Clyde was formally launched at the European Climate Change Adaptation Conference in June 2017, as a transformative initiative showing that collaboration helps to improve resilience and adaptation to a changing climate brings many other positive benefits - boosting local economies, reducing inequalities, improving public realm, protecting natural resources and attracting investment.

It is hoped now that the Partnership's work will make a significant contribution towards securing the long term climate resilience of a third of Scotland's population and a city region that generates £40Bn GVA per year - a third of Scotland's economic wealth. Going forward, the area-based approach will link into resilience initiatives in neighbouring parts of Scotland, and will be able to be extended across other regions of Scotland.

5.4.10 international cooperation on adaptation

Part 6 of this seventh national communication sets out how the UK is helping developing countries manage risk and build resilience to the impacts of climate change and builds on the progress reported in part 5.7 of the UK's sixth national communication. We also work closely with the European Union and its Member States on adaptation as detailed in part 5.7 of the sixth national communication. This work has continued since the previous communication through contributions to assessments and the sharing of best practice, in particular through Climate Adapt, the European climate adaptation platform. We continue to work to ensure that adaptation is integrated within European policies and programmes relating to vulnerable sectors.

Chapter 6 – Financial Assistance and Support for Technologies

6.1 Key developments

- Building on the provision of £3.87 billion in **International Climate Finance (ICF)** between 2011/12-2015/16, the UK has committed to further scale up climate finance to at least £5.8 billion between 2016/17-2020/21[158]. The UK's ICF helps developing countries mitigate and adapt to the impacts of climate change, reduce deforestation and pursue clean economic growth. The ICF is focussed on transformational change, reflecting the scale of the challenge of climate change. This includes unlocking the potential of the private sector, with UK ICF funding mobilising £500 million in private finance to date.
- Since 2011, the UK has used its ICF to install more than 400 megawatts of clean energy capacity and to reduce or avoid 9.2m tonnes of CO_2. These impacts will continue to grow as new and ambitious programmes like the £177.5 million Sustainable Infrastructure Programme are delivered. The UK continues to apply and share lessons learned from its extensive ICF monitoring & evaluation framework, improving effectiveness and enhancing transparency.
- Recognising that adaptation is a priority for many developing countries, the UK aims to spend half of its climate finance on adaptation, and achieved this aim in 2016. Since 2013, the UK has provided over £1.4 billion to in climate finance for adaptation. To date, the UK's ICF has supported more than 34 million people adapt to the impacts of climate change.
- The UK is committed to an effective international climate finance architecture, and has been one of the largest contributors to major multilateral climate funds like the Green Climate Fund (£720 million) and the Climate Investment Funds (£2 billion). The UK has also supported multilateral development bank ambition as they scale up their activities towards their 2020 climate finance pledges.
- The UK has supported international knowledge generating organisations such as the Intergovernmental Panel on Climate Change and has committed to global initiatives aimed at accelerating clean energy like Mission Innovation.

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[158] financial years 2011/12 to 2014/15

- In 2015, the UK, Germany and Norway (GNU) announced that they would provide up to $5bn between 2015 and 2020 in finance to tackle deforestation, subject to ambitious and high quality proposals.
- Through its ICF and other international action, the UK is continuing to scale up support towards the shared developed country goal of jointly mobilising $100 billion per year in climate finance in developing countries from a range of sources by 2020. Beyond this, the UK is focussed on helping developing countries put in place the conditions to align finance flows with low greenhouse gas and climate resilient development, including by creating the right conditions to unlock green investment for Nationally Determined Contributions (NDCs) and by phasing out the most polluting activities.

6.2 Introduction

Climate change is a global challenge requiring action from all countries. The UK has played a key role in demonstrating international leadership in reducing its own emissions and supporting other countries to do the same. In this chapter, we discuss the support and financial assistance that the UK provides to developing countries, where climate change represents the biggest challenge to long-term global poverty reduction, to help avert the worst outcomes of climate change and increase the resilience of the most vulnerable countries to a changing climate.

The remainder of the chapter is structured as follows:

- An overview of the types of climate finance provided by the UK, centred around its International Climate Finance (ICF);
- How climate finance has been allocated since the UK's Sixth National Communication, including adaptation and mitigation and with detailed examples of programming in UK priority areas of forestry, private finance and carbon markets;
- How the UK is acting to promote, facilitate and transfer technology to developing countries;
- Other actions the UK is taking to help developing countries access finance, attract investment and align finance flows with low greenhouse gas and climate-resilient development;
- How the ICF is using its monitoring & evaluation framework to apply lessons learned and improve over time.

6.3 Overview of UK Support and Channels

The UK is among the largest contributors of public climate finance and is committed to providing support which is transparent, transformative and in line with the needs and priorities of developing countries. UK climate finance builds on a tradition of UK leadership in providing support to developing countries.

Building on the provision of £3.87 billion in International Climate Finance (ICF) between 2011/12-2015/16, the UK has committed to further scale up climate finance to at least £5.8 billion between 2016/17-2020/21. This represents a new, dedicated climate commitment which is additional to historic (ODA) levels and has not diverted funds from existing development spending. UK Official Development Assistance has consistently risen over time, from £7.3 billion in 2009 to £13.4 billion in 2016. Whilst the UK remains committed to promoting climate smart development across the aid portfolio, consistent with the Global Goals and an essential condition for driving sustainable development and effective climate action, we have put in place a dedicated ring-fence to ensure our climate finance is identifiable from non-climate ODA.

The UK remains committed to promoting climate smart development across the aid portfolio, consistent with the Global Goals and an essential condition for driving sustainable development and effective climate action.

A key objective of UK climate finance is to improve the effectiveness of the international climate finance architecture, including by building in-country support and enhancing country ownership for low carbon climate-resilient development. The UK has an extensive network of officials based in developing countries working for the Department for International Development (DFID) and Foreign and Commonwealth Office (FCO). This ensures close relationships with governments and key organisations in these countries and the development of bilateral programmes based on developing country needs. The UK also provides support through multilateral funds and multilateral development banks. The UK continues to encourage and support the use of these funds in response to projects and plans driven by the needs of developing countries and in line with nationally determined comprehensive plans.

The UK is firmly committed to the joint developed country agreement to mobilise $100 billion of climate finance a year from a variety of sources by 2020. At COP21 in Paris, developed countries were asked to produce a 'concrete roadmap' to show how they would achieve this goal. The UK and Australia, working with other developed countries, produced this Roadmap and presented it at COP22 in Marrakech. The Roadmap indicated that based on current pledges, and building on the estimated level of $62 billion in climate finance mobilised in 2014, the $100 billion goal could be achieved with a modest increase in the rate of mobilisation of private finance. The UK continues to work with its international partners to implement the actions outlined in the Roadmap and make progress towards the goal, in line with developing country priorities.

Achieving the goals of the Paris Agreement will require a broad shift in finance flows to align the global economy with a pathway towards low greenhouse gas and climate resilient development. This transformational goal provides the basis for the UK's approach to climate finance, and the UK acts through a number of bilateral and multilateral channels to ensure that support helps to build capacity and nurture lasting change, for instance through engagement of private investors.

6.3.1 The UK's International Climate Finance (ICF)

Recognising the growing importance and urgency of tackling climate change and its impact on growth and poverty reduction, the UK invested £3.87 billion in International Climate Finance (ICF) from 2011-2016 (financial years 2011/12 to 2014/15). The UK has committed to provide at least a further £5.8 billion from 2016-2020 (financial years 2015/16 to 2020/21), with a commitment to achieve a 50:50 balance between mitigation and adaptation over this period. This will lead to a doubling in UK climate finance in 2020, relative to 2014. This commitment reflects our view that climate change is the biggest threat to the long-term eradication of global poverty, and that the impacts of climate change will hit the poorest hardest.

The UK's ICF is supporting a portfolio of investments managed by the Department for International Development (DFID), Department for Business, Energy and Industrial Strategy (BEIS), and the Department for Environment, Food and Rural Affairs (Defra). It aims to support international poverty eradication now and in the future by helping developing countries to: manage risk and build resilience to the impacts of climate change, take up low-carbon development at scale, and manage natural resources sustainably.

To achieve this, UK ICF delivers transformational change through well-targeted finance which, for example, helps to pay the incremental cost of making infrastructure investments climate-smart and avoid lock-in of high carbon technologies. It also incentivises countries to reduce

deforestation and promote sustainable land use. This demonstrates that low-carbon, climate-resilient development paths are viable and compatible with economic growth and poverty alleviation.

Cumulative data that we collect show that, between 2011/12 and 2016/17, UK ICF programmes have[159]:

- Supported **34 million people** to cope with the effects of climate change;
- Provided **12 million people** with improved access to clean energy;
- Reduced or avoided **9.2 million tonnes** of greenhouse gas (GHG) emissions (tCO2e);
- Installed more than **400 MW** of clean energy capacity; and
- Mobilised **£2.2 billion public** and **£500 million private finance** for climate change purposes in developing countries.

Public finance alone cannot bring about the transformation required to achieve the overarching goals of the Paris Agreement for climate resilience and staying below 2°C. The UK is committed to working alongside the private sector to promote the transformation necessary to align finance flows globally with the objectives of the Paris Agreement.

6.3.2 Prosperity Fund

The Foreign and Commonwealth Office (FCO) and its network of Posts around the world have advocated for a high ambition response to the collective challenge of limiting climate change during the reporting period. The partnerships that have been created between the UK and other countries have benefited from practical co-operation projects funded by the FCO Prosperity Fund, and the energy/low carbon work stream of its successor, the Cross Whitehall Prosperity Fund, launched in 2015. Programmes have focused on promoting reforms to energy markets drawing upon the UK's world-leading expertise on policy frameworks, energy system optimisation, promotion of renewable energy, roll out of smart technologies, and building a green finance industry to accelerate the transition to low carbon growth. Multi-year programmes worth up to £120 million under the new Cross Government Prosperity Fund will be designed in close co-operation with South East Asia, China, India, Brazil, and Mexico, and will be launched in 2018.

6.3.3 The Global Challenge Research Fund and the Newton Fund

The Global Challenges Research Fund and the Newton Fund leverage the internationally recognised strength of the UK's research base, ensuring that UK science takes a leading role in promoting research and innovation to address development challenges, including flooding and famine caused by climate change, environmental degradation and the development of low carbon energy. The funds play a critical role in advancing development for the poorest people and countries, promoting long term sustainable growth.

This forms part of the UK's wider approach to research which is outlined in more detail in Chapter 7 Research and Systematic Observations.

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[159] 2017 UK Climate Finance Results: https://www.gov.uk/government/publications/2017-uk-climate-finance-results

6.3.4 Contributions to Multilateral Development Banks

The UK is one of the largest contributors to multilateral development banks (MDBs), which have collectively committed over $100 billion in climate finance over the last four years. The MDBs have made significant pledges to scale up climate finance by 2020 and to better integrate climate considerations across their activities.

Since the previous National Communication the UK has provided further capital contributions to MDBs working in low income countries. The UK is the largest donor to the International Development Association and has committed £3,336 million to its 18th replenishment. The UK has also committed £460 million to the 14th replenishment of the African Development Fund.

The UK continues to work with the MDBs to encourage ambition, effectiveness and transparency in the scaling up their financing of climate activities in developing countries, their co-operation with national and regional institutions and the further mainstreaming of climate dimensions into development activities. MDBs have reported jointly on outflows of climate finance since 2011.

6.3.5 UK and 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 Country 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.

The UK is supporting Fiji as the first Small Island Developing States COP Presidency with £1.7 million of funding across 2017-2018. UK support to the Climate Development Knowledge Network (CDKN) was also continued in 2017 with up to £2 million provided to enable effective participation of the poorest developing nations in the UN climate negotiations.

As a member of the Intergovernmental Panel on Climate Change (IPCC), the UK makes voluntary contributions each year to the IPCC's Trust Fund. The UK has committed to contributing £115k per year in 2017, 2018 and 2019. The UK also committed to contributing an additional £115k in 2017 only, making its contribution £230k in total for this year.

6.4 UK Climate Finance

This section sets out how the UK directs its climate finance, firstly by outlining the support the UK provides to the operating entities of the UNFCCC Financial Mechanism and other cross-cutting multi-lateral funds; then providing an outline of UK support for mitigation and adaptation activities. Finally, the section sets out actions in a number of UK ICF sectoral priorities – forestry, mobilising private finance and establishing international carbon markets.

6.4.1 Cross-cutting support through Multilateral Climate Funds, including the operating entities of the UNFCCC financial mechanism

The UK has been a key supporter of both the Global Environment Facility (GEF) and the Green Climate Fund (GCF) since their formation and is committed to ensuring their effectiveness in delivering climate finance within the broader financial architecture.

6.4.1.1 The Green Climate Fund

Since becoming operational in 2015, **the Green Climate Fund (GCF)** has become the key multilateral climate fund, with a mandate to make 'an ambitious contribution to the global efforts towards attaining the goals set by the international community to combat climate change'. The UK is a strong supporter of the GCF having committed £720 Million for the initial resource mobilisation period, and is committed to ensuring that the GCF delivers maximum impacts in the developing countries it supports.

The GCF funds transformational projects with a strong focus on leveraging private finance, with a commitment to provide 50% of its resources for mitigation and 50% for adaptation. At least 50% of its adaptation support will be provided to particularly vulnerable countries including Least Developed Countries (LDCs), Small Island Developing States (SIDS) and African States. In the past year, the GCF has made significant progress in terms of programming, tightening its policy framework, and building the Secretariat's capacity. So far, the GCF has committed $2.65 billion of funding to 54 projects, representing a balanced geographical and thematic split, with over 50% of funds going to private sector projects, and over $400 million to Small Island Developing States.

Progress has also been made on enhancing direct access to finance, with the agreement in 2017 to pilot a Simplified Approvals Process for projects with up to $10 million of GCF financing, and the ongoing work to facilitate increased proposals from direct access entities which saw nine new direct access entities accredited to the GCF in 2017. The Readiness and Preparatory Support Programme set up by the GCF also aims to facilitate the activity of the Fund, recognising the need to support direct access entities in their applications and to assist countries with related processes under the UNFCCC such as the preparation of National Adaptation Plans. Over $40 million of GEF funds have been approved for readiness activities, with 60 countries benefitting from this support to date.

6.4.1.2 The Global Environment Facility

The UK is a long-standing contributor to **the Global Environment Facility (GEF)** to fund projects and activities providing not only climate change benefits, but also tackling broader environmental issues such as biodiversity and land degradation. The GEF is a funding mechanism for five UN conventions: Convention on Biological Diversity (CBD); Stockholm Convention on Persistent Organic Pollutants; Minamata Convention on Mercury; UN Convention to Combat Desertification (UNCCD) as well as the UN Framework Convention on Climate Change (UNFCCC). Programmes are implemented through 18 partners including multilateral development banks, UN agencies, and NGOs.

The GEF budget is replenished on 4-yearly cycles and a total of 39 countries contribute. The current sixth replenishment period (2014-2018) has a budget of $4.43 billion. The UK is contributing £210 million in total to GEF-6. Since its creation in 1991, GEF has implemented 1,010 climate change mitigation projects contributing to 2.7 billion tonnes of greenhouse gas emission reductions, equivalent of taking 560 million cars off the road each year. It has also led to the creation of 3,300 protected areas, covering more than, 860 million hectares, an area larger than Brazil.

6.4.1.3 Climate Investment Funds

The UK is the largest investor in the $8.3 billion **Climate Investment Funds (CIFs)**, having invested £1252.9 million between 2011/12 and 2016/17, to pilot low-emission and climate resilient development through projects implemented by the multilateral development banks. The CIFs now operate across 72 countries and have a total portfolio of 310 projects. CIFs finance is enabling the building of the equivalent of over a quarter of the current global installed geothermal and concentrated solar power. The projects are unlocking finance flows in the green markets of developing countries and are expected to generate $58 billion of co-financing. The CIFs are comprised of four key programmes, and we detail in the below sections how UK ICF support contributes to each of these programmes individually.

6.4.2 Mitigation: activities undertaken by the public and private sectors to finance emissions reductions

The Paris Agreement requires all Parties to put forward "nationally determined contributions" (NDCs), setting national targets for reducing emissions towards the common 'well below 2°C' increase goal. The UK's mitigation efforts seek to help meet the financing challenge of realising these emissions reductions by reducing risks to private investment, halting deforestation and accelerating technological change at scale. The UK is using its International Climate Finance to effect "transformational change" through targeted investment in innovative projects with the potential to be scaled up and replicated by others, and by tackling barriers that hold the private sector back from investing. This section describes some of the initiatives and actions that the UK is undertaking to support decarbonisation activities in developing countries. Through and beyond these examples, the UK also aims to raise capacity in countries and build on the UK's low carbon experience and expertise. Further examples of how the UK is enabling in country capacity are set out in section 5 of this chapter..

6.4.2.4 Accelerating technological change at scale

Raising ambition and accelerating the rate of decarbonisation is critical to achieving global climate goals. There has been a rapid shift towards renewable energy over the last few years. Sectors such as transport, buildings, urban planning, and energy efficiency offer significant potential to reduce emissions while delivering major economic, health and environmental benefits, but are not yet on a pathway consistent with the well below 2°C goal.

The UK's ICF is supporting developing countries to achieve economic growth in a sustainable way. Access to affordable, reliable and sustainable modern energy is central to this. Interventions are being supported at the regional, national, sub-national or sectoral level through UK bilateral and multilateral support. Many of these interventions aim to lay the conditions for increasing investment at scale.

The UK's main priorities are to:

- Build capacity and capability in countries to implement their NDCs and raise ambition further, working to overcome regulatory and institutional barriers, including sharing UK skills and expertise where it is helpful;
- Deliver clean energy to the millions of people currently without any access to electricity and other forms of modern energy;
- Push frontiers by demonstrating and deploying technologies, policies and approaches that are critical for a well below 2°C trajectory; and
- Drive decarbonisation at scale through the international development system – supporting the development banks to scale up their climate investments and become more climate-smart across their activities.

6.4.3 Contributing to international climate change mitigation funds

The following are examples of UK contributions to international climate change funds, in addition to support for the operating entities of the financial mechanism. A full list is provided in Table 7.b of the CTF (annexed)[160]:

The Clean Technology Fund (CTF) - Of the four funds that sit under the Climate Investment Fund, the UK has contributed £701 million between 2011/12 to 2016/17 to the Clean Technology Fund (CTF). The CTF provides concessional finance and technical assistance in 21 countries, delivering significant development benefits, such as increased energy security, reduced local air pollution, and job opportunities. It has supported national governments to identify and implement ambitious low carbon investment plans, and helped demonstrate technologies and create markets. South Africa's KaXu Solar One Concentrated Solar Power project, with funding from the Clean Technology Fund, has recently been awarded a *Momentum for Change Award* by the UNFCCC for its innovative and game-changing approach to climate change and wider economic, social and environmental challenges.

The **Scaling up Renewable Energy Programme (SREP)** is another of the four Climate Investment Funds. The UK has provided £268m to SREP, which aims to stimulate energy access and economic activity by working with governments to build renewable energy markets and support productive uses of energy at the household level. As of June 2017, SREP had endorsed investment plans for 19 pilot countries. Expected results under these plans, and the Fund's Private Sector Set Aside, include an estimated 6,686 gigawatt hours (GWh) of electricity to be generated annually from renewable energy sources (equivalent to the annual electricity production of Armenia) and new or improved access to clean, modern energy services for 17.3 million people (approximately the population of Malawi). The total estimated greenhouse gas (GHG) emissions to be avoided are approximately 5.4 million tons CO_2e/yr.

The Nationally Appropriate Mitigation Action (NAMA) Facility is a bilateral programme supported by the UK, working in partnership with the German Federal Ministry for the Environment (BMUB), Denmark and the European Commission. NAMAs are country owned projects, policies, or programmes that shift a technology or sector in a country onto a low-carbon development trajectory. The Facility seeks to support and fund the implementation of the most transformational parts of the NAMAs, for which countries are unable to attract private sector funding. It has an open application process, welcoming projects across a diverse range of sectors and geographies. Since 2012, 20 climate mitigation projects across 16 countries have been supported, with each project chosen for its ability to catalyse change in the sector. To support this demand the UK has committed £140 million into the Facility, of which £40 million has been allocated to the 5th Call of the Facility launched on 13 November 2017.

Further details on mitigation finance activities through the UK's focus on forestry, mobilising private finance and carbon pricing are found in subsequent sections.

6.4.4 Adaptation, including assistance provided to developing countries particularly vulnerable to the adverse effects of climate change in meeting the cost of adaptation

UK ICF investments aim to support international poverty reduction now and in the future by helping developing countries manage risk and build resilience to the impacts of climate change, take up low-carbon development at scale, and manage natural resources sustainably.The poorest and most vulnerable people in the world will be hit first and hardest by the impacts of

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[160] The UK provides the majority of its funding through trusted delivery partners which leads to complex delivery chains from its fund through to the final recipient. For this reason, the UK does not systematically track who the ultimate end recipient is (including whether it is public or private) and what their role is in the project. Examples of support are provided in CTF tables.

climate change. This is why the UK aims to spend half of its climate finance on adaptation - in 2016, 51% of the UK's ICF was spent on adaptation, with a focus on the poorest and most vulnerable countries.

We recognise the central importance of countries having a clear plan for adaptation that is tailored to the risks they are likely to face. The UK is committed to helping countries ensure they are able to put in place such plans to guide action.

The UK has already provided over £1.6 billion to help vulnerable developing countries between 2011 and 2016. The UK's ICF has to date helped 34 million people cope with the effects of climate change through by assisting developing countries to better:

- adapt to long term impacts well in advance, for example by changing or diversifying livelihoods and ensuring infrastructure is fit for purpose.
- anticipate and reduce the impact of climate variability and extremes for example through effective forecasting and preparedness measures.
- absorb the effects of climate extremes and disasters for example through effective and rapid response that enables people to cope with disaster and recover quickly.

6.4.4.1 UK action on adaptation

The UK provides finance through international funds as well as bilaterally, through multi country projects and civil society. The UK will focus on assisting people to **anticipate** the impact of change through better planning and forecasting, **adapt** to long term impacts well in advance, – for example by changing or diversifying livelihoods and ensuring infrastructure is fit for purpose – and to **absorb** the effects of disasters and climate extremes through effective and rapid response.

Programmes supported by the UK may work across all three areas of action as set out above.

A series of examples of UK activities in each of these areas is detailed below:

6.4.4.2 Adapt

- **Building Resilience to Climate Extremes and Disasters (BRACED**) - This programme is supporting local and national institutions to deliver policies and programmes that better integrate disaster risk reduction, climate adaptation and development approaches. It is supporting community level initiatives in 13 countries through 15 NGO consortia that are, for example, delivering improved climate information for agriculture, securing livestock migration routes, and building infrastructure to help crops avoid flood and capture water for future use.
- The £26 million **Climate High-Level Investment Programme in Ethiopia** closed earlier in 2017. This has so far supported more than 1.4 million people to cope with the effects of climate change, as well as building institutional capacity to ensure that the Ethiopian Government is more capable of assessing and addressing climate risks.
- **Introducing models for the sustainable management of mangroves in Madagascar** to help increase the resilience of coastal communities. The £10.1 million project, involving fisheries management and improvement and mangrove livelihood diversification, is expected to protect around 20,000 hectares of mangrove forests and benefit over 100,000 people.

Other programmes can have a particular focus;

6.4.4.3 Anticipate

- **Weather and Climate Information and Services for Africa (WISER**). This programme aims to enhance the resilience of poor people and of economic development in Africa to weather and climate shocks, by improving the quality and use of weather and climate forecasts and other information services. This will contribute to increased productivity of climate sensitive sectors, like agriculture, health and infrastructure. Improved weather information can also help to protect lives.
- The UK is supporting **Future Climate for Africa (FCFA**) research programme which aims to enhance the scientific understanding and prediction of climate variability and change in Africa and, at the same time, is working with stakeholders to bring this information into use in adaptation planning. FCFA includes 11 pilot studies across sub-Saharan Africa that are using climate information to inform decisions, including infrastructure development, climate-smart agriculture, and urban and national planning.

6.4.4.4 Absorb

- The UK is a major contributor to **African Risk Capacity (ARC)** which strengthens African governments' understanding of drought risk and enables them to buy insurance that will pay out after harvest failures due to droughts. Senegal, Mauritania and Niger received payments totalling $26.5 million after poor rains in 2014, providing food aid, animal fodder and other assistance to 1.3 million people. Malawi received a payment of $8.1 million in 2016, which they have used for emergency cash transfers to affected people and to replenish the national strategic grain reserve. Seven countries are eligible for insurance this year.
- **Pacific Catastrophe Risk Assessment and Financing Initiative**: provides technical assistance and enables insurance for the Pacific Islands to protect against natural disasters such as cyclones and tsunamis thereby reducing their reliance on humanitarian aid. Tonga, Marshall Islands, Cook Islands, Vanuatu, and Samoa (625,000 people in total) are currently insured.

6.4.4.5 Contributing to international climate change adaptation funds

Pilot Programme for Climate Resilience (PPCR): the UK is the largest contributor to the $1.2 billion Pilot Programme for Climate Resilience (PPCR), one of the four Funds that sit under the CIFs. The PPCR assists governments with the integration of climate resilience into development planning, and pilots innovative public and private solutions to climate-related risks, primarily in Least Developed Countries or Small Island Developing States. For example, a $15.75 million project in Mozambique will develop climate resilient infrastructure to improve the ability of 8,200 farming families to withstand extreme weather events.

Least Developed Countries Fund (LDCF): the UK is also a long-standing contributor to the Least Developed Countries Fund (LDCF), which supports LDCs in developing their National Adaptation Programmes of Action (NAPAs) and funding the resultant programming. Through our most recent contribution of £30 million the UK is aiming to help nearly a million people become more resilient to climate change, and to bring approximately 200,000 hectares of land under more sustainable management. This was the fourth contribution that the UK has made to the LDCF – total contributions amount to £122 million since 2006The LDCF has provided $8 million towards a project strengthening the climate resilience of vulnerable communities in Somalia.

Outcomes so far include the construction of a sand dam which has stored enough water for 40,000 people and their livestock to survive through the prolonged drought period in the Bari region.

6.4.5 Halting deforestation

As well as being responsible for at least 12% of global GHG emissions, deforestation threatens the livelihoods of millions through rising desertification, soil erosion, flooding, and falling biodiversity. Through its 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 is working with ambitious forest governments and private sector stakeholders to address market and governance failures linked to deforestation. The UK played a key role in brokering ambitious international and multi-stakeholder agreements, such as the New York Declaration on Forests in 2014 and the Leaders' Statement on Forests and Climate Change in Paris, 2015. The UK also works with private sector stakeholders through a range of initiatives including the BioCarbon Fund, the Partnership for Forests programme, and the Eco.Business Fund.

The UK ICF forests strategy aims to support progress towards halving global deforestation by 2020 and halting it by 2030. Together with Germany and Norway, the UK has pledged to collectively provide $5 billion between 2015 and 2020 to incentivise ambitious governments, companies and communities to protect our largest natural global carbon sinks. This will reduce greenhouse gas emissions, improve the livelihoods and climate resilience of forest-dependent people, and protect biodiversity, as well as providing other environmental benefits such as reducing desertification and flooding. Investment is targeted towards projects that improve forest governance and knowledge enhancement, pay for ecosystem services, boost biodiversity, promote climate smart agriculture and enable stronger community-led forest management, amongst other factors. The UK also supports public-private initiatives to promote zero deforestation supply chains, and innovative solutions to leverage private finance for sustainable forest and land-use.

The UK supports:

- sustainable climate-resilient growth;
- capacity building to improve governance, address land tenure, strengthen sustainable land-use, and promote the full and effective participation of indigenous peoples and local communities in programmes that reduce deforestation and forest degradation;
- the private sector to transform supply chains to become deforestation-free, and leverage significant private investment in forests and agriculture.

Through its ICF, the UK is supporting a number of bilateral and multilateral programmes, including the following examples, discussed in detail below:

The Forest Investment Programme (FIP) – part of the Climate Investment Funds, is a REDD+ mechanism that provides upfront financing for public and private investments in forestry and related sectors. The UK has contributed £223 million to the FIP. Its objectives include: (a) transformational change in developing countries' policies and practices; (b) piloting replicable models to generate learning on the link between investment and emission reduction, sustainable forest management (SFM), and enhanced carbon stocks; (c) leveraging additional resources to attain effective and sustained REDD+; (d) providing experience and lesson learning.

FIP grants and low-interest loans ($775 million), channeled through partner multilateral development banks (MDBs), are empowering countries to address the drivers of deforestation and forest degradation both inside and outside of the forest sector to achieve the triple win of being good for forests, good for development and good for the climate. FIP projects will result in an estimated reduction or avoidance of greenhouse gas (GHG) emissions of 11.17 MtCO2e, more than 1.1 million people will receive livelihood co-benefits, and an area of 27.8 million hectares will be under improved management.

REDD+ is a framework agreed under the UNFCCC to *Reduce Emissions from Deforestation and forest Degradation* and enhance forest carbon stocks (+) in developing countries. It is aiming to demonstrate the potential of a new land-use paradigm that delivers large-scale forest protection alongside sustainable agricultural intensification. The UK will continue to support "jurisdictional" REDD+ results-based finance that unlocks key barriers in the enabling environment and mobilises private finance, including the examples below:

- The UK has committed £145 million to the Forest Carbon Partnership Facility to support more than 40 countries to develop and then deliver ambitious plans to reduce deforestation. It provides payments based on progress to reduce deforestation as an incentive for countries to take action.
- The UK is also supporting the BioCarbon Fund with £115 million to fund policy reform and land-use projects across large areas to roll out new landscape-wide approaches that produce verified emission reductions from agriculture, forests and other land use. It will work hand in hand with progressive major commodity producers and buyers that are aiming to remove deforestation from their supply chains.

The UK has committed £73 million to the **REDD for Early Movers (REM)** programme which is an accelerator for the most ambitious and committed countries to reduce emissions from deforestation. REM rewards programmes that are already successful in driving down deforestation trends, with finance re-invested in agreed activities to deliver further results. UK support focusses on Colombia's programme to achieve zero net deforestation in its Amazon region as well as programmes to decouple increases in production from forest loss in two leading Brazilian States – Acre and Mato Grosso.

The Forest Governance, Markets and Climate (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 to influence reforms in timber-producing countries where governance failures often result in illegal logging and neglect of rights to forest land and resources for those living in poverty. By reducing illegal logging these people 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 (CO2e) 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.

Partnership for Forests adds value to standing forests in Africa, Latin America, and Indonesia by incubating new investments in agroforestry and non-timber forest products, helping local people – often indigenous communities and smallholder farmers – connect to new markets and scale up production for their products. It can also target commodities that are driving large-scale

deforestation by facilitating multi-stakeholder approaches and solutions which support implementation of zero-deforestation supply-chain commitments. The programme provides a mix of grants and technical assistance to project developers to bring projects aimed at creating deforestation-free commodity supply chains to commercial viability.

The Sustainable Rural Development project in Brazil will encourage small and medium sized farms to implement sustainable low carbon agriculture identified in the Brazilian Government's Plano ABC programme to avoid deforestation and restore degraded land in the Amazon and Atlantic Forests, expanding to the Cerrado next year. The programme aims to showcase best practices in implementing low carbon sustainable agriculture that protects and enhances the environment whilst increasing farming productivity and income.

The project supports farmers by:

- Improving access to information, such as demonstration farms and access to rural credit lines;
- Providing capacity building and technical assistance to support farmers to transition to low carbon technologies; and
- Financial incentives for farmers who successful in implementing of a low carbon agriculture management plan

The UK has invested £54.9 million into this project. The first phase aims to reduce deforestation by 16,500 hectares and restore 41,100 hectares. This will increase annual income per hectare 5-fold for 3,700 small and medium sized farms and will reduce emissions by 10.4 $MTCO^2e$ over 20 years.

6.4.6 Mobilising Private Finance

Mobilising private investment in climate action is crucial to meeting the global goal of limiting temperature increase to 2°C. However there are a range of market barriers that prevent investments from happening at scale in developing countries. Climate finance can help to overcome market barriers by building capacity and capabilities in developing countries. Using public climate finance to help create the conditions to enable the private sector to mobilise the investment needed is an essential step in delivering on the Paris Agreement, and for this reason the UK's ICF tests new and innovative approaches that can be replicated and scaled up by the private sector.

The UK provides concessional or market-rate finance to help projects reach financial close and demonstrate profitability, with the aim of reducing real and perceived risks and costs of low-carbon investments. The UK also facilitates access to finance by strengthening local financial institutions and broadening types of finance available in developing country markets. Because low-carbon technologies like renewable energy are often capital-intensive at the beginning, they are particularly sensitive to the cost and availability of capital.

In seeking to mobilise private finance, the UK is using its ICF to:

- Mobilise private climate finance internationally that would not otherwise flow to countries, and seek to create a sustainable climate investment market;
- Mobilise private sector engagement and finance in specific sectors and technologies that experience difficulties in accessing private finance or which pose long term financial risks;
- Create a better understanding of private finance internationally to inform future climate finance policy and climate projects.

The UK supports a range of specific private finance investments, a full list is provided in Table 7.b of the CTF (attached in the annex). This includes, but is not limited to the following examples:

The Sustainable Infrastructure Programme - In 2017 the UK established the Sustainable Infrastructure Program (SIP) in Latin America in partnership with the Inter-American Development Bank. The purpose of the programme is to enable and accelerate the implementation of the Nationally Determined Contributions in Latin America, initially Brazil, Colombia, Mexico and Peru, focusing on supporting and catalysing private sector investments in low carbon infrastructure.

The UK will provide up to £177.5 million from its ICF budget over 5 years to provide technical and financial support. This can include technical assistance to governments to help them shape their regulatory frameworks in a way that is attractive to private investors, support the development of local capital markets, while also investing in a few demonstration projects to show commercial viability.

UK Climate Investments - UK Climate Investments LLP has been mandated to invest in up to £200 million of UK ICF in low carbon projects in emerging markets its pilot phase (2015-2018). The Investment Mandate requires UKCI to make equity investments into renewable energy and energy efficiency projects in India and Sub-Saharan Africa. Through investing in a minority equity stake, UKCI aims to leverage additional private equity and debt investment into the projects.

The central objectives of the pilot are:

- Use a private sector actor to have a demonstration effect, build a successful track record and prove commerciality of low carbon investments to the broader market by making a strong return on investment; and
- Achieve better value for money by more effectively and nimbly interacting with the private sector.

UKCI's first investment in India was alongside a UK solar developer in a partnership platform to fund the development, acquisition and ownership of large scale solar power generation assets in India.

The Renewable Energy Performance Platform (REPP) -The REPP seeks to mobilise private sector development activity and investment in small and medium scale renewable energy projects (up to 25MW) in sub-Saharan Africa. REPP aims to increase the number of sound 'bankable' smaller renewable energy projects by assisting project proponents through~~out~~ the project development stage, by financing Technical Assistance, drawing on existing risk mitigation instruments such as political risk insurance and providing results-based finance where necessary. The UK has committed £48 million for 2015 to 2020.

The **Climate Public Private Partnership (CP3)** a £130 million programme that aims to support clean energy and demonstrate the commercial viability of investments in climate related businesses in emerging markets. By anchoring two private equity funds – i.e. providing committed investment into these funds to help attract additional investors - the programme mobilised private climate finance of $279 million and kick-started the largest private equity climate fund in Asia. The funds have so far invested in 68 businesses and renewable energy developers across developing countries in Asia, Africa and South and Central America. CP3 is expected to avoid 57.4m tonnes of CO2 equivalent over its lifetime (to 2026).

The eco.business Fund - The UK has invested £20 million into the eco.business Fund, which is a private-public partnership currently operating in Costa Rica, Ecuador, Nicaragua and El Salvador. The Fund promotes business and consumption practices that contribute to biodiversity conservation and the sustainable use of natural resources. By leveraging and de-risking investment from private sector donors the Fund will protect around 32,500 hectares of

biodiverse forest and deliver 280,000 tonnes of carbon dioxide savings. Within five years public sector finance in the eco.business Fund is projected to reach $147 million, bringing in private sector funding of $314 million.

6.4.7 Carbon Pricing

The UK government considers that carbon pricing is crucial to support and raise the ambition needed to tackle the climate change challenge. Carbon pricing can provide a cost effective and technology-neutral way of reducing emissions, and is another key focus for mobilising the private sector towards the achievement of the Paris Agreement goals. It is for this reason that the UK continues to promote the use of pricing instruments both domestically and internationally. Since 2005 the UK has been a participant in the EU Emissions Trading System (EU ETS), the world's largest system, and has been an active proponent of reform to help make it as effective as possible.

Internationally, the UK continues to support carbon pricing through a portfolio of programmes aimed at building capacity and piloting new approaches. Below are some examples:

- The UK has invested £7 million since 2011 in the $127 million World Bank managed **Partnership for Market Readiness (PMR)** fund, supporting 19 countries to design and put in place domestic initiatives such as carbon taxes or ETSs. This is done through the provision of grants to allow countries to implement Market Readiness proposals. The PMR supports Brazil, for example, to explore various carbon pricing instruments by carrying out analytical studies on alternative policy design options, assessing their impacts, and building modelling capacity.
- The UK is improving access to carbon finance in least developed countries through our involvement in the **World Bank's Carbon Initiative for Development (Ci-Dev).** Ci-Dev works in some of the poorest countries in Africa to prepare them to participate in the international carbon market while providing clean energy for households and communities. The program enables local developers to put their ideas into practice, and helps build capacity as needed, for example by aggregating many small projects at household or community level and calculating the carbon that has been saved in order to get a payment incentive. The UK has committed £49 million.
- In 2016, the UK contributed £60m to the new **Transformative Carbon Asset Facility.** The purpose of the TCAF is to support countries with sizeable mitigation potential to scale up their ambition as they implement their Nationally Determined Contributions under the Paris Agreement. Programmes are intended to showcase innovative methodologies for using carbon pricing at scale, to allow the host country to deliver greater emission reduction ambition than in their current Nationally Determined Contributions. Almost 90% of the funding will be spent on results-based purchases of emission reductions from supported programmes. Other donors in the TCAF are currently Norway, Sweden, Switzerland, Canada and Germany.

In 2015 the Paris Agreement reiterated the importance of carbon markets in meeting international commitments by establishing a new framework for voluntary cooperation to enable countries to go further on their mitigation ambition. These provisions will help make the UK vision for the future of the global carbon market a reality by providing the foundations to facilitate bottom-up cooperation while creating the necessary top-down structures, including key rules to avoid double counting of units.

6.5 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, energy resources are under pressure and CO2 emissions from today's energy use are already changing the climate. It is necessary 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.

Understanding that lesson sharing enhances programming, the ICF will continue to strengthen its Monitoring, Evaluation and Learning Program to support the generation and use of evidence and knowledge from across the portfolio.

These lessons are captured in publicly available evaluations. The NAMA Facility published their mid-term evaluation report earlier this year – highlighting that there are 'ample opportunities for learning and replication' across their portfolio. Another program, The Carbon Capture and Storage Trust Fund, used their evaluation of activities in the first phase of the program (released April 2016) to propose an evaluation framework for the second phase in order to effectively capture lessons.

The UK has also funded a Special initiative under the Climate Investment Funds focussed on Evaluation and Learning. The initiative supports learning based on evaluative and evidence-based activities within the CIF at different levels, including the project, program, thematic, and portfolio/fund levels. Within the initiative there are demand driven evaluations of CIFs programmes, portfolio level evaluations and a transformational change learning partnership involving multiple stakeholders including CIFs project staff, donors, and representative from multilateral climate funds.

The UK provides the majority of its funding through trusted delivery partners. This leads to complex delivery chains from its fund through to the final recipient. The UK does not systematically track indicators for technology transfer. The UK undertakes annual reviews of all of its programmes and these will include support provided for technology transfer. This enables progress to be tracked against project milestones and the UK publishes this information on the Development Tracker website.

As seen in the annexed table 8 of the CTF (annexed), examples of 'hard' technology such as the financing of solar infrastructure has been reported separately to 'soft' technology (i.e. capacity building) in table 9.

Below are some examples of technology transfer:

1) **Carbon Capture, Usage and Storage (CCUS):** Since 2012, the UK has provided £60 million to support developing countries to build up the technical and institutional knowledge necessary to enable the deployment of Carbon Capture, Usage and Storage (CCUS) technologies. The UK is extending this support by £10 million in 2017-2018.

   CCUS development and deployment is crucial for meeting the 2°C target set out under the Paris Agreement. The UK recently completed an evidence review of the global evidence base on CCUS, which highlights that globally, 12-14% of cost-effective decarbonisation needs to come from CCUS in order to meet the 2°C target.

   The programme aims to raise the level of technical understanding of CCUS within key developing countries, leading to the establishment of the necessary policy frameworks and incentive structures to support CCUS demonstration and ultimately accelerate the deployment of CCUS.

2) **The Clean Technology Fund (CTF)**, to which the UK is the largest contributor (providing £701 million), has demonstrated and deployed low carbon technologies at scale across 21 countries. Examples include supporting the first generation of utility scale Concentrated Solar Power (CSP) plants to be built in developing countries, with the plant in South Africa now providing power to 80,000 people and winning a Momentum for Change award from the UNFCCC. CTF finance for the Noor CSP complex in Morocco has helped to bring down technology costs and overall CTF has supported around a fifth of global CSP deployment to date. The fund has dramatically scaled up geothermal development across multiple countries, as well as a wide range of other renewable and clean transport technologies.

3) **Capacity Building and Transparency**: As agreed by COP21, the Capacity Building Initiative for Transparency (CBIT) was established by the Global Environment Facility (GEF) in 2015 to support developing countries to meet new reporting requirements under the enhanced transparency framework of the Paris Agreement. The UK is the largest donor to CBIT to date, committing £10 million from the ICF and £1 million from the Scottish Government.

4) **The Asian Development Bank (ADB)'s Clean Energy Fund** was set up to improve energy access, energy security and the transition to low-carbon technologies through cost-effective investments. The UK's contribution of £10 million is specifically used to fund the technical assistance elements of the fund.

5) **Climate Innovation Centres Programme:** The UK funded Global Network of Climate Innovation Centres programme provides funding to the World Bank's Climate Technology Programme (CTP) to support the design, implementation, and international coordination of Climate Innovation Centres (CICs) in developing countries. The programme assists local entrepreneurs develop innovative technology and business solutions to domestic energy, resource and environmental challenges.

   The UK also supports CICs in Ethiopia and Vietnam through bi-lateral programmes, while there are additional non-DFID supported CICs in South Africa, the Caribbean, Ghana and Morocco. The programme helps gather evidence on climate technology innovation in developing countries, enabling national CICs to respond to technology trends.

6.5.1 Securing policy commitments to accelerate low carbon technology deployment through multilateral initiatives

The UK has 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:

- **Mission Innovation** - the UK is a leading member of Mission Innovation, an international initiative which aims to dramatically accelerate clean energy innovation to make clean energy widely affordable;
- Sustainable Energy for All (SE4All) - The UK supports Sustainable Energy for All (SE4All), which monitors delivery of Sustainable Development Goal 7 (SDG7). SDG7 seeks to achieve
  - Universal access to modern energy services for all by 2030 by
  - Doubling the share of renewable energy in the global energy mix
  - Doubling the global rate of improvement in energy efficiency
- **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 development and deployment, both in OECD and major non-OECD countries. The UK funds various IEA Technology Collaboration Programmes (TCPs) relating to low carbon energy, and the UK has active engagement in the IEA's Renewable Energy Working Party. The UK has announced that it will make a leading £8 million contribution to the IEA's new Clean Energy Transitions Programme, which will provide key emerging economies with cutting technical assistance on the energy transition.

- **International Renewable Energy Agency (IRENA)** - The UK supports IRENA's mission to promote widespread and sustainable use of renewable energy through its role as: a centre of excellence for energy transformation, a global voice for renewables, a network hub for international collaboration, and a source of support and advice. The UK has been an IRENA Council member for 2016-2017 and has helped to drive forward IRENA's medium-term strategy which is consistent with UK government objectives regarding energy security and decarbonisation.
- **Clean Energy Ministerial (CEM) -** the CEM is a forum to promote and share lessons learned from policies and programmes that advance clean energy technology. The UK is a member of a number of the CEM's initiatives, such as the initiative on Super-Efficient Equipment and Appliance Deployment. The also contributed funding towards the new CEM Secretariat hosted at the IEA;
- **International Partnership for Energy Efficiency Co-operation (IPEEC)** - IPEEC is a forum to allow major economies to co-operate and collaborate on all aspects of energy efficiency policy. IPEEC's work is undertaken through a series of Task Groups and the UK actively participates in a number of these Groups, including those working on appliance standards, buildings, finance and data. The UK also contributes funding to support the work of the IPEEC Secretariat.

6.6 Other actions to accelerate the alignment of finance flows with low greenhouse gas and climate resilient development

The Paris Agreement's Article 2.1c commits Parties to collectively align finance flows with low greenhouse gas and climate resilient development. This will require a transformation beyond public finance alone, including greater action to develop carbon markets, remove policy misalignments, establish green finance capabilities, build in-country capacity, and integrate climate resilience into national development planning. The OECD has estimated that the additional $0.6 trillion needed to make global infrastructure investment climate compatible from 2016-30[161] will likely be offset over time by fuel savings resulting from low-emission technologies and infrastructure. The key challenge will be mobilising this additional investment.

It is for this reason that the UK's ICF places a strong emphasis on transformational change, through targeted investment in innovative projects and technologies with the potential to be scaled up and replicated. The UK also undertakes a number of activities which more indirectly enable developing country ambition by helping to attract finance for climate action. A selection of these activities is listed below.

6.6.1 Helping developing countries to attract investment

The UK supported the inaugural **Climate Finance Accelerator (CFA)** initiative, a catalytic intervention designed to address the demand for turning countries' Nationally Determined Contributions (NDCs) into finance plans with pipelines of investment-grade projects. The CFA

[161] OECD (2017), *Investing in Climate, Investing in Growth*, OECD Publishing, Paris.

fast tracks the translation of countries' NDCs into finance plans to attract necessary investment by matching government, finance and capital market players from the selected countries of Colombia, Mexico, Nigeria and Vietnam with project and green finance experts from the City of London. This transaction-oriented platform brought together policy makers and private sector financiers to identify financing propositions for projects that align with NDC priorities. The dialogue between these two engaged constituencies included strengthening enabling environments for scaling up climate action and creating action plans for developing NDC financing plans. The CFA builds countries' capacities to engage with the private sector whilst accelerating NDC financing propositions to an investable level.

The NDC Partnership programme, to which the UK contributes, aims to help turn NDCs into specific strategies and measures. It raises ambition globally by enhancing cooperation and support for the successfully implementation of NDCs and related Sustainable Development Goal (SDG) commitments, with the ultimate goal of reaching climate-resilient and low carbon growth. The NDC Partnership is a way for countries, intergovernmental organisations, civil society and the private sector to align their plans and actions to achieve the NDCs. It will provide guidance on identifying possible sources of finance, useful tools, and key data to those who need it whilst also providing a way for sharing lessons and experiences in responding to the challenging and complex need to implement the NDCs.

Promoting International Green Finance the UK's policy leadership in green finance, including by co-chairing the G20 Green Finance Study Group[162] and through endorsing the recommendations of the Financial Stability Board's Task Force on Climate-related Financial Disclosures, helps contribute to the global growth in green finance and increase the flow of finance for low carbon, climate resilient investment. The first offshore green bond issued by an Indian entity and the first green bond issued by a Chinese bank were listed on the London Stock Exchange and $20bn of green bonds are currently listed in London, comprising 59 bonds in seven currencies. The UK Government works with the City of London Green Finance Initiative (a market development group bringing together market participants, academics and civil society) to develop international partnerships. Partnerships with China and Brazil, which involve bringing private sectors from those countries together with UK partners to share knowledge and expertise, make policy recommendations to government and engage in joint work. Further partnerships are planned with India and Mexico.

6.6.2 Removing policy distortions and accelerating the energy transition

In addition to its financial support for **carbon pricing initiatives** and domestic carbon pricing policy, the UK is committed to ensuring that the global carbon pricing system is cemented in environmental integrity and helps increase alignment and participation while opening up policy options for countries to become more ambitious over time. In this respect, in 2016 the UK joined the 18 other signatories of the Ministerial Declaration on Carbon Markets, thus committing to work to ensure the development of high standards for the environmental integrity of the international market mechanisms of the post-2020 period. In September 2017, the UK joined 25 other national and subnational governments to endorse a joint statement pledging to strengthen action on climate change through renewed cooperation on carbon markets.

At COP23, the UK and Canada launched the **Powering Past Coal Alliance,** a global alliance uniting governments, businesses and organizations in taking action to accelerate clean growth and climate protection through the rapid phase-out of traditional coal power. The alliance aims to bring together over 50 national and sub-national governments as well as businesses that are committed to phasing out unabated coal. The UK has already committed to phase out

[162] This is now the G20 Sustainable Finance Board's Task Force on Climate-related Financial Disclosures

unabated coal-fired electricity as part of our domestic energy policies to reduce greenhouse gases. However, we recognise the need to accelerate the international transition from burning coal to using cleaner power sources, and are offering technical and practical help globally to accelerate this transition through our International Climate Finance support to the Clean Technology Fund, Clean Technology Fund and International CCUS programme amongst others.

The UK also supports the phasing out of fossil fuel subsidies which, along with the establishment of carbon markets, is essential for enabling cost-effective climate action. The UK has been a key proponent of initiatives to phase out these subsidies through the G20 and other fora.

6.7 Monitoring & Evaluation, Transparency and how the UK has applied lessons learnt from its ICF to ensure project quality

The UK's ICF benefits from an extensive monitoring and evaluation system, which makes use of 16 Key Performance Indicators to assess ICF performance against intended outcomes. Our approach to monitoring & evaluation was recognised by the UK's Independent Commission on Aid Impact review of our ICF, which noted its role in helping multi-lateral climate funds become more effective. The UK is seeking to further strengthen this approach through programme specific monitoring and evaluation activities and **ICF Monitoring, Evaluation and Learning (MEL) programme** at portfolio level. The MEL programme will support the generation and use of evidence and knowledge from across the ICF. It will produce results and evidence of ICF achievements and effectiveness to support continual improvements in project selection and design, and inform the design of future funds and programmes.

Our reported results are based directly on this framework, ensuring that the scrutiny the UK applies to determining in-house results is reflected in its external reporting. This includes ensuring that, where appropriate, all activities make a clear assessment of actual costs and evidence in determining climate specificity and additionality in estimating private finance mobilised through our public finance. The UK is committed to further developing the evidence base on how public finance and policy measures can attract private finance, including through helping to fund and participate in the OECD Research Collaborative for Tracking Private Finance. And the UK is committed to the avoidance of double counting, having played a key role in developing the Technical Working Group methodology used to enable OECD-CPI analysis of aggregate mobilisation of private finance.

The UK also works closely with the OECD in reporting climate finance, including through the use of Rio-Markersand providing data on the core contributions made to multilaterals and UN organisations. The finance mobilised through these contributions will be a function of how these multilateral organisations use their contributions to finance climate activities.

In addition the UK tracks climate finance in order to meet annual reporting requirements under Article 16 of the EU GHG Monitoring Mechanism Regulation (MMR).

The ICF's approach to monitoring & evaluation has enabled us to learn lessons from the successes and failures of ICF projects and enables us to improve our approach over time.

6.8 Bilateral and regional contributions related to the implementation of the convention: Financial Contributions to the Global Environment Facility

	£ million	US$ million
	2014-2016	2014-2016
Global Environment Facility (GEF)	105.0	149.55

Notes

1. Figures indicate total contribution to the Global Environment Facility, and not just the climate-specific elements.
2. Exchange rate used is £1 = US$1.4243 . This is the average of the annual rates on 31/12 of 2014, 2015 and 2016
3. The 2013 contribution of £52.5m was not available at the time of submission for the UK's 6th National Communication

Chapter 7 – Research and Systematic Observation

7.1 Selected highlights

The UK is committing to research on both climate science and observations, and mitigation and adaptation actions. Selected highlights include:

- Funding two major research programmes on a global temperature rise of 1.5°C to contribute to the body of evidence to be assessed by the IPCC in its Special Report on Global Warming of 1.5°C.
- Publication of the second UK Climate Change Risk Assessment, setting out the priority risks and opportunities for the UK posed by climate change.
- Continued work under the world-leading Met Office Hadley Centre Climate Programme, with the work plan for 2018-2021 now in place. This plan will help the UK meet the needs of the post-Paris science agenda.
- Continued UK support for the IPCC, through government funding and through the contributions of the UK's world-leading research community.
- Major collaborative projects with international partners, such as the Climate Science for Service Partnership China and the Ganga Delta – Bay of Bengal Interactions programme with India.
- UK involvement in the Sentinel programme, which has included provision of the satellite platform for the Sentinel-5 Precursor mission. This was successfully launched in October 2017, bridging the data gap between Envisat and Sentinel-5 providing measurements of greenhouse gas concentration in the atmosphere.
- Significant investment in UK funding for science and innovation: £2.5 billion is expected to be invested in research, development and demonstration of low-carbon energy, transport, agriculture and waste between 2015 and 2021.
- Pioneering programme of work on Greenhouse Gas Removal Technologies and their implications.
- Work with European partners on the development of MicroCarb, a satellite monitoring system for CO_2 sources and sinks across the whole earth.
- The continued development of the UK DECC (Deriving Emissions linked to Climate Change) Network of tall towers. This provides top down verification of the UK's emission inventory.

7.2 Introduction

The UK continues to be a world leader in research into climate research and observations as well as the mitigation and adaptation strategies and technologies required to respond to the challenges posed by climate change. The UK has an extensive array of expertise within the country and continues to lead and engage in collaborative research efforts with partners across the world.

7.3 Research

7.3.1 Introduction to research

There is an extensive body of evidence that the world's climate is changing, that humans play a crucial role in this, and that the impacts of these changes will, on balance, have significant negative consequences for humans and the planet. The Fifth Assessment Report[163] (AR5) of the Intergovernmental Panel on Climate Change (IPCC) states that anthropogenic greenhouse gases and other anthropogenic drivers "are *extremely likely* to have been the dominant cause of the observed warming since the mid-20th century." Moreover, continued emissions will "increase the likelihood of severe, pervasive and irreversible impacts for people and ecosystems."

Since the publication of AR5, research has continued to refine and further strengthen the conclusions of AR5. For example, the scientific community has made important advancements in the ability to attribute specific weather events to climate change, continued to make progress in the understanding of short-term climate variability and is shedding further light on the feedback mechanisms in the earth system that may interact with anthropogenic forcing.

As will be demonstrated in the rest of this chapter, the UK is at the forefront of efforts to enhance our understanding of the science of climate change. We recognise the crucial importance of the IPCC in summarising and disseminating this information in support of robust climate policy. The UK will play a prominent role in supporting the 6th Assessment Cycle, through widespread participation by UK scientists and their research and via Government support for the IPCC process through financial and technical assistance.

In addition to the 6th Assessment Report, the UK is looking forward to the forthcoming IPCC Special Reports. In particular, there is a crucial need for improved understanding of the implications of the Paris Agreement goal to pursue efforts to limit global temperature rise to 1.5°C above pre-industrial levels. Through dedicated 1.5°C research programmes, the UK is making a concerted effort to enhance the evidence base for consideration by the IPCC.

The following sections will describe UK climate science priorities, the structure of research funding in the UK, outline the use of research in support of policy and then focus on examples of research under the required UNFCCC subject areas.

7.3.2 UK approach to the delivery of climate research

7.3.2.1 UK delivery of climate research: priorities and vision

The delivery of climate science in the UK ultimately follows a clear strategic vision. The fundamental principle is that UK and international climate action must be underpinned by a robust evidence base on the science of climate change.

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[163] https://www.ipcc.ch/pdf/assessment-report/ar5/syr/AR5_SYR_FINAL_SPM.pdf

While this evidence base is both strong and wide ranging, there is a continued need to develop the evidence base in order to understand and manage the risks of climate change, including developing mitigation and adaptation strategies, and to exploit any opportunities and minimise trade-offs of mitigation and adaptation actions.

The UK Government's vision for action on climate change is summarised in the Clean Growth Strategy[164] (CGS). Within the CGS there is a dedicated discussion of climate science and the fundamental support it provides for our ambitious decarbonisation agenda. This discussion also outlines our key policy focused climate science priorities. These were developed and approved by the Government Chief Scientific Advisors (CSAs) and are:

1. Present weather and climate risks globally and within the UK;
2. Future climate over this century under different emissions scenarios globally and within the UK, including extreme weather events;
3. Climate risks and impacts from future climate variability and change;
4. Emission pathways compatible with different levels of warming including timing and a consideration of technologies to achieve net zero emissions;
5. Impacts and opportunities of mitigation and adaptation; and
6. The case for early action: implications of delaying mitigation actions.

Through Government funding, through the Research Councils, and in collaboration with our international partners, we work to support research into these questions and other priorities identified by the scientific community. This research of course necessitates a response, both in terms of mitigation and adaptation, and we are active in pursuing research in both of these areas:

Mitigation

The Clean Growth Strategy details the funding the UK provides in support of the mitigation efforts required to address the challenges posed by climate change. The UK Government has significantly increased its investment in low carbon innovation. Between 2015 and 2021 we expect to invest (subject to value-for-money projects being put forward) over £2.5 billion in research, development and demonstration of low-carbon energy, transport, agriculture, and waste. This includes:

- Up to £505 million from the Energy Innovation Programme, which aims to accelerate the commercialisation of innovative clean-energy technologies and processes;
- Up to £1.2 billion from the combination of UK Research Councils investments and Innovate UK – now being brought into one organisation with the creation of UK Research and Innovation. These investments include funding for the Energy Systems Catapult and the Offshore Renewable Energy Catapult.
- Up to £246 million for the Faraday Challenge, which will ensure the UK builds on its strengths and leads the world in the design, development and manufacture of electric vehicle batteries.

[164] https://www.gov.uk/government/publications/clean-growth-strategy

- Up to £620 million from a range of Departments, including Department for Business, Energy and Industrial Strategy (BEIS), Department for Transport (DfT), Department for International Development (DfID), and Department for Environment, Food and Rural Affairs (Defra).
- Ofgem is making available to GB gas and electricity network companies up to £720 million of regulated expenditure for them to support smarter, more flexible, efficient, and resilient gas and electricity networks.

Adaptation

The UK Government publishes a UK-wide Climate Change Risk Assessment (CCRA) every five years to assess the risks for the UK from the current and predicted impacts of climate change. The first CCRA was published in 2012 by Defra, which is the department co-ordinating the UK Government's programme of work on adaptation. Defra asked the Adaptation Sub-Committee of the Committee on Climate Change (ASC) to prepare an independent Evidence Report to inform the second CCRA (CCRA2), which was presented to Parliament in January 2017[165]. The CCRA2 will feed into the development of the next UK National Adaption Programme (NAP), expected in 2018. The objectives of the NAP are: improving the evidence base; developing adaptive capacity in key sectors; providing the conditions for adaptation by removing barriers and supporting others; and taking action to adapt.

Following the systematic review of the available evidence in the CCRA2, the UK government endorsed the six key areas of climate change risk that need to be managed as a priority identified by ASC in their Evidence Report. These priorities are related to risks of flooding and coastal change, the impact of high temperatures on health and wellbeing, risks to natural capital, risks of future water shortages, impacts on the global food system, and risks arising from new and emerging pests and diseases.

The CCRA Evidence Report highlights additional research priorities where further evidence is needed 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. The following areas have been identified as priority evidence gaps: development of UK spatial modelling capability; development of a consistent set of socio-economic scenarios for the UK; robust decisions support frameworks; continued and enhanced investment in monitoring observed changes; better understanding of behaviour change; improved understanding of adaptation options available and their effectiveness in reducing risk. Defra and the ASC are working with Research Councils to address these priorities to inform future CCRAs.

Future UK work on adaptation will be assisted by the successor to the UK Climate Projections 09 project, UKCP18, for which work is currently underway. This will deliver a major upgrade to the range of UK climate projection tools designed to help decision-makers assess their risk exposure to climate.

UKCP18 will provide improvements to the existing projections which currently consist of guidance material, graphical displays of potential future climate change and datasets that users can utilise for their own purposes. Importantly, it will continue to enable a range of possible future conditions rather than just a best estimate, allowing users to make decisions according to their preferred level of resilience to future changes and make informed choices about adaptation.

There have been many updates to increase the usefulness of the dataset since the original launch and UKCP09 remains a vital source for informing UK adaptation. However, recent

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[165] https://www.gov.uk/government/publications/uk-climate-change-risk-assessment-2017

advances in climate science and the ability of supercomputers to run more and better climate simulations, combined with an evolving user requirement, mean it is now appropriate to develop UKCP18.

7.3.2.2 UK delivery of climate research: capability and excellence

The UK is extremely well placed to address the research priorities associated with climate change, because of the strength of our climate science research community. There are numerous centres of climate science excellence in NERC centres, UK universities and an increasing focus on applied and policy-relevant research within the private sector.

A leading flagship programme is the BEIS and Defra co-funded Met Office Hadley Centre Climate Programme (MOHCP). This delivers world-leading scientific evidence on climate variability and change, and provides the core science evidence on which UK government can make decisions to help the UK become resilient to climate variability and change, benefit from opportunities for growth and engage in international climate negotiations.

The MOHCP makes a vital contribution to the UK national climate capability by providing a central role in development of infrastructure and translating, delivering and applying climate science. It focuses on both direct policy-relevant research and improving the underlying fundamental science.

The current iteration of the MOHCP, 2015-2018 is addressing four priority theme areas:

- Climate sensitivity, thresholds and the water cycle
- Earth system processes
- Dynamics of climate variability and change
- Regional climate and extremes

In addition to these research themes, enhancements to infrastructure have been across a number of areas, including observational datasets and modelling architecture. Supercomputer facilities were upgraded during the current MOHCP.

The 2018-2021 work plan of the MOHCP has recently been agreed and has a central focus of serving the needs of UK Government by providing policy-relevant scientific evidence and advice to support the needs of the Paris Agreement. The programme is designed around the key questions identified above. It will also continue the development of fundamental science and core UK climate science infrastructure.

7.3.2.3 Research funding

Climate science is a priority area for Government funding of science. More broadly, investment in the UK's science, research and innovation base is viewed as fundamental by the Government. UK science is the most productive in the G7 and from 3.2% of global research and development (R&D) spend, the UK accounts for 16% of the most highly-cited research articles. Recent examples of the Government's commitment to science funding include:

- Increasing research and development investment by £4.7 billion over the period 2017-18 to 2020-21. This equates to an extra £2 billion per year by 2020-21 and is an increase of around 20% to total government R&D spending, more than any increase in any parliament since 1979.
- This R&D investment funding is additional to the protection of science resource funding that was announced at the spending review in autumn 2015, where science resource funding was protected in real terms, at £4.7 billion per year, until 2020/21.

- £300 million over the next four years to increase the number of PhDs and fellowship programmes, to develop research talent and attract the brightest minds to the UK.
- Investing £1.5 billion over the period 2016/17 to 2020/21 in the Global Challenges Research Fund for UK science to support research on global issues affecting developing countries. The Newton Fund will also be doubled to £150 million a year by 2021.
- £100 million investment to attract highly skilled researchers to the UK through its new Ernest Rutherford Fund. The Rutherford Fund will provide fellowships for early-career and senior researchers, from the developed world and from emerging research powerhouses such as India, China, Brazil and Mexico, helping to maintain the UK's position as a world-leader in science and research.

7.3.2.4 Government departments and their agencies

The following section provides background information on those departments and agencies who are engaged with the climate research agenda.

BEIS is the lead government department covering mitigation policy and, as highlighted above, plays a central role in funding research into low-carbon technologies. BEIS also leads the UK Government input into the IPCC and provides funding for research that contributes to the climate science evidence base feeding into the IPCC.

Defra is responsible for several policy areas that are associated with GHG emissions including: agriculture, forestry, land management, waste, and fluorinated gases. Defra works with BEIS to ensure specific government policies on low-carbon energy and decarbonisation measures are sustainable and aligned with Defra's objectives on the environment, food production and rural economy including ensuring opportunities for maximising co-benefits such as cleaner air. Defra is also responsible for the adaptation agenda described above.

DFID has an active interest in the funding of climate science as part of its work leading UK efforts to end extreme poverty and tackle the great global challenges of the 21st century. Further details on DFID funding of research, which spans both mitigation and adaptation, can be found in the international cooperation section below.

DfT (and the Office for Low Emission Vehicles) is also heavily involved in low-carbon policy in the UK, given the significant contribution that transport emissions make to total UK emissions and the challenges in decarbonising this sector. The UK's ambition is for a modern, low-carbon, low-pollution transport system with zero emissions in 2050. In support of this, a range of research projects are being undertaken, including funding for innovative technologies such as lighter vehicles, longer-lasting car batteries, charging and grid support, zero-emissions Heavy Goods Vehicles and advanced fuels.

A number of agencies and public bodies exist to advise and implement the UK environmental strategy, including climate change:

- 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.
- The Centre for Environment, Fisheries and Aquaculture (Cefas) commissions and carries out a range of research activities connected to the aquatic environment, including the impacts of climate change and the UK's ability to adapt to it.
- Innovate UK is the UK's innovation agency. It drives productivity and growth by supporting businesses to realise the potential of new technologies, develop ideas and make them a commercial success. It is heavily involved in the funding of research into low carbon technologies.

The UK Space Agency consolidates funding for space programmes from across government, the Research Councils and other public bodies. The UK Space Agency is responsible for civil 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 including CEOS. Climate change science and adaption is a core priority in terms of fundamental science, space missions, data management, processing and analytics and the generation of climate services.

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. PHE has been working steadily on the scientific basis for action on sustainability. PHE scientists were actively engaged in the development of the second UK Climate Change Risk Assessment, partner with a number of institutions researching the impacts climate change may have on health (for example through the Health Protection Research Unit in Environmental Change and Health) and are evaluating evidence of a number of interventions designed to mitigate the ill-effects of a changing climate, so that future policies are informed by the best available evidence

7.3.2.5 Devolved Administrations

The Scottish Government is a significant funder of research relating to the environment, fisheries, and agriculture. A major driver for this policy-related research is adaptation to, and mitigation of, climate change on Scotland's agriculture, rural communities and environment. In addition, a Centre of Expertise on Climate Change established by Scottish Government funding continues to provide an interface between policy and researchers, enhance the levels of knowledge exchange, and provide advice on both mitigation and adaption on policy areas ranging across energy, transport, housing and health, agriculture and the environment.

The Welsh Government is engaged as an active partner in a number 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 range of additional climate change research and funds Natural Resources Wales to act as its principal adviser on the environment

7.3.2.6 Coordination mechanisms

In addition to the underpinning climate science vision discussed above, there are specific coordination mechanisms and functions that help to guide UK climate science.

BEIS hosts the Government Office for Science which ensures that all levels of government receive the best scientific advice possible and create policies that are supported by strong evidence. The Government Office for Science runs the Foresight Programme which helps

the UK government to think systematically about the future, based on the latest science and evidence. One current foresight project concerned with climate change is the Future of the Sea, which is considering the role that science and technology can play in understanding and providing solutions to the long-term issues affecting the sea, including climate change.

The Research & Innovation for our Dynamic Environment (RIDE) Forum has evolved from the Living With Environmental Change (LWEC) partnership, which provides coordination and alignment of research activities in environmental change. It is a forum of 19 public sector member organisations who hold a stake in environmental change research, innovation, training and capabilities, whether that be as funders, providers and/or users. The RIDE Forum's unique contribution lies in its breadth. It brings together the complementary resources of the many different disciplines and publically-funded sector stakeholders needed to increase our understanding of the natural, social, economic and technological systems interacting with environmental change and the translation of that knowledge into innovating policy and practice. It focuses on the UK perspective and challenges, whilst necessarily placing that in the international context.

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) 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.

For UK Government-funded research into low-carbon technology, the Energy Innovation Board has been formed to replace and build on the work of the Low-Carbon Innovation Coordination Group to provide an even greater opportunity to collaborate at a strategic level. This new Board was Chaired by Sir Mark Walport, the Government's former Chief Scientific Advisor, and is currently Chaired by Professor Chris Whitty and attended by senior civil servants across BEIS, Innovate UK, Research Councils, DCLG, Defra, DFID, DfT, Ofgem and with HMT as observers.

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.

7.3.2.7 Research Councils and UK Research and Innovation (UKRI)

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 research councils are:

- 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)

Each research council has a particular strategic perspective on funding of climate science. NERC is the UK's leading public funder of environmental science. NERC invests around £290 million each year in cutting-edge research, postgraduate training and innovation in universities and research centres, alongside £34 million capital in world-class laboratories, plus additional capital in large research infrastructure. Climate change is a fundamental issue for NERC-supported research which aims to address 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 spatial 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 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.

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 carbon dioxide emissions. EPSRC's specific focus is on engineering and scientific research into new low-carbon energy technologies, both for energy generation 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) and improvements to the input into models (i.e. better sensors and data acquisition). Research on mitigation and adaptation strategies for energy and infrastructure is 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.

ESRC views understanding the social science of climate change as an important area for its funding. ESRC recognises the need to both lead specific areas of social science relevant to climate change, for example related to economics, and also to contribute to interdisciplinary research to understand issues such as decision-making, human behaviour and governance in the context of the wider research agenda.

MRC has over-arching strategic priorities related to climate science, including exploring the relationship between our environment and human health and wellbeing, and the impacts on

human disease. The MRC encourages partnership working in the international community to accelerate progress in global health research, including addressing the challenges which arise from climate change.

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.

STFC works with partners, such as NERC, the Met Office, Defra, BEIS and industry, to enable climate change research. STFC's main research areas are astronomy, particle physics and nuclear physics, but it hosts and provides access to world-leading facilities, technologies and expertise serving the whole of the UK research base. Examples of this include operating the Centre for Environmental Data Analysis[166], managing the IPCC Data Distribution Centre[167], providing data services for the Copernicus Climate Change Service and the European Space Agency, leading the development of data standards and data service standards in the context of the World Climate Research Programme (WCRP) Coupled Model Intercomparison Project (CMIP), and hosting the JASMIN data storage and analysis platform.

Following the Nurse review of Research Councils in 2015, the UK Government is implementing the headline recommendation of the establishment of a single research and innovation funding body – UK Research and Innovation (UKRI). It will incorporate the seven existing Research Councils, Innovate UK and the research funding roles of the Higher Education Funding Council for England. UKRI will catalyse a more strategic, agile and interdisciplinary approach to addressing global challenges and play a key role in helping the UK strengthen its competitiveness as part of its Industrial Strategy.

7.3.3 International cooperation

This section describes the extensive work that the UK undertakes in climate-related research with partners across the globe. It presents a broad look at international collaboration before discussing examples of UK support for adaptation and mitigation projects. Finally there is a discussion of potential barriers to exchange of relevant data.

7.3.3.1 International Programmes and Collaboration

The UK is an enthusiastic participant in a wide range of international programmes related to climate science and recognises the value of collaborations that enable scientists from differing countries and regions to work in partnership and to leverage UK expertise in support of significant global challenges.

Funding for a number of international programmes comes from two major sources, the Global Challenges Research Fund[168] (GCRF) and the Newton Fund[169]. From 2016 to 2021, the GCRF will invest £1.5 billion in funding that harnesses the expertise of the UK's world-leading researchers, focusing on challenge-led disciplinary and interdisciplinary research on development issues. It mobilises the UK's world-leading research base to address key challenges facing developing countries, including threats to the sustainability of natural resources; flooding and famine resulting from climate change and environmental degradation.

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166 http://ceda.ac.uk

167 http://www.ipcc-data.org

168 http://www.rcuk.ac.uk/funding/gcrf/

169 http://www.newtonfund.ac.uk/

The Newton Fund builds research and innovation partnerships with 18 partner countries to support their economic development and social welfare, and to develop their research and innovation capacity for long-term sustainable growth. The total budgeted UK investment for the Newton Fund is £735 million from 2014 to 2021. Examples of this research are provided in the subsequent section.

The UK continues to be an active supporter and contributor to the work of the IPCC. During this current assessment cycle, members of the UK research community will participate as coordinating lead authors, lead authors and review editors. Several research programmes also seek to contribute to the body of evidence to be assessed in the IPCC special reports and assessment report this cycle. Additionally, BEIS funds the IPCC Working Group III Technical Support Unit, which is co-chaired by Prof Skea of the UK and Prof Shukla of India, with a grant for up to £2.56 million.

The World Climate Research Programme (WCRP) is a joint programme of the World Meteorological Organization (WMO), the International Council for Science (ICSU) and the International Oceanographic Commission (IOC) established to determine the predictability of climate and the impact of human activities on climate. Research programmes co-ordinated by the WCRP have made huge contributions to our understanding of climate models, the climate system and the prediction and impacts of climate change.

The UK are heavily involved in WCRP and UK scientists lead the majority of the Grand Challenges including Clouds, Circulation and Climate Sensitivity, Carbon Feedbacks in the Climate System, Weather and Climate Extremes, Regional Sea-level Change and Coastal Impacts and Near-Term Climate Prediction. The UK also has representation on WCRP Working Groups, for example the Working Group on Coupled Modelling, Working Group on Numerical Experimentation, Working Group on Subseasonal to Interdecadal Prediction, Working Group on Regional Climate as well as the WCRP Advisory Councils on modelling and data.

UK researchers have worked together with European partners on a large number of Horizon 2020-funded programmes. Examples of these include:

- PRIMAVERA - developing a new generation of advanced and well-evaluated high-resolution global climate models, capable of simulating and predicting regional climate with unprecedented fidelity, for the benefit of governments, business and society in general.
- CRESCENDO - a coordinated European contribution to the **6th Coupled Model Intercomparison Project** (CMIP6). CRESCENDO in particular better informs a number of key Model Intercomparison Projects (MIPs) where biogeochemical and aerosol components are of critical importance to delivering realistic future projections.
- **EUSTACE (EU Surface Temperature for All Corners of Earth)** - providing publicly available daily estimates of surface air temperature since 1850 across the globe for the first time by combining surface and satellite data using novel statistical techniques.
- **EUCP (European Climate Prediction system) - developing** an innovative ensemble climate prediction system based on high-resolution climate models for Europe for the near-term (approximately 1 to 40years). This will be used to produce consistent, authoritative and actionable climate information, to support climate-related risk assessments and climate change adaptation programmes and underlain by authoritative methodological guidance.

- TRANSRisk (Transition Pathways and Risk Analysis for Climate Change Mitigation and Adaptation Strategies) – assessing low-emission transition pathways that are technically and economically feasible and acceptable from a social and environmental viewpoint.
- INNOPATHS (Innovation Pathways, Strategies and Policies for the Low-Carbon Transition in Europe) – working with work with key economic and societal actors to generate new, state-of-the-art low-carbon pathways for the European Union.

The UK is a member of the Joint Programming Initiative "Connecting Climate Knowledge for Europe" (JPI Climate), a platform to address European societal and research objectives on climate change. It aligns research priorities according to a jointly-agreed Strategic Research and Innovation Agenda, with the aim of complementing and supporting other initiatives at the European level. JPI Climate facilitates the coordination and collaboration in order to help underpin European efforts to confront climate change. UK researchers have participated in JPI Climate project calls, all of which feature extensive collaboration with European and non-European partners. Examples include:

- INTEGRATE - an integrated data-model study of interactions between tropical monsoons and extra-tropical climate variability and extremes
- EUPHEME - demonstrating the capability of an integrated attribution system to meet the needs of European stakeholders for advice on how the risks of extreme weather and climate events are being affected by human-induced climate change.
- WINDSURFER – developing new methods and tools to better quantify current extreme wind and wave risk and understand how it might change in the future.

The UK is taking forward research and development on mitigation and adaptation technologies under the Joint Programming Initiative on Agriculture, Food Security and Climate Change (JPI-FACCE) European Research Area Network on Greenhouse Gases from Agriculture and Silviculture. We are also developing our understanding of mitigation and adaptation through engagement with the Global Research Alliance on Agricultural GHGs.

The Belmont Forum is a group of the world's major and emerging funders of global environmental change research. It was co-founded by NERC and the National Science Foundation (USA) in 2009. Currently there are 24 BF members and 6 partner organisations, and NERC sits on the steering committee.

The purpose of the Belmont Forum is to enable its members and their research communities to address some of the key challenges and opportunities presented by global environmental change through developing multilateral, transdisciplinary Collaborative Research Actions (CRAs) that build on existing, national investments and where working nationally is not adequate to address the scope of the challenge.

NERC has partnered with key international funders under the Belmont Forum and JPI Climate on a collaborative research call on 'Climate services, climate predictability and inter-regional linkages'. The aim of the call is to contribute to the overall challenge of developing climate services with a focus on interregional linkages role in climate variability and predictability. Within this NERC funding is specifically supporting research whose aim is to improve some aspect of our understanding of linkages (tele-connections) between the climate in the polar regions and the tropics. This is particularly in relation to the monsoon systems, with the aim of improving the prediction of monsoon rainfall on sub-seasonal to decadal timescales and/or future changes in the polar regions.

In 2015, the Foreign and Commonwealth Office brought together scientists and officials from the governments of the UK, US, China and India to better understand the global societal risks posed by climate change in the 21st century. The resultant 'Climate Change: A Risk Assessment' report (2015) assessed future emissions and the subsequent response and what the implications of this were for systemic global risks.

7.3.3.2 Climate understanding and adaptation

The UK recognises that the damaging impacts of climate change are already being felt in countries around the world and that weather and climate play a significant role in the daily lives of many people. This is particularly the case in the developing world where exposure and vulnerability are high. As such, the UK places great importance on cooperation with international partners to deliver research that will help those most impacted by the world's changing climate.

Whilst it is possible to identify interventions that will increase the resilience of poor peoples' livelihoods to an uncertain climate future, the range and cost of adaptation options and improved resilience measures could be significantly improved by enabling the production of more accurate and tailored climate and weather forecasts and enhanced operating procedures for responding to forecasts and early warning systems.

The UK, and DFID in particular, is supporting research programmes that increase capacity in this area and advance our knowledge of the practical application of climate science in the developing country context.

To better understand and improve confidence in predictions of climate variability and change across sub-Saharan Africa on timescales to support adaptation, DFID and NERC are investing in a £20 million Future Climate for Africa research programme. This programme has a major focus on climate science and modelling, underpinned by the principle of informing real decisions, with an emphasis on enhancing the usefulness of climate science and projections, and by adopting a multidisciplinary approach.

On shorter timescales, the Weather and Climate Information Services for Africa programme (WISER) is on track to deliver transformational change in the quality, accessibility and use of weather and climate information at all levels of decision making for sustainable development in Africa. The Met Office is leading the East African component of this programme, enhancing national and regional weather observing and forecasting capabilities in the region. Pan-African work is led by the UNECA African Climate Policy Centre (ACPC).

Identifying pathways for adaptation and improved resilience are key features of the development landscape. DFID research is helping countries find different ways of adapting to climate change. The Building Resilience and Adaptation to Climate Extremes and Disasters (BRACED) programme is helping people become more resilient to climate extremes in South, Southeast Asia, in the African Sahel and neighbouring countries. This is through improved integration of disaster risk reduction and climate adaptation methods into development approaches, influencing local, national and international policies and practices.

DFID recognises that adaptation support needs to be underpinned with rigorous research and evidence, to inform decision-making. 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' - areas where a strong climate change signal is combined with a large concentration of vulnerable, poor, or marginalized people - by supporting collaborative research to inform adaptation policy and practice. The Science for Humanitarian Emergencies and Resilience (SHEAR) research programme, co-funded with NERC, leads DFID's efforts to improve understanding of how climate/weather observations and forecasting can lead to more effective

decision-making to reduce exposure of the most vulnerable to the increased risks posed natural hazards, including those presented by a changing climate, through measures such as provision of risk information, early warning systems and forecast-based financing.

DFID and NERC are also currently jointly investing in a £4 million, 18-month research programme on understanding the impacts of El Niño events. This programme aims to address the need to have a better understanding of the impacts of the El Niño event in low and middle income countries. The aim of the work is to ultimately contribute increased resilience to El Niño events.

DFID, NERC and ESRC are jointly funding work to investigate interlinked environmental systems, how they relate to poverty alleviation and how they may be impacted by future environmental change (including climate change). ESPA (Ecosystem Services for Poverty Alleviation), was a £41 million programme, providing new knowledge to demonstrate 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.

Through the Newton-Bhabha Fund, NERC is working with India on a number of programmes relevant to climate change. For example, the Sustaining Water Resources for Food, Energy and Ecosystem Services programme (£3m UK contribution, with matched Indian research effort) is aiming to develop a whole systems approach to basin modelling to enable informed decision making about the management of India's water resources. These models will have a forecasting capability that can be used to study future trends including the impact of climate change. In addition, NERC and India's Ministry of Earth Sciences are currently developing a Ganga Delta – Bay of Bengal Interactions programme, which, over the coming years will invest £4.8 million (matched through equivalent Indian research effort) to understand how the Ganga Delta and Bay of Bengal are being impacted by climate change and human activity and how the risks to the ecosystem services they provide can be mitigated.

Other work with Indian partners includes a £5.7 million project assessing Drivers of variability in the South Asian monsoon. This programme focuses on processes driving variability, seasonality and predictability in the South Asian monsoon, with the goal of improving predictions on all timescales. A coordinated field campaign happened in 2016 utilising NERC aircraft. Finally, a UK-India Joint Virtual Centre on Clean Energy is being developed to solve the integration problem with smart grids and energy storage, and develop affordable, renewable energy solutions for communities that do not have access to reliable electricity supplies.

The Weather and Climate Science for Service Partnership Programme (WCSSP) comprises projects to develop partnerships harnessing UK scientific expertise to build the basis for strengthening the resilience of vulnerable communities to weather and climate variability, supported by the UK government's Newton Fund. The Met Office is a Newton Fund delivery partner on behalf of UK government and administers the fund through the WCSSP programme which currently includes the following projects: the Climate Science for Service Partnership China (CSSP China), the Weather and Climate Science for Service Partnership South Africa (WCSSP South Africa) and Climate Science for Service Partnership Brazil (CSSP Brazil).

As part of CSSP China, for example, the MOHC has identified skill in predicting summer rainfall in the Yangtze river basin months ahead using its seasonal forecasting model. This skill has led to the development of a prototype seasonal forecasting product for the China Meteorological Administration (CMA) who use it, along with their own forecast, to advise different water

management organisations in the Yangtze basin including the Three Gorges Dam. New CSSP China climate service prototypes are currently in development around wind energy, food security and urban resilience.

Sharing and effectively communicating this growing body of research evidence to policy makers is vital for focusing efforts to combat climate change. Decision makers are therefore being supported by the Climate and Development Knowledge Network (CDKN) through the design and delivery of climate compatible development. CDKN priorities have ranged over time, from climate risk analyses to strengthen resilience, to supporting climate negotiators from least developed countries.

7.3.3.3 Mitigation technologies

Promoting the development of low-carbon technologies and encouraging their uptake will help developing countries achieve a cleaner future that supports economic growth. To that end, in recent years there has been a significant expansion in UK aid support to clean energy access research and innovation, aligned with the UN Global Goal 7 and a recognition in that framework of the centrality of technology innovation and diffusion, particularly regarding clean technologies.

UK aid-funded research and innovation support to clean energy includes substantial contributions targeting Sustainable Energy, Access and Gender (SEAG), New Energy Applications and Delivery Models (NEADM) with Shell Foundation, Green Mini Grids Africa, the Moving Energy Initiative (MEI) supporting sustainable energy provision in humanitarian situations, and the Crowd Power programme which is testing crowdfunding platforms as a way of securing finance.

DFID support has also included substantial multilateral contributions, generating knowledge and data public goods via the World Bank Energy Sector Management Assistance Programme (ESMAP) in areas aligned with the 3 Global Goal targets, a stream of funding alongside Research Councils into primary 'cleantech' research and innovation in universities, in addition to a programme seeking to scale up access to clean cooking solutions and improve the sustainability of bioenergy use.

DFID continues to improve efficiency of delivery of vital services to strengthen resilience to shocks and assist in enabling clean development and has recently sought to do this in partnership with the private sector. For example the Mobile for Development Utilities (M4D) fund_ has supported 21 clean energy technologies with grant funding and business development assistance. The fund, implemented by the mobile phone operator trade body GSMA (Groupe Spéciale Mobile Association), helps early-stage businesses take their mobile-based innovations towards scale by partnering with mobile network operators in country.

DFID is also partnering with Unilever on the TRANSFORM research programme, to pilot and help scale-up innovative modern energy business solutions for low income household needs. To date, the programme has supported eight small, clean energy businesses across sub-Saharan Africa and South Asia.

7.3.3.4 Barriers to dissemination of research

Despite the extensive body of collaborative research undertaken by UK scientists, it is recognised that barriers continue to exist to the dissemination of data and research. The UK Government believes that Open Access to research is a public benefit which enhances transparency, scientific integrity and rigour, stimulates innovation, promotes public engagement, and improves efficiency in research. The UK is widely recognised as being the leading nation in the Open Access and Open Data movements.

Since the Finch Report[170] was published in 2012, the UK has made substantial progress towards the objective of ensuring that publicly-funded research is made available through an Open Access route. From 2017 it is anticipated that almost all journal articles published by UK university academics will be available under Open Access routes. Of these, approaching 20% will be available on the date of publication and without any further restriction. These figures are higher than anywhere else in the world. Such progress has been stimulated by:

- Clear mandates and, in some cases, financial support from RCUK, the Funding Councils, and major charitable funders
- The development of a dense network of institutional repositories at universities, complemented by subject repositories
- The development of new routes to Open Access by publishers and Learned Societies
- The development of an underpinning infrastructure

Nevertheless further effort is required. To this end, in 2015 the Minister for Universities and Science, Jo Johnson, requested an independent report from Professor Adam Tickell, Chair of the UK Open Access Co-ordination Group, on open access to research policy. As part of this advice, a recommendation was made that a roadmap for national open research data infrastructure be produced, with a set of recommendations. A Taskforce was established to deliver this.

The first Taskforce report[171] observed that there remain significant barriers to sharing data, including the lack of infrastructure for data access and preservation, concerns about personal or commercially confidential information, or lack of incentives for researchers.

The report also notes that NERC's commitment to data sharing means that the situation for environmental data is somewhat better than that in most other subject areas. NERC operates a number of data centres (*http://www.nerc.ac.uk/research/sites/data/*), which are responsible for maintaining environmental data and making them available to all users. Data is made available under the NERC data policy, which specifies that NERC-funded scientists must make their data openly available within two years of collection and deposit it in a NERC data centre for long term preservation. NERC makes its environmental data available free of charge apart from special cases that involve third party data (there may be a charge for information products).

NERC has developed a data catalogue service based on a metadata standard designed to meet the requirements of the GEMINI2 profile which represents the implementation in the UK of the EU INSPIRE directive for environmental information. All NERC discovery metadata is required to meet this standard.

NERC is developing the roles of its data centres into a more integrated user-focused set of services, aiming to maximise the economic and social impact of environmental research. As part of this strategy, it is developing a Data Commons which provides both storage and computing power, along with work spaces and data labs that enable researchers to bring data and computation to the archive of datasets preserved in the centres. But it is also developing tools – web interfaces, apps, machine-to-machine interfaces and the like – and other services that can transform data into information products for a variety of users in environmental communities, business, and the public sector, as well as in academia. And through partnerships

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[170] https://www.acu.ac.uk/research-information-network/finch-report

[171] http://www.universitiesuk.ac.uk/policy-and-analysis/research-policy/open-science/Pages/open-research-data-task-force.aspx

with other organisations – notably the Environmental Science to Services Partnership with the Met Office, the Environment Agency and the Ordnance Survey – it is establishing hubs, thematic clusters and portals, some of them linked to the EU INSPIRE programme.

7.3.4 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.

Success in climate services is a combination of having the right information and being able to interpret it effectively to generate valuable guidance. The UK has world leading scientific, technical and policy expertise on climate change adaptation and mitigation.

In the UK, the Met Office leads on climate services and provides them for and on behalf of UK Government for a variety of end-users. For example, the MOHC Climate Programme provides tailored climate services around food security and UK farming impacts to UK government. One aspect of this service quantifies the risk of certain pests and pathogens surviving in the UK with warmer seasons. Another measures current weather and climate risk to UK wheat yields and how it may change in the future.

The MOHC Climate Programme also provides a climate service around carbon budgets and air quality. This focuses on the impact of climate change on air quality, highlighting the benefits of climate change mitigation on air quality across all continents.

Other services might be mandated by government but delivered to, for instance, industry. For example, the Met Office has been providing the energy industry with tailored seasonal forecasts during winter, to support their decision-making. Others could be in support of government Official Development Assistance (ODA) actions and feed into international users such as the CSSP China Three Gorges Dam climate service prototype. Other climate services could inform a wider community wishing to adapt or provide a tool for other climate service providers who focus on adaptation to incorporate into their work (e.g. UKCP18).

The Met Office's National Climate Information Centre (NCIC), which provides an accessible catalogue of UK weather and climate information going back hundreds of years, also provides a climate service to the public.

Beyond the Met Office, The British Atmospheric Data Centre (BADC) can help businesses, entrepreneurs and innovators create 'bridging' tools, such as software. These bridge the gap between datasets, which BADC hold, and front line decision-making products. The BADC helps researchers locate, access, and interpret atmospheric data. BADC is also the UK node for the Earth System Grid Federation, the repository for the world's leading research and modelling on global climate change.

UK universities have a strong track record providing environmental services and this is expanding overseas. For example, a range of universities are a part of the Adaptation and Resilience in the Context of Change Network which supports capacity building, awareness raising and informs new approaches to identify, assess and address climate risk from evolving science and research.

Recent work by the Environment Agency demonstrates the practical application of climate services and the strength of UK expertise in this area. The Environment Agency produced Thames Estuary 2100, a management plan for the River Thames, by developing a 'Flexible Adaptation Pathways' methodology. This work is a critical part of the Thames Estuary's long

term flood investment strategy. The pathways approach has since been used in the USA, the Netherlands, Australia and New Zealand, and ensures flood risk management plans are adapted to cope with extreme climate impacts.

The Environment Agency, along with Defra, have since 2009, used the Adaptation Reporting Power (ARP) to work with over 100 UK infrastructure businesses and public bodies to help them identify their vulnerabilities to extreme weather and develop action plans to increase their resilience.

7.3.5 UK Research Programmes

The following section describes examples of UK funded research programmes, addressing the priority areas identified in UNFCCC guidance.

7.3.5.1 Climate process and climate system studies, including paleoclimate 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.

Cryosphere:

Changes in Antarctic 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. However there remain large uncertainties deriving from the cryosphere in predictions of future sea level rise over the 50-200 year time horizon. NERC has provided £7.4 million to the Ice Sheet Stability research programme (primarily focused on the Pine Island Glacier), with the goal of improving our 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.

NERC, in partnership with the National Science Foundation in the US, is also investing in research on the Thwaites Glacier. The 2015 SCAR (Scientific Committee on Antarctic Research) horizon scan singled out this location as a 'region of particular concern' with grants funded under this programme aiming to substantially improve decadal and longer-term (century to multi-century) projections of ice loss and sea level rise originating from the Thwaites Glacier.

Polar oceans:

The Southern Ocean is one of the most important components of the global carbon cycle, having captured half of all human-related carbon that has entered the ocean to date. This vast anthropogenic perturbation to the Southern Ocean carbon system is activating a range of complex climate feedbacks, many of which are poorly understood and quantified.

NERC is investing in two complementary research programmes to address the uncertainties in the future behaviour of the Southern Ocean carbon sink and therefore substantially reduce uncertainty in 21st century global climate change projections. The Ocean Regulation of Climate by Heat and Carbon Sequestration and Transports, is an £8.4 million programme that will focus on a subset of the physics of heat and carbon uptake. The Role of the Southern Ocean in the Earth System is a £7 million programme that addresses the biogeochemistry of this region.

Atmospheric circulation:

Improved prediction of the European climate is critical for the UK, with the impacts of unusual weather episodes such as the 2003 heat wave, 2010 cold winter and 2012 wet summer felt across society and the economy. Recent developments in observation, modelling and data

reanalyses provide an exceptional scientific opportunity to increase understanding of the causes and predictability of these unusual seasons. NERC is investing £2.5 million to establish the underlying processes and mechanisms that underpin regional climate variability, assess the representation of those processes in climate models, and develop improvements to the models and hence regional climate predictions from months to years ahead.

Surface temperature trends:

NERC is investing in a £3 million project to better understand the causes of periods where the rate of global mean surface temperature is increased or decreased at decadal time scales compared with long term trends at centennial time scales. This work aims to generate new knowledge of the drivers, processes and mechanism causing observed anomalous periods, in order that long-term climate predictions can be generated with greater confidence.

Methane budget:

The atmospheric level of methane has increased by 50% since the pre-industrial times and accounts for roughly 20% of the total increase in radiative forcing. Our understanding of the drivers of this trend remains limited and there are methodological disagreements, with emission estimates derived from process studies of sources differing from those from direct observations of the air. NERC is investing £4 million in work aiming to close the global methane budget.

North Atlantic climate system:

Major changes are occurring across the North Atlantic climate system in ocean and atmosphere temperature and circulation, in sea ice thickness and extent and in key atmospheric constituents such as ozone, methane and aerosols. Changes in the North Atlantic directly affect the UK's climate, weather and air quality, with major economic impacts on agriculture, fisheries, water, energy, transport and health. The North Atlantic also has global importance since changes here drive changes in climate, hazardous weather and air quality further afield, such as in North America, Africa and Asia. NERC is investing £9 million in a five-year research programme to enhance the UK's capability to detect, attribute, and predict changes in the North Atlantic climate system.

Understanding dangerous climate thresholds:

UK scientists are investigating the possibility of crossing future dangerous thresholds in the climate system, such as irreversible decline of the Greenland Ice Sheet, dieback of the Amazon rainforest and collapse of The Atlantic Meridional Overturning Circulation (AMOC). For example, new work shows there is now greater confidence that partial irreversible loss of the West Antarctic Ice Sheet has already begun and that East Antarctica and northeast Greenland are potentially more sensitive to climate change than first thought, which has implications for future sea level rise and associated impacts.

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. The £10.1 million Changing Water Cycle 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.

Weather extremes and climate change:

Recent world-leading climate attribution research from the UK shows that the effects of climate change on some extreme weather and climate events can be detected with high confidence. The Met Office Hadley Centre has been contributing to the Bulletin of the American Meteorological Society (BAMS) special report on event attribution since its inception five years ago.

7.3.5.2 Modelling and prediction, including general circulation models

Climate modelling:

Climate modelling in the UK is led through the Met Office Hadley Centre Climate Programme, funded by BEIS and Defra. This relationship ensures that the world leading modelling capability of the UK, feeds directly into UK Government and informs policy. Significant developments have been made in this area through the installation of a new supercomputer at the Met Office. This opens up the potential for more detailed and higher resolution climate models, which will provide more accurate information on climate variability and change to decision-makers and society.

The latest collection of Met Office climate models (HadGEM3) shows many significant improvements relative to previous versions. This improved model is underpinning the latest generation of UK Climate Projections (UKCP18) as well as the UK Earth System model (UKESM), which will represent the UK contribution to the next coupled model intercomparison project (CMIP6) and the next IPCC Assessment Report (AR6).

The UKESM project is a £9 million collaboration between the Met Office and NERC to develop, apply and analyse the next generation of UK Earth System models. The first version of UKESM (UKESM1) includes a full representation of the global carbon cycle, enabling investigation of allowable carbon emissions compatible with long-term global temperature goals of 1.5 and 2°C. It also includes an advanced treatment of atmospheric chemistry and aerosols, facilitating investigation of the co-benefits of mitigation policies on both climate change and air quality. UKESM1 will also contain interactive treatment of both the Greenland and Antarctic ice sheets in the future, allowing more realistic projections of future global and regional sea level rise. This model forms a toolkit to ensure that climate policy is built on the best available climate science evidence base.

In addition to UKESM, NERC is investing £5 million (with resources matched by the Met Office) in its 'understanding and representing atmospheric convection across scales' programme. This will build on developments in understanding of convection in recent years to significantly improve the parameterisation of convection within models, which remains a limitation. This will lead to substantial improvements in both the weather and climate models that are critical to society's ability to reduce the impacts of hazardous weather and inform decisions regarding mitigation of and adaptation to climate change.

Climate prediction:

The UK views the prediction of climate variability and change for the coming seasons to a decade ahead as a key area of climate science. In recent years the Met Office seasonal and decadal prediction systems have been substantially upgraded to a much higher resolution in both the atmosphere and the ocean, resulting in significantly improved skill.

Key improvements include a new capability to predict the large-scale circulation in the North Atlantic region (the North Atlantic Oscillation), and hence European winter conditions, a season ahead using the Met Office seasonal forecasting system. This work has been extended to show that skilful prediction is now possible up to a year ahead, using the Met Office decadal

prediction system. This opens up the possibility of potential boosts in climate services on monthly to sub-yearly timescales for a range of sectors including transport, energy and the insurance industry.

Furthermore, skilful predictions of summer rainfall in other regions, that are sensitive to weather and climate variability, are now possible. This has been demonstrated in the Sahel, from months to years ahead. Predicting whether droughts will happen is a key goal of decadal climate predictions, and would enable early action to help prevent future humanitarian disasters.

7.3.5.3 Research on the impacts of climate change

Impacts of a 1.5°C rise in global temperature:

NERC, in conjunction with BEIS, is investing £1.2 million in projects which will provide evidence to the UK Committee on Climate Change and input to the IPCC Special Report on Global Warming of 1.5°C. The projects will advance understanding through addressing linkages between the cumulative level of future net emissions and temperature increases in the 1.5°C to 2°C temperature range, feasibility of pathway options that limit warming to 1.5°C and their additional consequences, and the environmental impacts of a 1.5°C temperature rise compared to 2°C.

Global impacts:

The MOHC is involved in HELIX (High-End cLimate Impacts and eXtremes), a major international programme assessing the impacts of climate change at specific levels of global warming – 1.5°C, 2°C, 4°C and 6°C above pre-industrial levels. HELIX is revealing findings of considerable policy significance, for example that river flooding risks are projected to increase, with countries representing more than 70% of the world's population and gross domestic product potentially seeing flood risks increase by over 500%.

Avoided impacts:

AVOID2 was a £1.45 million research programme to address the impacts, and impacts avoided, at different temperature targets (along with research on mitigation pathways and their feasibility). The clear conclusion was that that the impacts from 2°C global warming are considerably less than in a world where emissions of greenhouse gases continue at current rates. UK scientists continue to make advances in this area, for example with recent MOHC work demonstrating that the benefits of reducing greenhouse gas emissions can be detected much earlier than previously thought.

Arctic:

The Arctic is the fastest changing environment on the planet, supporting diverse yet still poorly understood ecosystems. Changes in the ocean and sea ice environment of the Arctic will generate major but unknown changes in Arctic ecosystems, affecting biological processes at every level of organisation- from genetics and physiology to food webs, biogeochemical cycles, species distribution and whole ecosystems. NERC is investing £16 million in a five-year research programme, the Changing Arctic Ocean, to understand how change in the physical environment (ice and ocean) will affect the large-scale ecosystem structure and biogeochemical functioning of the Arctic Ocean, the potential major impacts and provide projections for future ecosystem services.

Flooding from intense rainfall:

Intense rainfall events commonly last for a short period of time but present flood forecasters and flood risk managers with major problems. Our knowledge of processes associated with rainfall extremes is relatively poor and we cannot predict associated flood risks with any significant

degree of confidence. This knowledge gap is of particular concern as there is a widespread recognition that the occurrence of high-intensity rainfall is likely to increase as a result of climate change. There is an urgent need to develop new science with respect to intense rainfall events, in order to appropriately inform risk mitigation and management options and improved planning and operational maintenance. The NERC-led Flooding from Intense Rainfall programme is investing £5.2 million to improve the length and accuracy of forecasts of the occurrence and intensity of rainfall associated with convective storms; identify the susceptibility of different catchment types to high intensity rainfall; and enhance flood risk management.

Droughts and water scarcity:

Droughts and water scarcity jointly pose a substantial threat to the environment, agriculture, infrastructure, society and culture in the UK, yet our ability to characterise and predict their occurrence, duration and intensity, as well as minimise their impacts, is often inadequate. Five UK research councils (NERC, in collaboration with ESRC, EPSRC, BBSRC and AHRC) are investing £12 million in a five-year interdisciplinary research programme to support improved decision making in relation to droughts and water scarcity by providing research that identifies, predicts and responds to the interrelationships between their multiple drivers and impacts.

7.3.5.4 Socio-economic analysis, including analysis of both the impacts of climate change and response options

Much of the UK's work in this area is internationally facing. The ESRC Centre for Climate Change Economics and Policy was created in 2008 and has been influential in shaping debate within the international climate change community including the World Bank and OECD. Additionally, CCCEP have undertaken activities nationally such as influencing policy changes to the UK's Flood RE insurance scheme and have delivered in excess of 600 publications to the research field so far.

The Nexus Network has taken a holistic approach looking at the interactions between Food-Energy-Water within the Environment including climate change. This has led to an influential Nexus 2020 report which engaged with 250 stakeholders to create the 40 most important research questions for business sustainability. ESRC has also been active in Europe through the JPI Climate programme, including the European Perceptions of Climate Change project.

Research also addresses UK specific needs, for example ESRC created urgency funding to respond to the UK flooding that took place in 2013 and investigate the social aspects of those floods.

ESRC is also now building a platform for future work in the social space, having just agreed a new priority research area in climate change. This will build on existing investments in this space to build the evidence base on governance and behaviour, to understand what is needed to make effective policies, as well as understanding climate risk, trust and communication and the impact this has on decision making at a national, regional and community level. ESRC also intends to continue research relevant to the Food-Energy-Environment-Water Nexus, and how managing climate change can affect these interrelationships.

7.3.5.5 Research and development on mitigation and adaptation technologies.

Note that examples of this theme of research are also found above in the discussion of research and international cooperation.

Government funded innovation

As described earlier, the UK government is investing significantly in lowcarbon innovation. At Autumn Statement 2015, the government committed to double the UK's energy innovation spend, such that by 2021 it will have doubled to over £400 million per year, with £2.5 billion expected to be invested by 2021 across low carbon energy, transport, agriculture and waste.

Energy innovation has seven sectors:

- Innovative renewables - investing in renewable energy innovation to bring the cost of technologies down. This includes around £177 million in investments from BEIS, Innovate UK, and the Research Councils.
- Innovative smart energy system technologies - enabling a smarter, more efficient energy system is a priority for the UK Government. In the "Upgrading our energy system: smart systems and flexibility plan" published in July 2017, the Government committed up to £70 million to smart energy system innovation, with additional contributions from Innovate UK and Research Councils, resulting in a total investment of around £265 million in smart systems research, development, and demonstration.
- Nuclear innovation – an investment of around £460 million across Government, Research Councils and Innovate UK.
- Innovative low carbon industry – Government is expected to invest around £162 million in industrial research and innovation, including Carbon Capture, Use and Storage (CCUS). As part of this commitment, BEIS expects to invest around £100 million in low carbon industrial innovation to reduce the risks and costs of accelerating the roll out of low carbon technologies which will enable UK industry to remain competitive.
- Green finance - Government is supporting private investment into sustainable projects and infrastructure. The City of London's Green Finance Initiative was established in 2016 at the request of Government to promote the UK as a global centre for green finance. Government has supported the LENDERS project through Innovate UK which aims to improve estimations of energy costs for homeowners when calculating mortgage affordability. To build on the UK's global leadership in the sector, BEIS and HMT will be co-hosting a Green Finance Taskforce that will bring together senior leaders from the financial sector. This Taskforce will work with industry to accelerate the growth of green finance, and help us deliver the investment required to meet the UK's carbon reduction targets.
- Energy entrepreneurs fund - a competitive funding scheme to support the development and demonstration of state-of-the-art technologies, products and processes in the areas of energy efficiency, power generation and heat and electricity storage. The Energy Entrepreneurs Fund seeks the best ideas, irrespective of source, across these energy technology areas from the public and private sector. The scheme particularly aims to assist small- and medium-sized enterprises, including start-ups, and those companies that are selected will receive additional funding for incubation support. Since 2012 there have been five phases of the Energy Entrepreneurs Fund. Over that time BEIS has invested around £50 million of grant money in over 100 companies. Those companies have secured over £35 million in private funding and are still attracting further investment. Phase six was launched in the Clean Growth Strategy in October 2017.

In line with the doubling of our domestic energy innovation programme, the UK will continue to play a leading role in international research efforts to reduce the costs of low carbon energy,

working with other countries to strengthen collaboration and transparency in clean energy research, development, and demonstration. To demonstrate this commitment, at the COP21 climate change conference in Paris, the UK joined Mission Innovation.

Mission Innovation is an international initiative which aims to accelerate clean energy investment and innovation in order to provide reliable and affordable energy for all.

Lower carbon energy system and economy:

The use of low-carbon sources of energy could pose challenges to the security and reliability of energy supply. A £2 million SUPERGEN Energy Networks Hub (HubNet) set out to drive innovation in electricity, gas and heat networks and planning, smart grid operation and control, new network and infrastructure technologies and firstly understanding and then utilising the demand-side of the energy equation. A good example of the HubNet work with economic and policy impact is the development of a Dynamic Transmission Investment Model (DTIM) which determines optimal network plans given data on the generation mix and demand and data on the cost of transmission assets, storage, demand-side action and cost of interruptions. It demonstrated potentially significant interaction between offshore grid and interconnection among North Sea countries and assessed the benefits of offshore grid taking the role of interconnection.

Greenhouse gas removal:

The large scale removal of greenhouse gases from the atmosphere is assumed in nearly all global scenarios that succeed in holding the increase in the global average temperature to well below 2°C above pre-industrial levels. The feasibility, mechanisms and implications of greenhouse gas removal (GGR) are, however, insufficiently understood. NERC, along with EPSRC, ESRC and BEIS, are investing £8.6 million in projects aiming to better define the 'real world' feasibility of GGR techniques that might significantly assist in achieving climate policy goals from a range of technical, economic, societal and environmental perspectives. The GGR research programme will also synthesise and assess existing and newly-acquired information on potential GGR techniques, making those informed assessments easily available and useful to the national and international policy-making community for maximum impact.

Air pollution and urban environmental control:

Currently, approximately half of the energy use, carbon dioxide emissions and exposure to air pollution in cities is due to either buildings or transportation and this level is increasing. EPSRC is investing £4.1 million in a five year research programme, called Managing Air for Green Inner Cities (MAGIC) at the University of Cambridge, to develop a facility consisting of an integrated suite of models and associated management and decision support tools that allow the city design to become its own heating, ventilation and cooing (HVAC) system.

Reduction in industrial energy use:

Reducing industrial energy demand could make a substantial contribution towards decarbonisation. EPSRC is investing in a £3 million Centre for Industrial Energy, Materials, Energy and Products (CIE-MAP) as part of the End Use Energy Demand (EUED) research centres. In close collaboration with industry and government partners, CIE-MAP aims to enable delivery of significant reductions in the use of both energy and energy-intensive materials in the industries that supply the UK's physical needs. The research area includes; (i) efficiency gains that can be made in industry including use of heat and improvements in processes; (ii) changing the use of materials needed to produce products including material substitution, light

weighting and circular economy; (iii) changing the way the final consumer (industry, households or government) use products to reduce energy demand including product longevity and shifts from goods to services.

Carbon capture, usage and storage (CCUS):

BEIS has announced that it will be investing up to £100 million to support CCUS and industrial energy innovation, this includes a £20 million Carbon Capture and Utilisation Demonstration Programme. EPSRC has invested a further £6 million to support the UK Carbon Capture and Storage Research Centre (UKCCSRC) up to 2022 to lead and coordinate a programme of underpinning research on all aspects of CCS in support of basic science and UK government efforts on energy and climate change. UKCCSRC brings together over 250 of the UK's world-class CCS academics to provide a national focal point for CCS research and development. A key priority is supporting the UK economy by driving an integrated research programme and building research capacity that is focused on maximising the contribution of CCS to a low-carbon energy system for the UK.

Bioenergy:

BBSRC and EPSRC jointly fund the £5 million Supergen Bioenergy Hub which brings together industry, academia and other stakeholders to focus on the research and knowledge challenges associated with increasing the contribution of UK bioenergy to meet strategic environmental targets in a coherent, sustainable and cost-effective manner. It will do this by taking a "whole systems" approach to bioenergy, so that we focus on the benefits that new technologies can bring within the context of the whole production and utilisation chain. In order to ensure focused research with rapid dissemination and deployment this will be done in close collaboration with industrial partners and other stakeholders, including government agencies. The hub will also take an expressly interdisciplinary approach to bioenergy, ensurin. important issues are addressed, such as the impacts of land-use change not just as scientific quantification exercises, but taking due account of the social and economic impacts. The science requirements of the bioenergy hub will be underpinned by the BBSRC Networks in Industrial Biotechnology and Bioenergy.

Marine renewable energy mix towards 2050:

The IEA International Vision for Ocean Energy sets a goal of installing 337 gigawatts of wave and tidal capacity, creating 1.2 million jobs and reducing CO_2 emissions by 1 billion tonnes by 2050. With the SUPERGEN Marine programme and the UK Centre for Marine Energy Research (UKCMER), EPSRC is investing in the world-leading research, innovation, development, demonstration and deployment of wave and tidal energy. For example, the three year EcoWatt2050 project is using computer models to simulate ways in which the deployment of multiple large scale wave and tidal energy arrays can be planned and arranged so as to minimise environmental impacts and offset effects of climate change.

7.4 Systematic observations

Systematic observations in the UK and its overseas territories are made by a number of national agencies and organisations. The UK Met Office is the lead agency for making and collecting meteorological and atmospheric observations, and participates in the Global Climate Observing System (GCOS). Observations are also made by others including the NERC Centres and Surveys. 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), the Scottish Environment Protection Agency (SEPA), Natural Resources Wales (NRW), 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.

The UK participates in many systematic observations programmes and considerably more detail can be found in Annex 3. A brief overview of the UK observations outlined in Annex 3 is given in the following sections.

7.4.1 Data quality

Considerable effort is devoted to quality control, especially in those areas where the UK has particular expertise. As the observations lead, the Met Office takes particular interested in this area. 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. Any changes to observing networks go through a robust set of checks before implementation to ensure that GCOS monitoring principles are upheld.

The Met Office climate network includes three stations which have been recognised as centennial observing stations as part of the WMO long-term observing stations initiative. Other subsets of the UK climate network, such as the Central England Temperature sites also recognise the importance of sites with long and unbroken records. The Met Office works closely with the observing sites to ensure the continuation of the record wherever possible and have automated a number of climate stations in the past.

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. This includes assessing exposure using the WMO CIMO siting classification for land observing sites.

In addition to the day-to-day treatment of data, larger projects related to data quality are periodically undertaken. For example, the Met Office recently moved to using a new model of radiosonde across the observing network and as part of the project an extensive programme of intercomparison flights were conducted at stations across the network (including the BAS radiosonde station at Halley). The purpose of these intercomparison flights was to ensure the relative performance of the old and new radiosondes is well understood and documented for future reference.

The Met Office is committed to the principles of free and unrestricted exchange of essential data, as defined by the World Meteorological Organisation Resolution 40, which sees meteorological observations from the Met Office observations networks made available to the meteorological community via the WMO Information System (WIS). A key development to ensure the continued availability of meteorological and environmental data internationally is the WMO Integrated Global Observing System (WIGOS). WIGOS is currently in the implementation phase and the Met Office is actively supporting WIGOS and leading its implementation within the UK.

7.4.2 Atmospheric observations

The UK's contribution to the Global Climate Observing System (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 UK land surface observing network currently comprises 242 ordinary climate stations and

157 synoptic stations. There are an additional 2645 rainfall-only stations. These stations are all compliant with GCOS standards, but are more subject to site changes or closures than the above networks.

The British Antarctic Survey (BAS) runs four 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), for their operational periods where the data have been digitised.

The Met Office contributes to the EUMETNET Surface Marine programme (E-SURFMAR) (managed by Meteo-France), which deploys around 120 drifting buoys per year in the North Atlantic, Nordic Seas and Mediterranean. The Met Office also procures and deploys around ten drifting buoys each year in the South Atlantic/Southern Ocean in support of the global drifter array.

The Met Office currently manages around 250 Voluntary Observing Ships (VOS) making manual observations of which around 220 meet climate (VOSClim) standards. It also operates the real-time monitoring centre for VOSClim data. The Met Office has further developed the Autonomous Marine Observing System (AMOS), which has now been installed on 59 ships, three land stations in the Falklands and one Met Office-Plymouth Marine Laboratory collaborative buoy in the English Channel.

Over the last two years, the Met Office has been developing a second-generation AMOS, which from 2018 is planned to be rolled out on all automated marine platforms. All VOS data are exchanged on the Global Telecommunication System (GTS) and available to the International Comprehensive Ocean-Atmosphere Data Set (ICOADS). This includes the contribution from two ships operated by BAS.

The Met Office presently operates ten moored buoys, mainly to the west of the UK and in Biscay, which contribute to the wider WWW/GOS surface network.

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 two sites in the UK, at Lerwick and Camborne. There are also two GUAN stations overseas: St Helena and Mt. Pleasant, and two GUAN stations in UK overseas territories: Gough Island (run by SAWS) and Bermuda. The Met Office assists BAS with its GUAN station at Halley and the BAS Rothera upper-air programme is GCOS compliant in all respects, except that it has flights on only four out of seven days a week. It is not a GUAN station but still submits its data via GTS. The Met Office also assists the GUAN sites: Seychelles, Rarotonga, Tarawa and Funafuti through the 'Voluntary Cooperation Programme' (VCP).

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 or 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 British Antarctic Survey routinely measures mesospheric temperatures at Rothera and Halley stations.

BEIS funds the DECC Network, is a network of tall tower sites which is used to monitor atmospheric concentrations of greenhouse gases in order to verify the UK's emissions inventory.

7.4.3 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.

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) for VOS data, with responsibility for basic quality control of ship data, and collection of those data in delayed-mode format (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 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 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 three from the UK itself (Lerwick, Newlyn and Stornoway) plus Gibraltar and eight 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 RAPID-26N program maintains an array of instruments spanning the Atlantic that is designed to monitor the Atlantic Meridional Overturning Circulation and the associated poleward transport of heat by the ocean. Lead by the NOC the array is a collaboration with the University of Miami and NOAA in the USA.

The UK Argo Programme contributes to the international Argo array that makes global measurements of temperature and salinity in the water column. The UK presently has around 165 active floats contributing to the Argo float array, including seven floats that make additional measurements of bio-geochemical variables. The UK Argo programme is managed by the Met Office and operated in partnership with NOC Southampton, BODC and PML.

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 timeseries in excess of 20 years and the observing meets the GCOS Climate Monitoring Principles (GCMPs).

7.4.4 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, 67 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

- Climate Change, and broader sustainability issues, feature in the educational curricula of the UK and its devolved administrations
- Since the Sixth National Communication, the UK has continued to develop the 2050s Global calculator, as well as supporting 10 countries in developing their own calculators. All 10 calculators have now been launched, along with Global calculator.
- The launch of the Government's Clean Growth Strategy included a dedicated Green Britain week to focus on climate and air quality issues across the UK

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. 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.

8.3 Education and training

8.3.1 England

The new National Curriculum was first taught in schools from September 2014. The programmes of study for science and geography cover sustainability and climate change in depth at key stage 3 and above. At primary school level pupils are taught about the fundamental concepts and relevant background knowledge that underpin this topic. Whilst the National Curriculum does not have to be followed in Academy schools, most do use it as a benchmark for the curriculum they deliver.

In science, primary school pupils are taught the scientific concepts that underpin weather, climate and biodiversity. For instance, in key stage 1(5-7 year olds), pupils are 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 (7-11 year olds), pupils are 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 are taught that environments can change, and that this can pose dangers to living things. They are also taught about the concept of gases and the movement of the earth relative to the sun.

All of these topics provide a firm foundation for the study of climate science in key stage 3 (11-14 years old), where pupils are taught about the composition of the atmosphere, the carbon cycle and the importance of recycling. Ecosystems and biodiversity are also covered in depth. Crucially, pupils are also taught specifically about the production of carbon dioxide by human activity and the effect that this has on the climate. The key stage 4 (14-16 years old) science curriculum sets out that pupils should be taught about evidence for the composition and evolution of the Earth's atmosphere since its formation, and the evidence, and uncertainties in evidence, for additional anthropogenic causes of climate change.

In geography, pupils are given more information about the different types of weather and climate in particular parts of the world, and the processes that give rise to them. In key stage 1, pupils are 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 are taught about climate zones, biomes, vegetation belts and the water cycle. At key stage 3, pupils are taught about change in the climate from the Ice Age to the present. In addition, pupils are taught how human and physical processes interact to influence and change landscapes, environments and the climate. They are also taught that human activity relies on effective functioning of natural systems.

8.3.2 Wales

The Welsh Baccalaureate Qualification (WBQ) is delivered at Foundation, Intermediate and Advanced levels in schools, colleges and training centres across Wales. Within the compulsory Core at each level, 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). Additionally, there are opportunities for students to undertake work experience and voluntary activity.

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.

8.3.3 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.

The purpose of CfE is to enable young people to become 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 sets 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 also developed a number of online resources, including resources on Weather and Climate Change ,and Exploring Climate Change (*https://education.gov.scot/improvement/036-weather-and-climate-changehttps://education.gov.scot/improvement/exploring-climate-change)*.

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 National Qualifications Geography Courses, National 3 to Higher, include an option to study Global Issues. These are:

- Climate Change;
- Natural Regions;
- Environmental Hazards;
- Trade and Globalisation;
- Tourism; and
- Health.

Similarly, the Environmental Science Courses are explored through the following areas of study:

- Living Environment;
- Earth's Resources; and
- Sustainability.

8.3.3.2 Learning for Sustainability (LfS)

In March 2013 Scottish Ministers accepted all thirty-one recommendations in the LfS Report from the One Planet Schools Working Group (published December 2012 - *http://www.gov.scot/Topics/Education/Schools/curriculum/ACE/OnePlanetSchools)* and an LfS National Implementation Group was established in February 2014 to deliver on the recommendations. In March 2016 the LfS National Implementation Group published its concluding report, 'Vision 2030+'. It noted the positive progress of LfS in Scottish schools whilst also making a number of recommendations to enable Scotland to meet the Group's on-going vision for LfS to 2030 and beyond. The Scottish Government is committed to building on the progress which has been achieved to date and is taking action to ensure the profile of LfS is both maintained and enhanced.

8.3.3.3 Learning for Sustainability Scotland (LfS Scotland)

Learning for Sustainability Scotland – Scotland's Regional Centre of Expertise (RCE) on Education for Sustainable Development (ESD) acknowledged by the United Nations University – 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.

8.3.3.4 Community learning – 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 over £85 million to 986 individual projects across 622 communities. Current Ministerial priorities focus on projects which deliver the greatest reduction in carbon emissions and support to Scotland's most deprived communities. The fund supports a range of activity and has helped communities to reduce, reuse and recycle their waste, increase the energy efficiency of homes and community buildings, encourage active travel and the use of low-carbon transport, and produce local food.

8.3.3.5 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 Higher Education

The development of local industry is a driving force for the courses provided by the Ulster University in the area of Renewable Energy Engineering, with the intention to develop the local talent to service the ever increasing need for capable engineers.

These courses, which include an MSc in Renewable Energy and Energy Management, a BSc in Energy and a BEng in Renewable Energy Engineering, provide industry-ready engineers to address the current issues in the industry as well as developing new forms of power generation and distribution.

The Centre for Sustainable Technologies at Ulster University undertakes multidisciplinary research to design, create, develop, improve, demonstrate and evaluate emerging, existing and alternative sustainable renewable energy, building design, construction materials, transport and environmental modification technologies. Current research projects include:

- Storage Platform for the Integration of Renewable Energy, focusing on how the wide-scale deployment of mass energy storage can allow very high levels of renewable energy to be integrated into power grids globally.
- A modelling, optimisation and experimental study of distributed energy storage
- Energy Storage and Demand-Side Flexibility within Future Electricity Markets

In March 2017, Ulster University was awarded a prestigious £633,044 research grant for a major study into safeguarding the security and stability of renewable energy supply across the island of Ireland. Funded by the Department for the Economy under the Science Foundation Ireland

Investigators Programme Partnership, Ulster University researchers will work in partnership with University College Dublin. The aim of the research is to explore the extent to which variable renewable energy, especially wind energy, can generate a stable electricity source to meet the needs of the population.

8.3.4.2 Environmental skills

Colleges in Northern Ireland also offer direct innovation and R&D support to employers and provide assistance to bring new ideas in the renewable energy and sustainable technology sectors to the market. This includes support for new product and process development in areas such as biogas, biomass, low energy construction (including Nearly Zero Energy Buildings and Passive House techniques) and industrial energy conservation. This support is channelled through College Innovation centres and one example is the Centre for Renewable Energy and Sustainable Technologies (CREST) at South West College (SWC). CREST provides industry R&D, demonstration and testing facilities for new renewable energy products. The facilities are available to SMEs across Northern Ireland, who have ideas for new products or process developments but who do not have the physical and/or technical capacity to develop, test and commercialise them. The facilities include laboratory space, testing equipment, demonstration technologies and the assistance of technical staff to help bring ideas and concepts to the next stage of development. The CREST centre itself is a demonstrator of sustainable construction technologies and is one of the most sustainable buildings in the UK and Ireland, meeting the Passive House, BREEAM Excellent and Carbon Neutral building standards.

8.4 Public Awareness

8.4.1 Insight

The BEIS Energy and Climate Change Public Attitudes Tracker (formerly the DECC Public attitudes tracker) 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. The survey was set up 2012 by DECC to understand and monitor public attitudes to the Department's main business priorities.

The most recent data (23rd Wave of data) was collected from 27th September – 1st October 2017 using face-to-face in-home interviews with a representative sample of 2,150 households in the UK.

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 1.1 million followers across Twitter, Facebook, Google+ and other channels (http://www.youtube.com/themetoffice, *https://twitter.com/metofficenews*);
- The Met Office Science Twitter account shares insights into Met Office weather and climate science, technology and STEM. Followers are highly engaged and the account performs exceptionally well, increasing the reach of Met Office science.
- the Met Office's YouTube channel hosts a range of videos which have had more than 6.6 million views (*http://www.youtube.com/user/TheMetOffice)*;
- a wordpress blog features around 1000 posts across a wide range of weather and climate issues which have had 4.7 million views from 2.8 million visitors 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 has an award-winning outreach programme aimed at encouraging young people to study science, technology, engineering and maths (STEM) and to find out more about the work of the Met Office, including climate science. More than 280 staff are STEM Ambassadors and the types of activities delivered vary widely, from workshops in schools to public engagement at music festivals. We reach more than 10,000 young people each year;
- 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 UK/Global 2050 Calculator

The 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. 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.

The Calculator has a unique web interface that is available for free online and is designed for policy makers and stakeholders. It provides instant results and allows users to consider the consequences and trade-offs of different scenarios. To aid transparency, the underlying Excel model is also available online, allowing technical users to explore all the assumptions and follow the calculations. From 2012 to 2017 a simplified, animated version called My2050 was available that allowed the public to build their own pathways that meet our 2050 emissions reduction target. A toolkit for teachers was also available to support its use in schools, offering lesson plans linked to the national curriculum. [The UK 2050 Calculator is currently being updated and is due to be launched in 2018.]

The former Department for Energy and Climate Change (now the Department for Business, Energy and Industrial Strategy) received funding from the International Climate Fund to support 10 developing countries to build their own Calculators, as well as to develop a Global Calculator.

All ten of these country Calculators have now launched, and they are having an impact on policy. For example, four countries used their models in the development of their Nationally Determined Contributions (NDCs) for the Paris Agreement. There are now over 30 Calculators around the world covering different countries, regions and cities. The Global Calculator can be used to explore global options for reducing greenhouse gas emissions and meeting the international 2˚C target, and to see how those options affect one another. Access to the Calculator is available free online (*http://www.globalcalculator.org/*)

8.4.4 Clean Growth Strategy and Green Great Britain Week

In October 2017, the Government published the Clean Growth Strategy, which sets out its proposal for decarbonising all sectors of the UK economy through the 2020s. As part of this, the strategy sets out plans to launch a Green Great Britain Week by working with private partners and NGOS. The aim of the event is to[172]:

- focus on climate and air quality issues across the UK
- Demonstrate our progress and successes on climate action
- Share the latest climate science
- Highlight and promote economic opportunities arising from clean growth especially to international investors

Social Media has been used as a tool to generate wider awareness of the UK government's work on Clean Energy. In the run up to the publication of the Clean Growth strategy the BEIS twitter account @beisgovuk was used to raise awareness of the release and content of the strategy, including a livestream of the launch.

8.4.5 UK Climate Change Risk Assessment and National Adaptation Programme

Under the 2008 Climate Change Act, the government is required to publish a UK wide Climate Change Risk Assessment (CCRA) every five years. The most recent one was published in 2017. As part of this, the Department for the Environment, Food, and Rural Affairs (DEFRA) asked the Adaptation Sub Committee of the Committee on Climate Change to prepare an independent Evidence report on the latest risks and opportunities for the UK regarding climate change. The report will feed into the next UK National Adaptation Programme[173].

In compiling the report, the committee engaged with various stakeholders, and the report was peer reviewed by a technical review panel, and stakeholder and external reviewers, including a conference at the Royal Society[174].

8.4.6 England

Climate Local was the primary initiative for local government action on climate change. It 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 helped councils across the country to capture the

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[172] https://www.gov.uk/government/publications/clean-growth-strategy

[173] https://www.theccc.org.uk/tackling-climate-change/preparing-for-climate-change/uk-climate-change-risk-assessment-2017/introduction-to-the-ccra/

[174] https://www.theccc.org.uk/tackling-climate-change/preparing-for-climate-change/uk-climate-change-risk-assessment-2017/introduction-to-the-ccra/

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.

As of 2016, 113 councils and one national park had signed up to Climate Local and 71 action plans have been submitted, covering 96 councils and a national park.[175] The programme was discontinued.

8.4.7 Wales

Since 2013, the focus of the Welsh Government's public awareness activity on climate change has been through digital channels, primarily the Welsh Government's website, infographics and social media. Activity is planned around key milestones to maximise impact. For instance, digital public awareness campaigns were undertaken during UNFCCC COP 21 and COP 23 using social media and publishing of blog articles. The Welsh Government also uses online interactive tools to help the public understand greenhouse emissions and international mitigation activity.

The Welsh government also provides 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. For instance Resource Efficient Wales was a Welsh Government service (2014 to 2017) that provided trustworthy information, advice and help for people and organisations to save on energy, water and waste.

The Welsh Government has recently strengthened its legislative framework on climate change through the introduction of the Well-Being of the Future Generations Act 2015 and Environment Act 2016. Climate change is integral to all the Well-being of Future Generations Act's well-being goals which recognises that the case for action on climate change is clear and fundamental to our future prosperity and future resilience of our communities. This Act also established a Future Generations Commissioner for Wales and as at its heart effective public involvement to better understand the needs of communities and people. Engagement work in 2016-17 has identified climate change as one of the Commissioner's key emerging priorities.

Young people are also at the heart of Welsh Government's approach to public engagement on climate change and environmental matters. For instance during bill stages of the Environment Act the Keep Wale Tidy ran a completion using the Young Reporters for the Environment (YRE) as the means of raising awareness among the 11-21 age group.

8.4.7.1 Size of Wales

In addition to funding the Eco-Schools programme (details at Chapter 3) which helps to raise awareness of climate change in schools containing over 400,000 children in Wales, the Welsh Government contributes funding towards the core costs of the tree-planting and conservation charity Size of Wales which was created by the Wales' Millennium Development Goals Task Force as part of Wales' response to the dual challenges of climate change and international poverty reduction.

The original aim of Size of Wales was to bring people in Wales together to help sustain an area of tropical forest "the size of Wales" (some two million hectares) as part of a national response to climate change. The goal was reached in March 2013 and, since then, Size of Wales and its supporters have set a new target of protecting an area of rainforest equivalent to "twice the size of Wales" (four million hectares).

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[175] https://www.local.gov.uk/sites/default/files/documents/download-climate-local-an-d5c.pdf

Through its work, Size of Wales unites communities, businesses, third sector organisations and schools to help forge lasting links with some of the world's poorest people. They have direct links to rainforest projects and communities to assist sustainable management of forest resources and to make a significant contribution to reducing global carbon emissions. By doing so, Size of Wales helps Wales meet its global responsibilities and targets for tackling climate change. Size of Wales is involved in work in Uganda, DR Congo, Kenya, Peru, Zimbabwe and Guyana.

By providing support towards core funding costs, the Welsh Government ensures all funds raised by supporters can be allocated directly to rainforest projects. To date, the Waterloo Foundation has provided an annual "match funding" pot which ensures donations for forestry projects up to that amount are effectively doubled.

Core funding also covers climate change education and awareness raising projects. This delivers a specific climate change education programme targeted at primary and secondary schools. The programme includes free workshops, assemblies, resources and projects about climate change and deforestation aimed at encouraging and enthusing pupils to understand and take action on climate change in their communities. Size of Wales' work in schools helps to spread awareness of climate change and why forests are vital to our global climate systems by helping to absorb the carbon dioxide we emit. Size of Wales works closely with Eco-Schools in delivering this work to children and young people.

Size of Wales also has close links with the "10 Million Trees" tree-planting project in Mbale, Uganda which receives ongoing funding under the Wales for Africa programme which comes under the responsibility of the Welsh Government's First Minister. This project has already planted over 6 million trees and forms a key part of the education and engagement work carried out by Size of Wales. It showcases pioneering work in providing incomes for farmers and families through fruit and coffee crops and bee-keeping, shade for animals and people, soil stabilization and helping reduce carbon emissions.

8.4.7.2 Go Green Day

Go Green Day is the annual fundraising day organised by Size of Wales which sees schools, businesses and communities across Wales take action to increase climate change awareness and raise funds for forest projects across Africa and South America.

Go Green Day helps deliver the two key priorities in tackling climate change:

- By reducing greenhouse gases we produce by changing the way we use energy;
- By preparing for the consequences of the climate change that is already happening because of greenhouse gases already emitted.

Go Green Day provides an opportunity to support a Wales-wide fundraising day of action to help tackle climate change and safeguard tropical forests. All proceeds raised during Go Green Day are doubled by the Size of Wales match fund. People learn more about climate change and the importance of trees, both in a Wales and in a global context and the many environmental, social and economic benefits they bring.

8.4.7.3 Plant!

Size of Wales is also involved in the "Plant!" scheme whereby two new trees are planted to celebrate every new birth and adoption in Wales, one in Wales and one in Mbale, Uganda. The scheme is delivered in Wales by Natural Resources Wales in conjunction with the Woodland Trust. Over 300,000 trees have been planted to date and a series of events is planned for 2018 to commemorate the scheme's 10th anniversary.

8.4.8 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. As part of on-going engagement with the public, the Scottish Government initiated a series of climate conversations across Scotland to 'take the temperature' of public views on climate change and actions that might be needed to tackle it. Findings from the first series of Climate Conversations held throughout 2016 have been published on our the Scottish Government website[176]

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.

Through Scotland's Climate Week, the Scottish Government supports engagement on climate change in the public sector. Scotland's Climate Week has been running since 2016. It is designed to engage people and organisations in events and activities in order to raise the profile of climate change and inspire action across the public sector and beyond.

8.4.9 Northern Ireland

An objective of the current Northern Ireland Climate Change Adaptation Programme is to raise awareness of the likely effects of climate change and the need for adaptation action. To meet this objective, Northern Ireland departments continually engage with sector stakeholders to improve resilience to the impacts of climate change and share best practice in promoting adaptation.

Climate Northern Ireland, which was set up and is funded by the Northern Ireland Government, has formed an extensive partnership across government and through a number of external stakeholders. It 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 and raise awareness.

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[176] http://www.gov.scot/Topics/Environment/climatechange/lowcarbonbehaviours/findings-from-climate-conversations

Annex 1: UK's third biennial report to the UNFCCC

1. Introduction

The UK is pleased to submit its third 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 2015 total emissions for the UK by UNFCCC coverage were 506.8 $MtCO_2e$. This compares with emissions of 796.8 $MtCO_2$ in 1990, representing a decrease in emissions of around 36.4%.

Common Tabular Format (CTF) Table 1 shows a summary of greenhouse gas emissions for the UK from 1990 to 2015 by gas and by sector. The data are presented under UNFCCC coverage with and without net emissions or removals from LULUCF.

Figure 1 shows the trend in emissions between 1990 and 2015 for the basket of seven greenhouse gases (GHGs) covered by the Kyoto Protocol. Annual GHG emissions estimates for 2015 were an estimated 38% below the fixed base year[1] 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 2.7 and 2.8 of the UK's 7th National Communication.

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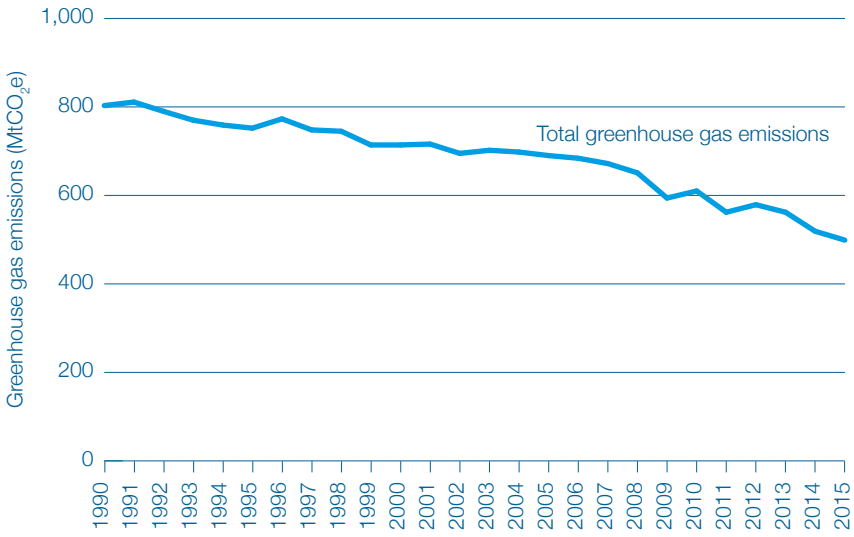
[1] The Base Year for emissions of carbon dioxide, methane and nitrous oxide is 1990. The Base Year for emissions of fluorinated gases (F-gases) is 1995. The Fixed Base Year is taken from the UK's Initial Report under the Kyoto Protocol. This report was submitted in 2006, based on emissions reported 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 $MtCO_2$-eq.

Figure 1: UK emissions of GHGs, 1990–2015, $MtCO_2e$.



Source: 2015 UK Greenhouse Gas Emissions

Carbon dioxide had the largest share of UK greenhouse gas emissions in 2015, making up 81% of the inventory. Methane was the second largest with 11%, followed by nitrous oxide with 5%, other greenhouse gases made up 3% of emissions. Further information can be in found in section 2.6 of the UK's 7th National Communication. The Energy Supply sector had the largest share of UK greenhouse gas emissions in 2015, making up 29% of the inventory, further information can be found in 2.6 of the UK's 7th National Communication.

2.2 National inventory arrangements

The UK's GHG inventory is compiled under contract to the Department of Business Energy and Industrial Strategy (BEIS)[2] by a consortium led by the environment consultancy Ricardo Energy and Environment (REE). REE[3] 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 REE 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 BEIS by the Centre for Ecology and Hydrology (CEH) and Forest Research.

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).[4] 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

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[2] Department of Business Energy and Industrial Strategy, 1 Victoria Street, London SW1H 0ET, Tel: +44(0) 2072155000, email: enquiries@beis.gov.uk

[3] Ricardo Energy and Environment, 30 Eastbourne Terrace, London, W2 6LA, Tel: +44 (0) 1235 753 000, email: enquiry-ee@ricardo.com

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

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 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 7th National Communication.

2.3 Changes since the last National Communication

Since the publication of the sixth National Communication in 2013, 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 sixth National Communication can be found in section 2.10 of the UK's 7th 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 Seventh National Communication.

3. Quantified economy-wide emission reduction (QEWER) target

Chapter 3 of the Seventh National Communication provides information on the policies and measures that contribute to the UK meeting its quantified economy-wide emissions targets.

3.1 EU Target

Alongside the European Union 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.

The EU has also agreed on a new 2030 framework for Climate and Energy under the Clean Energy Package, which includes targets and policy aims and objects for the period 2020-2030. The targets for 2030 are:

- at least a 40% cut in greenhouse gas emissions
- at least a 27% share of renewable energy consumption
- at least 27% energy savings

3.2 Domestic Target

Introduction

The 2008 Climate Change Act[5] 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. This section discusses the carbon budgets and the UK's progress in achieving them.

The targets:

The UK has established in law the first five carbon budgets covering the period from 2008-2032, with the sixth carbon budget due to be set in 2021.
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

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

To calculate UK performance against these targets, data is taken from the UK Greenhouse Gas Inventory (as detailed in Chapter 2 of the Seventh 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:

- 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
- 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).
- 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 fifth carbon budget was set excluding aviation and shipping.

These carbon budgets limit greenhouse gas emissions as set out in the following table:

Targets and projected performance	CB1 (2008-12)	CB2 (2013-17)	CB3 (2018-22)	CB4 (2023-27)	CB5 (2028-32)
Carbon budget level ($MtC0_2e$)	3,018	2,782	2,544	1,950	1,725
of which traded	1,233	1,078	985	690	590
of which non-traded	1,785	1,704	1,559	1,260	1,135
Percentage reduction below base year levels	25%	31%	37%	51%	57%

The carbon budgets extend to UK territory only (i.e. England, Wales, Scotland and Northern Ireland) and not to the UK's Overseas territories.

3.3 Achieving the targets

The government has in place a clearly defined suite of policies to reduce emissions to meet its carbon budgets, which are detailed in Chapter 3 of the Seventh National Communication, and Table 3 of Annex 2. Based on the latest projections published in the latest Energy and Emissions Projection, the UK met the first carbon budget with headroom of 36 $MtCO_2e$, and is projected to meet the second and third carbon budgets with headroom of 125 and 143 $MtCO_2e$, respectively.

There are projected shortfalls against the fourth and fifth carbon budgets of 94 $MtCO_2e$ and 196 $MtCO_2e$, respectively, as policies and proposals in the Clean Growth Strategy[6] are developed more fully, their impacts will be included as appropriate in future projections. In December 2011, the Government published its Carbon Plan which set out proposals for achieving the emissions reductions committed to in the first four carbon budgets. In October 2017, the Government published the Clean Growth Strategy, setting out possible pathways for meeting the fifth carbon budget. Focus on key policies and proposals include:

- Accelerating clean growth.
- Improving business and industry efficiency accounting for 25% of UK emission.
- Improving homes accounting for 13% of UK emissions.

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[6] BEIS Clean Growth Strategy, published in October 2017, available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/651916/BEIS_The_Clean_Growth_online_12.10.17.pdf

- Accelerating the Shift to Low Carbon Transport accounting for 24% of UK Emissions.
- Delivering Clean, Smart, Flexible Power accounting for 21% of UK Emissions.
- Enhancing the Benefits and value of our Natural Resources accounting for 15% of UK Emissions.

These are explored in more depth in Chapter 3 of the Seventh National Communication.

The Climate Change Act permits the Government to use 'flexibilities', such as surplus from previous Carbon budgets or the purchase of good quality international carbon credits to meet carbon budgets. The government will decide whether to use flexibilities to help meet the fourth and fifth carbon budgets following consultations with Devolved Administrations, and obtaining and taking into account advice from the Committee on Climate Change.

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 2015 – Publications – GOV.UK);
- An annual report from the independent Committee on Climate Change on progress against carbon budgets (Meeting Carbon Budgets – 2016 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: 2017 – Publications – GOV.UK).

3.5 Historical Performance

The First Carbon budget required that total UK greenhouse gas emissions did not exceed total UK greenhouse gas emissions do not exceed 3,018 $MtCO_2e$ over the five year budget period (2013-2017), which equated to approximately 25% below the Carbon budget. The net UK carbon account for the 2008-2012 period was 2,982 $MtCO_2e$, meaning the first carbon budget was met with a headroom of 36 $MtCO_2e$.

3.6 Projected performance

The UK estimates future performance against the target's using BEIS' updated Energy and Emissions projections. Unlike the National Communication report, the Energy and Emissions Projections (EEP)[7] also includes planned policies (this scenario is known as 'with additional measures' or WAM). Further detail can be found in Chapter 4 of the Seventh National Communication

[7] Figures available in Energy and Emission Projection report due to be published in January 2018.

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 second carbon budget, 2013-2017

The second carbon budget requires that total UK greenhouse gas emissions do not exceed 2,782 $MtCO_2e$ over the five year budget period (20013-2017), which equates to an average over the period of approximately 31% below the carbon budget baseline.

4.2 Pace of Emissions Reductions:

In October 2017, the Government published its Clean Growth Strategy,[8] setting out policies and proposals for meeting future carbon budgets and illustrative pathways for the 2050 target. Table 1 provides an updated version of the Clean Growth Strategy's summary of performance against carbon budgets[9] with the initial estimates of a subset of new early stage policies and proposals included.

The updated projections for the fourth and fifth carbon budgets (including estimates of emission reductions from a subset of Clean Growth Strategy policies and proposals) suggests that the UK could deliver 97 per cent and 95 per cent of the required performance against 1990 levels – for carbon budgets which will end in ten and fifteen years' time respectively.

Table 1: Performance against carbon budgets (UK coverage, with additional measures and CGS policies) $MtCO_2e$

		Carbon budget:				
		1 (2008-12)	2 (2013-17)	3 (2018-22)	4 (2023-27)	5 (2028-32)
		Actual	Projection	Projection	Projection	Projection
Carbon Budget level, cumulative emissions		3,018	2,782	2,544	1,950	1,725
Average required reduction vs 1990 emissions, %		-25%	-31%	-37%	-51%	-57%
Existing policies[10]	Projected emissions, Mt	2,982	2,657	2,401	2,044	1,921
Existing and new policies and proposals[11]	Projected emissions, Mt	2,982	2,657	2,401	2,014	1,841
	Result vs. Budget, emissions, Mt	-36	-125	-143	64	116
	Result vs. Budget, %	-1.2%	-4.5%	-5.6%	3.3%	6.7%

Source: Energy and Emissions Projections 2017

[8] Clean Growth Strategy: published in October 2017. https://www.gov.uk/government/publications/clean-growth-strategy

[9] The Clean Growth Strategy quoted the latest available projections at the time of publication (EEP 2016). Emissions projections from the Clean Growth Strategy are therefore not directly comparable to the projections within this report.

[10] This represents the 'with additional measures' scenario, i.e. including planned policies but not including new policies and proposals from the Clean Growth Strategy.

[11] Includes emissions reduction estimates of a subset of new early stage policies and proposals from the Clean Growth Strategy showing an additional potential reduction of up to 30Mt and 80Mt over the fourth and fifth carbon budget periods respectively.

Based on the 'with additional measures' scenario, progress against future carbon budgets is projected to be as follows:

- The 2017 projections show that the second and third carbon budgets, covering 2013 to 2022, are likely to be achieved. The reference case projection would meet the second carbon budget with a margin of 125 $MtCO_2e$ and the third carbon budget with a margin of 143 $MtCO_2e$.
- There are projected shortfalls for the fourth carbon budget. These projections are highly uncertain and only some of this uncertainty is captured in modelling and presented in the ranges here (see Chapter 6 of the EEP report).
- As policies and proposals in the Clean Growth Strategy are developed more fully, their impacts will be included as appropriate in future EEP editions.

5. Projections

5.1 Key developments

In 2015, emissions of the basket of seven greenhouse gases (GHGs) covered by the Kyoto Protocol[12] are estimated to be 499 million tonnes of carbon dioxide equivalent ($MtCO_2e$), 37.8% lower than the 1990 level of 803 $MtCO_2e$. Emissions from this basket of GHGs are projected to fall to 414 $MtCO_2e$ (48% below the 1990 level) by 2020 and 382 $MtCO_2e$ by 2030 (52% below the 1990 level).

- Emissions of carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) are projected to be 44%, 65% and 57% 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 2nd Biennial Report, the UK has implemented further policies to help meet its EU effort sharing, renewable energy and energy efficiency targets, and the Carbon Budgets[13] set under the 2008 Climate Change Act.[14]

5.2 Overall projections of GHG emissions

This chapter presents the UK's GHG emissions projections, in a scenario 'with existing measures' (or 'WEM'), along with assumptions and methodology. The UK projections provide the basis for this Biennial Report.

Table 2 sets out the UK's historic emissions to 2015 and *with existing measures* projections from 2020 to 2035, by GHG. The historic emissions set out in this chapter are based on the UK GHG inventory 1990 – 2015 published and submitted to the UNFCCC in 2017.

The tables of emissions in this chapter are reported on the basis of UNFCCC coverage, which includes UK Crown Dependencies and Overseas Territories and excludes the impact of planned policies.

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[12] The basket of greenhouse gases covered by the Kyoto Protocol consists of seven gases: carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, sulphur hexafluoride and nitrogen trifluoride.

[13] http://www.legislation.gov.uk/uksi/2009/1259/article/1/made

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

They show that UK GHG emissions including LULUCF are projected to be 48% below 1990 levels in 2020 and 52% below in 2030.

Table 2: UK Greenhouse gas emissions by gas (UNFCCC coverage), $MtCO_2e$

	Inventory						Projections			
GHG excluding LULUCF	**1990**	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**
Carbon Dioxide	595.3	559.8	560.6	563.6	507.5	415.7	346.5	318.1	322.9	326.4
Methane	135.3	128.8	111.0	89.3	68.2	52.6	46.8	43.7	41.2	40.3
Nitrous Oxide	48.9	39.5	29.2	25.4	22.5	21.7	20.5	20.1	20.0	20.0
Hydrofluorocarbons	14.4	19.1	9.9	13.2	16.5	16.0	11.1	7.3	4.3	2.7
Perfluorocarbons	1.7	0.6	0.6	0.4	0.3	0.3	0.3	0.3	0.3	0.3
Sulphur Hexafluoride	1.3	1.3	1.8	1.1	0.7	0.5	0.4	0.4	0.4	0.5
Nitrogen Trifluoride	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	**796.8**	**749.1**	**713.1**	**692.9**	**615.7**	**506.8**	**425.5**	**389.9**	**389.1**	**390.1**
Change from 1990	**0.0**	**-0.1**	**-0.1**	**-0.1**	**-0.2**	**-0.4**	**-0.5**	**-0.5**	**-0.5**	**-0.5**
GHG including LULUCF										
Carbon Dioxide	598.5	560.4	558.8	558.4	499.9	406.8	333.8	307.4	314.2	319.3
Methane	135.3	128.8	111.1	89.4	68.3	52.6	46.8	43.7	41.2	40.3
Nitrous Oxide	51.3	41.9	31.4	27.3	24.2	23.2	22.1	21.9	21.9	22.0
Hydrofluorocarbons	14.4	19.1	9.9	13.2	16.5	16.0	11.1	7.3	4.3	2.7
Perfluorocarbons	1.7	0.6	0.6	0.4	0.3	0.3	0.3	0.3	0.3	0.3
Sulphur hexafluoride	1.3	1.3	1.8	1.1	0.7	0.5	0.4	0.4	0.4	0.5
Nitrogen Trifluoride	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	**802.5**	**752.1**	**713.6**	**689.7**	**609.9**	**499.4**	**414.4**	**381.0**	**382.4**	**385.0**
Change from 1990	**0.0**	**-0.1**	**-0.1**	**-0.1**	**-0.2**	**-0.4**	**-0.5**	**-0.5**	**-0.5**	**-0.5**
Net LULUCF emissions										
Carbon Dioxide	3.2	0.6	-1.8	-5.2	-7.5	-8.9	-12.7	-10.7	-8.6	-7.1
Methane	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nitrous Oxide	2.5	2.4	2.3	1.9	1.7	1.5	1.6	1.8	1.9	2.0
Total	**5.7**	**3.0**	**0.5**	**-3.2**	**-5.8**	**-7.4**	**-11.1**	**-8.9**	**-6.7**	**-5.1**

Source: UK GHG Inventory, 2017 Energy and Emissions Projections

5.3 Projections by sector

Table 3 shows how historical and projected GHG emissions are distributed across sectors of the UK economy.

Table 3: GHG emissions by source (UNFCCC coverage), $MtCO_2e$

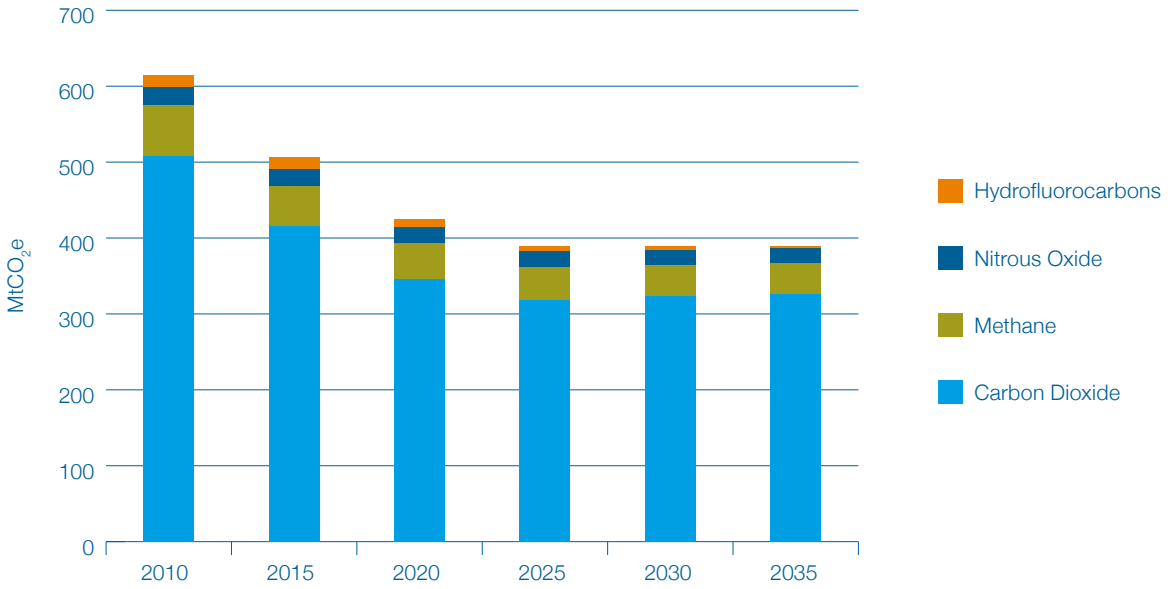
	Inventory						Projection			
Sector	**1990**	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2030**
Agriculture	59.3	58.7	55.2	51.5	48.9	49.4	46.9	45.0	44.6	44.4
Business	114.6	112.5	116.5	110.1	95.1	84.9	76.2	66.7	60.0	57.5
Energy Supply	279.1	239.2	222.2	232.3	208.1	145.5	87.6	69.3	75.6	77.7
Industrial processes	60.0	50.9	27.1	20.6	12.7	12.7	10.0	9.4	9.0	8.8
Land use, land use change and forestry	5.7	3.0	0.5	-3.2	-5.8	-7.4	-11.1	-8.9	-6.7	-5.1
Public	13.5	13.3	12.1	11.2	9.7	8.1	7.0	6.9	7.5	7.9
Residential	80.4	82.0	89.1	86.1	87.9	66.7	66.8	67.7	71.7	75.4
Transport	123.0	123.3	127.8	131.7	121.3	121.0	117.1	112.8	109.4	107.7
Waste management	66.9	69.3	63.0	49.4	31.9	18.4	13.9	12.2	11.2	10.7
Total net GHG emissions	**802.5**	**752.1**	**713.6**	**689.7**	**609.9**	**499.4**	**414.4**	**381.0**	**382.4**	**385.0**

Source: UK GHG Inventory, 2017 Energy and Emissions Projections

5.4 Projections by gas

Figure 2 shows the projected emissions trends by greenhouse gas.

Figure 2: GHG projected emissions by gas (UNFCCC coverage, with additional measures, excluding LULUCF), $MtCO_2e$



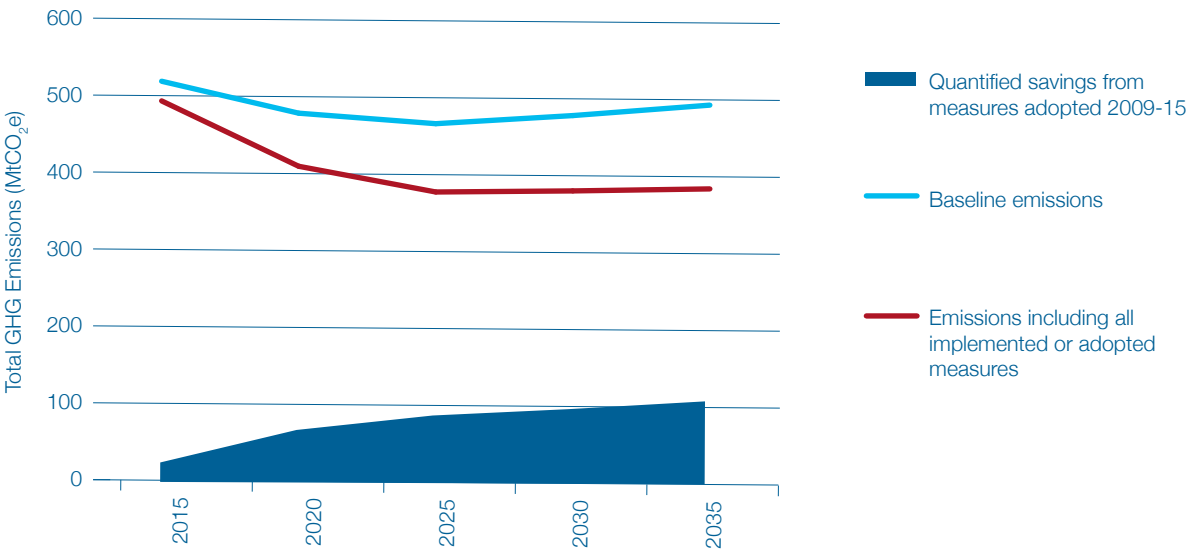
Source: UK GHG Inventory, 2017 Energy and Emissions Projections

5.5 Total effect of policies and measures

The projections presented here (the 'with existing 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 the Annex. It does not include policies which are classed as planned, so these figures differ from those quoted in the Energy and Emissions Projections.

Figure 3 and Table 12 below show the estimated emissions savings and the effect on projected emissions attributable to policies adopted between April 2009 and July 2017, as estimated in the 2017 UK EEP. For example, in 2020 we project that UK policies will deliver emissions reductions of almost 50 $MtCO_2e$.

Figure 3: Projected impact of adopted and implemented policies (UK coverage), $MtCO_2e$



Source: 2017 Energy and Emissions Projections

Table 4: Projections of total net GHG emissions in the 'with existing measures' scenario, UK coverage ($MtCO_2e$)

	2015	2020	2025	2030	2035
Emissions excluding the impact of measures adopted between 2009-15 (baseline)	525	483	470	480	494
Savings from measures adopted 2009-15 (excluding planned policies)	26	69	89	98	109
Emissions including all implemented or adopted measures (excluding planned policies)	499	414	381	382	385

5.6 Projections methodology

Projections of the UK's emissions of CO_2 and combustion-related emissions of other greenhouses gases (CH_4 and NO_2) have been largely derived from the BEIS Energy and Emissions Projections (EEP) model suite. This models the UK energy market including final sector energy use and the electricity supply sector. It includes a mixed (top down/ bottom up) econometric model of energy demand and combustion related greenhouse gas (GHG) emissions for the UK economy 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).

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. Industrial process emissions are calibrated by relating inventory emission to production.

The EEP model projects emissions using prospects for fossil fuel prices, carbon prices, economic growth and demographics. Sources for these assumptions are given in the chapter.

Projections of energy demand by fuel and sector 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 for this National Communication we do not include those that only have planned status.

The overall modelling approach is similar to that used in the previous Biennial Report, although there have been improvements in each sector.

The UK's dependant crown dependencies and overseas territories are not included in the projections the UK produces annually to monitor progress against its own carbon budgets. For this Biennial Report the UK has supplemented its annual projection with projections for these areas consistent with the UK 1990-2015 GHG Inventory (see chapter 1).

The UK has produced simple trend projections for GHGs within each sector, assuming a continuation of the linear trends observed in the period 2007-2015.

5.7 Key assumptions

The UK's energy and emissions projections are based on a set of key assumptions about UK economic growth, demographic changes in the UK and future fuel price trajectories. The main sources of the projections are the forecasts made by the UK's Office for Budget Responsibility and Office for National Statistics, supplemented by IMF projections of world growth. Fuel prices are those produced by BEIS.

Updated Energy and Emissions Projections are published annually. This uses the economic assumptions and projections produced for the UK government by the Office of Budget Responsibility (OBR).

UK GDP up to 2021 is based on the March 2017 Economic and Fiscal Outlook[15] and beyond 2021 is based on the January 2017 Fiscal Sustainability Report.[16]

Population projections were produced in 2014 by the UK's Office for National Statistics (ONS)[17] alongside a supporting methodology description.[18]

Household projections are based on those produced by the Department for Communities and Local Government which combine ONS population projections with household formation propensities.[19] Projections were produced separately for England (2014), Scotland (2012), Wales (2011) and Northern Ireland (2012) and combined to produce UK figures.

5.8 Quality Assurance/Quality Control

Quality assurance of modelling undertaken by government departments has taken on a greater emphasis following the publication of the Macpherson Review in 2013.[20]

Energy projections and the energy-related emission projections are produced in BEIS by a small team (the 'EEP modelling team') whose key 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.

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 Committee on Climate Change (CCC).

5.9 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 36 key parameters, including GDP, population, fossil fuel prices, annual temperatures and policy savings were combined in a 10000 run Monte Carlo simulation to assess the overall uncertainty range for the UK's emissions projections. Figure 4 shows the results of this probabilistic analysis.

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15 http://budgetresponsibility.org.uk/efo/economic-fiscal-outlook-march-2017/

16 http://budgetresponsibility.org.uk/fsr/fiscal-sustainability-report-january-2017/

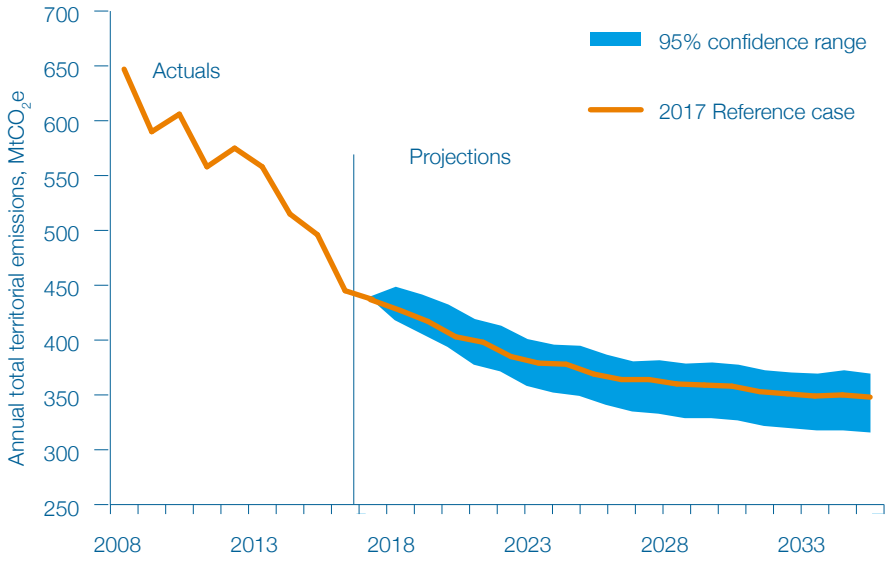
17 https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationprojections/bulletins/nationalpopulationprojections/2015-10-29

18 https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationprojections/methodologies/nationalpopulationprojectionsqmi

19 https://www.gov.uk/government/statistical-data-sets/live-tables-on-household-projections

20 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/206946/review_of_qa_of_govt_analytical_models_final_report_040313.pdf

Figure 4: Uncertainty in UK projected emissions (UK coverage, with additional measures), $MtCO_2e$



Source: 2017 Energy and Emissions Projections

5.10 Differences from the last Biennial Report

The table below summarises the differences between the projections in this and the last Biennial Report, which was based on projections produced in 2015.

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 and economic growth assumptions.

The projections have also been updated to take into account improvements to the historical inventory and other improvements to methods, emission factors and activity data.

The net effect of these changes is to reduce projected emissions in 2020 from 44% below 1990 levels in the Sixth National Communication to 48% below 1990 levels in the Second Biennial Report. The projected reduction of 40 $MtCO_2$ between the two projections is mostly due to projected reductions in CO_2 emissions.

Table 5: Comparison with last Biennial Report, $MtCO_2e$

	Second Biennial Report			Third Biennial Report		
GHG including LULUCF	1990	2020	Projected change	1990	2020	Projected change
Carbon Dioxide	599.3	368.2	-39%	598.5	333.8	-44%
Methane	137.2	48.0	-65%	135.3	46.8	-65%
Nitrous Oxide	57.2	26.8	-53%	51.3	22.1	-57%
Hydrofluorocarbons	14.6	11.0	-25%	14.4	11.1	-23%
Perfluorocarbons	1.7	0.2	-87%	1.7	0.3	-84%
Sulphur Hexafluoride	1.3	0.5	-63%	1.3	0.4	-70%
Nitrogen Trifluoride	–	–	-13%	0.0	0.0	-100%
Total GHG	**811.2**	**454.6**	**-44%**	**802.5**	**414.4**	**-48%**

6. Provision of financial, technological and capability-building support to developing countries

6.1 Key developments

- Building on the provision of £3.87 billion in **International Climate Finance (ICF)** between 2011/12-2015/16, the UK has committed to further scale up climate finance to at least £5.8 billion between 2016/17-2020/21.[21] The UK's ICF helps developing countries mitigate and adapt to the impacts of climate change, reduce deforestation and pursue clean economic growth. UK ICF is focussed on transformational change, reflecting the scale of the challenge of climate change. This includes unlocking the potential of the private sector, with UK ICF mobilising £500 million in private finance to date.
- Since 2011, the UK has used its ICF to install more than 400 megawatts of clean energy capacity and to reduce or avoid 9.2m tonnes of CO_2 equivalent. These impacts will continue to grow as new and ambitious programmes like the £177.5 million Sustainable Infrastructure Programme are delivered. The UK continues to apply and share lessons learned from its extensive ICF monitoring & evaluation framework, improving effectiveness and enhancing transparency.
- Recognising that adaptation is a priority for many developing countries, the UK aims to spend half of its climate finance on adaptation, and achieved this aim in 2016. Since 2013, the UK has provided over £1.4 billion to in climate finance for adaptation. To date, the UK's ICF has supported more than 34 million people to adapt to the impacts of climate change.
- The UK is committed to an effective international climate finance architecture, and has been one of the largest contributors to major multilateral climate funds like the Green Climate Fund (£720 million) and the Climate Investment Funds (£2 billion). The UK has also supported multilateral development bank ambition as they scale up their activities towards their 2020 climate finance pledges.
- The UK has supported international knowledge generating organisations such as the Intergovernmental Panel on Climate Change and has committed to global initiatives aimed at accelerating clean energy like Mission Innovation.

[21] Financial years 2011/12 to 2014/15.

- In 2015, the UK, Germany and Norway (GNU) announced that they would provide up to $5 billion between 2015 and 2020 in finance to tackle deforestation, subject to ambitious and high quality proposals.
- Through its ICF and other international action, the UK is continuing to scale up support towards the shared developed country goal of jointly mobilising $100 billion per year in climate finance for developing countries from a range of sources by 2020. Beyond this, the UK is focussed on helping developing countries put in place the conditions to align finance flows with low greenhouse gas and climate resilient development, including by creating the right conditions to unlock green investment for Nationally Determined Contributions (NDCs) and by phasing out the most polluting activities.

6.2 Introduction

Climate change is a global challenge requiring action from all countries. The UK has played a key role in demonstrating international leadership by reducing its own emissions and supporting other countries to do the same. This chapter will discuss the support and financial assistance that the UK provides to developing countries, where climate change represents the biggest challenge to long-term global poverty reduction, to help avert the worst outcomes of climate change and increase the resilience of the most vulnerable countries to a changing climate.

The remainder of the section is structured as follows:

- An overview of the types of climate finance provided by the UK, centred around its International Climate Finance (ICF).
- How climate finance has been allocated since the last Biennial Review, including adaptation and mitigation and with detailed examples of programming in UK priority areas of forestry, private finance and carbon markets.
- How the UK is acting to promote, facilitate and transfer technology to developing countries.
- Other actions the UK is taking to help developing countries access finance, attract investment and align finance flows with low greenhouse gas and climate-resilient development.
- How the ICF is using its monitoring and evaluation framework to apply lessons learned and improve over time.

6.3 Overview of UK Support and Channels

The UK is among the largest contributors of public climate finance and is committed to providing support which is transparent, transformative and in line with the needs and priorities of developing countries. UK climate finance builds on a tradition of UK leadership in providing support to developing countries.

UK climate finance is provided from the Official Development Assistance (ODA) budget which has consistently risen over time, from £7.3 billion in 2009 to £13.4 billion in 2016. UK climate finance represents a new commitment which is additional to historic ODA levels and is not diverting or detracting from broader development spending. The UK has a dedicated ring-fence of its ODA budget for climate finance – the ICF – and uses this as a frame of reference to ensure our climate finance is separate from non-climate ODA. We can also track the amount of climate finance within the overall ODA spend and also the non-climate related ODA spend to ensure that non-climate ODA is not decreasing as our climate spend increases.

The UK remains committed to promoting climate smart development across the aid portfolio, consistent with the Global Goals and an essential condition for driving sustainable development and effective climate action.

A key objective of UK climate finance is to improve the effectiveness of the international climate finance architecture, including by building in-country support and enhancing country ownership for low carbon climate-resilient development. The UK has an extensive network of officials based in developing countries working for the Department for International Development (DFID) and Foreign and Commonwealth Office (FCO). This ensures close relationships with governments and key organisations in these countries and the development of bilateral programmes based on developing country needs. The UK also provides support through multilateral funds and multilateral development banks. The UK continues to encourage and support the use of these funds in response to projects and plans driven by the needs of developing countries and in line with nationally determined comprehensive plans.

The UK is firmly committed to the joint developed country agreement to mobilise $100 billion of climate finance a year from a variety of sources by 2020. At COP21 in Paris, developed countries were asked to produce a 'concrete roadmap' to show how they would achieve this goal. The UK and Australia, working with other developed countries, produced this Roadmap and presented it at COP22 in Marrakech. The Roadmap indicated that based on current pledges, and building on the estimated level of $62 billion in climate finance mobilised in 2014, the $100 billion goal could be achieved with a modest increase in the rate of mobilisation of private finance. The UK continues to work with its international partners to implement the actions outlined in the Roadmap and make progress towards the goal, in line with developing country priorities.

Achieving the goals of the Paris Agreement will require a broad shift in finance flows to align the global economy with a pathway towards low greenhouse gas and climate resilient development. This transformational goal provides the basis for the UK's approach to climate finance, and the UK acts through a number of bilateral and multilateral channels to ensure that support helps to build capacity and nurture lasting change, for instance through engagement of private investors.

6.3.1 The UK's International Climate Finance (ICF)

Recognising the growing importance and urgency of tackling climate change and its impact on growth and poverty reduction, the UK invested £3.87 billion in International Climate Finance (ICF) from 2011-2016 (financial years 2011/12 to 2014/15). The UK has committed to provide at least a further £5.8 billion from 2016-2020 (financial years 2016/17 to 2020/21), with a commitment to achieve a 50:50 balance between mitigation and adaptation over this period. This will lead to a doubling in UK climate finance in 2020, relative to 2014. This commitment reflects the UK's view that climate change is the biggest threat to the long-term eradication of global poverty, and that the impacts of climate change will hit the poorest hardest.

The UK's ICF is supporting a portfolio of investments managed by the Department for International Development (DFID), Department for Business, Energy and Industrial Strategy (BEIS), and the Department for Environment, Food and Rural Affairs (Defra). It aims to support international poverty eradication now and in the future by helping developing countries to manage risk and build resilience to the impacts of climate change, take up low-carbon development at scale, and manage natural resources sustainably.

To achieve this, UK ICF delivers transformational change through well-targeted finance which, for example, helps to pay the incremental cost of making infrastructure investments climate-smart and avoid lock-in of high carbon technologies. It also incentivises countries to reduce deforestation and promote sustainable land use. This demonstrates that low-carbon,

climate-resilient development paths are viable and compatible with economic growth and poverty alleviation.

Cumulative data collected between 2011/12 and 2016/17 shows that UK ICF programmes have:[22]

- Supported **34 million people** to cope with the effects of climate change;
- Provided **12 million people** with improved access to clean energy;
- Reduced or avoided **9.2 million tonnes** of greenhouse gas (GHG) emissions (tCO_2e);
- Installed more than **400 MW** of clean energy capacity; and
- Mobilised **£500 million private finance** for climate change purposes in developing countries.

6.3.2 Prosperity Fund

The Foreign and Commonwealth Office (FCO) and its network of Posts around the world have advocated for a high ambition response to the collective challenge of limiting climate change during the reporting period. The partnerships that have been created between the UK and other countries have benefited from practical co-operation projects funded by the FCO Prosperity Fund, and the energy/low carbon work stream of its successor, the Cross Government Prosperity Fund, launched in 2015. Programmes have focused on promoting reforms to energy markets drawing upon the UK's world-leading expertise on policy frameworks, energy system optimisation, promotion of renewable energy, roll out of smart technologies, and building a green finance industry to accelerate the transition to low carbon growth. Multi-year programmes worth up to £120 million under the new Cross Government Prosperity Fund will be designed in close co-operation with South East Asia, China, India, Brazil, and Mexico, and will be launched in 2018.

6.3.3 The Global Challenges Research Fund and the Newton Fund

The Global Challenges Research Fund and the Newton Fund leverage the internationally recognised strength of the UK's research base, ensuring that UK science takes a leading role in promoting research and innovation to address development challenges, including flooding and famine caused by climate change, environmental degradation and the development of low carbon energy. The funds play a critical role in advancing development for the poorest people and countries, promoting long term sustainable growth.

6.3.4 Contributions to Multilateral Development Banks

The UK is one of the largest contributors to multilateral development banks (MDBs), which have collectively committed over $100 billion in climate finance over the last four years. The MDBs have made significant pledges to scale up climate finance by 2020 and to better integrate climate considerations across their activities.

Since the previous National Communication the UK has provided further capital contributions to MDBs working in low income countries. The UK is the largest donor to the International Development Association and has committed £3,336 million to its 18th replenishment. The UK has also committed £460 million to the 14th replenishment of the African Development Fund.

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[22] 2017 UK Climate Finance Results: https://www.gov.uk/government/publications/2017-uk-climate-finance-results

The UK continues to work with the MDBs to encourage ambition, effectiveness and transparency in the scaling up their financing of climate activities in developing countries, their co-operation with national and regional institutions and the further mainstreaming of climate dimensions into development activities. MDBs have reported jointly on outflows of climate finance since 2011.

6.3.5 UK and 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 Country 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.

The UK is supporting Fiji as the first Small Island Developing States COP Presidency with £1.7 million of funding across 2017-2018. UK support to the Climate Development Knowledge Network (CDKN) was also continued in 2017 with up to £2 million provided to enable effective participation of the poorest developing nations in the UN climate negotiations.

As a member of the Intergovernmental Panel on Climate Change (IPCC), the UK makes voluntary contributions each year to the IPCC's Trust Fund. The UK has committed to contributing £115k per year in 2017, 2018 and 2019. The UK also committed to contributing an additional £115k in 2017 only, making its contribution £230k in total for this year.

6.4 UK Climate Finance

This section sets out how the UK directs its climate finance, firstly by outlining the support the UK provides to the operating entities of the UNFCCC Financial Mechanism and other cross-cutting multilateral funds; then providing an outline of UK support for mitigation and adaptation activities. Finally, the section sets out actions in a number of UK ICF sectoral priorities – forestry, mobilising private finance and establishing international carbon markets.

6.4.1 Cross-cutting support through Multilateral Climate Funds, including the operating entities of the UNFCCC financial mechanism

The UK has been a key supporter of both the Global Environment Facility (GEF) and the Green Climate Fund (GCF) since their formation and is committed to ensuring their effectiveness in delivering climate finance within the broader financial architecture.

The Green Climate Fund

Since becoming operational in 2015, **the Green Climate Fund (GCF)** has become the key multilateral climate fund, operating at scale to support low-greenhouse gas, climate resilient development in developing countries, with a mandate to make 'an ambitious contribution to the global efforts towards attaining the goals set by the international community to combat climate change'. The UK is a strong supporter of the GCF having committed £720 million for the initial

resource mobilisation period (2015-18), and is committed to ensuring that the GCF delivers maximum impacts in the developing countries it supports.

The GCF funds transformational projects with a strong focus on leveraging private finance, with a commitment to provide 50% of its resources for mitigation and 50% for adaptation. At least 50% of its adaptation support will be provided to particularly vulnerable countries including Least Developed Countries (LDCs), Small Island Developing States (SIDS) and African States. In the past year, the GCF has made significant progress in terms of developing its project portfolio, refining its policy framework, and building the Secretariat's capacity. So far, the GCF has committed $2.65 billion of funding to 54 projects, representing a balanced geographical and thematic split, with around 50% of funds going to private sector projects, and over $400 million to Small Island Developing States.

Progress has also been made on enhancing direct access to finance, with the agreement in 2017 to pilot a Simplified Approvals Process for projects with up to $10 million of GCF financing, and the ongoing work to facilitate increased proposals from direct access entities which saw nine new direct access entities accredited to the GCF in 2017. The Readiness and Preparatory Support Programme set up by the GCF also aims to facilitate the activity of the Fund, recognising the need to support direct access entities in their applications and to assist countries with related processes under the UNFCCC such as the preparation of National Adaptation Plans. Over $40 million of GEF funds have been approved for readiness activities, with 60 countries benefitting from this support to date.

The Global Environment Facility

The UK is a long-standing contributor to **the Global Environment Facility (GEF)** to fund projects and activities providing not only climate change benefits, but also tackling broader environmental issues such as biodiversity and land degradation. The GEF is a funding mechanism for five UN conventions: Convention on Biological Diversity (CBD); Stockholm Convention on Persistent Organic Pollutants; Minamata Convention on Mercury; UN Convention to Combat Desertification (UNCCD) as well as the UN Framework Convention on Climate Change (UNFCCC). Programmes are implemented through 18 partners including multilateral development banks, UN agencies, and NGOs.

The GEF budget is replenished on 4-yearly cycles and a total of 39 countries contribute. The current sixth replenishment period (2014-2018) has a budget of $4.43 billion. The UK is contributing £210 million in total to GEF-6. Since its creation in 1991, the GEF has implemented 1,010 climate change mitigation projects contributing to 2.7 billion tonnes of greenhouse gas emission reductions, equivalent of taking 560 million cars off the road each year. It has also led to the creation of 3,300 protected areas, covering more than, 860 million hectares, an area larger than Brazil.

Climate Investment Funds

The UK is the largest investor in the $8.3 billion **Climate Investment Funds (CIFs)**, having invested £1,253 million between 2011/12 and 2016/17, to pilot low-emission and climate resilient development through projects implemented by the multilateral development banks. The CIFs now operate across 72 countries and have a total portfolio of 310 projects. CIFs finance is enabling the building of the equivalent of over a quarter of the current global installed geothermal and concentrated solar power. The projects are unlocking finance flows in the green markets of developing countries and are expected to generate $58 billion of co-financing. The CIFs are comprised of four key programmes, further detailed as appropriate in the below sections, explaining how UK ICF support contributes to each of these programmes individually.

6.4.2 Mitigation: activities undertaken by the public and private sectors to finance emissions reductions

The Paris Agreement requires all Parties to put forward "nationally determined contributions" (NDCs), setting national targets for reducing emissions towards the common 'well below 2°C' increase goal. The UK's mitigation efforts seek to help meet the financing challenge of realising these emissions reductions by reducing risks to private investment, halting deforestation and accelerating technological change at scale. The UK is using its International Climate Finance to effect "transformational change" through targeted investment in innovative projects with the potential to be scaled up and replicated by others, and by tackling barriers that hold the private sector back from investing. This section describes some of the initiatives and actions that the UK is undertaking to support decarbonisation activities in developing countries. Through and beyond these examples, the UK also aims to raise capacity in countries and build on the UK's low carbon experience and expertise. Further examples of how the UK is enabling in country capacity are set out in section 5 of this chapter.

Accelerating technological change at scale

Raising ambition and accelerating the rate of decarbonisation is critical to achieving global climate goals. There has been a rapid shift towards renewable energy over the last few years. Sectors such as transport, buildings, urban planning, and energy efficiency offer significant potential to reduce emissions while delivering major economic, health and environmental benefits, but are not yet on a pathway consistent with the 'well below 2°C' goal.

The UK's ICF is supporting developing countries to achieve economic growth in a sustainable way. Access to affordable, reliable and sustainable modern energy is central to this. Interventions are being supported at the regional, national, sub-national or sectoral level through UK bilateral and multilateral support. Many of these interventions aim to lay the conditions for increasing investment at scale.

The UK's main priorities are to:

- Build capacity and capability in countries to implement their NDCs and raise ambition further, working to overcome regulatory and institutional barriers, including sharing UK skills and expertise where it is helpful;
- Deliver clean energy to the millions of people currently without any access to electricity and other forms of modern energy;
- Push frontiers by demonstrating and deploying technologies, policies and approaches that are critical for a 'well below 2°C' trajectory; and
- Drive decarbonisation at scale through the international development system – supporting the development banks to scale up their climate investments and become more climate-smart across their activities.

Contributing to international climate change mitigation funds

The following are examples of UK contributions to international climate change funds, in addition to support for the operating entities of the financial mechanism. A full list is provided in Table 7.b of the CTF (annexed):[23]

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[23] The UK provides the majority of its funding through trusted delivery partners which leads to complex delivery chains from its fund through to the final recipient. For this reason, the UK does not systematically track who the ultimate end recipient is (including whether it is public or private) and what their role is in the project. Examples of support are provided in CTF tables.

The Clean Technology Fund (CTF) – Of the four funds that sit under the Climate Investment Fund, the UK has contributed £701 million between 2011/12 to 2016/17 to the Clean Technology Fund (CTF). The CTF provides concessional finance and technical assistance in 21 countries, delivering significant development benefits, such as increased energy security, reduced local air pollution, and job opportunities. It has supported national governments to identify and implement ambitious low carbon investment plans, and helped demonstrate technologies and create markets. South Africa's KaXu Solar One Concentrated Solar Power project, with funding from the CTF, has recently been awarded a *Momentum for Change Award* by the UNFCCC for its innovative and game-changing approach to climate change and wider economic, social and environmental challenges.

The **Scaling up Renewable Energy Programme (SREP)** is another of the four Climate Investment Funds. The UK has provided £268m to SREP, which aims to stimulate energy access and economic activity by working with governments to build renewable energy markets and support productive uses of energy at the household level. As of June 2017, SREP had endorsed investment plans for 19 pilot countries. Expected results under these plans, and the Fund's Private Sector Set Aside, include an estimated 6,686 gigawatt hours (GWh) of electricity to be generated annually from renewable energy sources (equivalent to the annual electricity production of Armenia) and new or improved access to clean, modern energy services for 17.3 million people (approximately the population of Malawi). The total estimated greenhouse gas (GHG) emissions to be avoided are approximately 5.4 million tons CO_2e/yr.

The Nationally Appropriate Mitigation Action (NAMA) Facility is a bilateral programme supported by the UK, working in partnership with the German Federal Ministry for the Environment (BMUB), Denmark and the European Commission. NAMAs are country owned projects, policies, or programmes that shift a technology or sector in a country onto a low-carbon development trajectory. The Facility seeks to support and fund the implementation of the most transformational parts of the NAMAs, for which countries are unable to attract private sector funding. It has an open application process, welcoming projects across a diverse range of sectors and geographies. Since 2012, 20 climate mitigation projects across 16 countries have been supported, with each project chosen for its ability to catalyse change in the sector. To support this demand the UK has committed £140 million into the Facility, of which £40 million has been allocated to the 5th Call of the Facility launched on 13 November 2017.

Further details on mitigation finance activities through the UK's focus on forestry, mobilising private finance and carbon pricing are found in subsequent sections.

6.4.3 Adaptation, including assistance provided to developing countries particularly vulnerable to the adverse effects of climate change in meeting the cost of adaptation

UK ICF investments aim to support international poverty reduction now and in the future by helping developing countries manage risk and build resilience to the impacts of climate change, take up low-carbon development at scale, and manage natural resources sustainably. The poorest and most vulnerable people in the world will be hit first and hardest by the impacts of climate change. This is why the UK aims to spend half of its climate finance on adaptation – in 2016, 51% of the UK's ICF was spent on adaptation, with a focus on the poorest and most vulnerable countries.

The UK recognises that the central importance of countries having a clear plan for adaptation that is tailored to the risks they are likely to face. The UK is committed to helping countries ensure they are able to put in place such plans to guide action.

The UK has already provided over £1.6 billion to help vulnerable developing countries between 2011 and 2016. The UK's ICF has to date helped 34 million people cope with the effects of climate change through by assisting developing countries to better:

- adapt to long-term impacts well in advance, for example by changing or diversifying livelihoods and ensuring infrastructure is fit for purpose.
- anticipate and reduce the impact of climate variability and extremes for example through effective forecasting and preparedness measures.
- absorb the effects of climate extremes and disasters for example through effective and rapid response that enables people to cope with disaster and recover quickly.

UK action on adaptation

The UK provides finance through international funds as well as bilaterally, through multi-country projects and civil society. The UK will focus on assisting people to **anticipate** the impact of change through better planning and forecasting, **adapt** to long term impacts well in advance – for example by changing or diversifying livelihoods and ensuring infrastructure is fit for purpose – and to **absorb** the effects of disasters and climate extremes through effective and rapid response.

Programmes supported by the UK may work across all three areas of action as set out above.

A series of examples of UK activities in each of these areas is detailed below:

Adapt

- **Building Resilience to Climate Extremes and Disasters (BRACED**) – This programme is supporting local and national institutions to deliver policies and programmes that better integrate disaster risk reduction, climate adaptation and development approaches. It is supporting community-level initiatives in 13 countries through 15 NGO consortia that are, for example, delivering improved climate information for agriculture, securing livestock migration routes, and building infrastructure to help crops avoid flood and capture water for future use.
- The £26 million **Climate High-Level Investment Programme in Ethiopia** closed earlier in 2017. This has so far supported more than 1.4 million people to cope with the effects of climate change, as well as building institutional capacity to ensure that the Ethiopian Government is more capable of assessing and addressing climate risks.

Other programmes can have a particular focus;

Anticipate

- **Weather and Climate Information and Services for Africa (WISER**) – this programme aims to enhance the resilience of poor people and of economic development in Africa to weather and climate shocks, by improving the quality and use of weather and climate forecasts and other information services. This will contribute to increased productivity of climate sensitive sectors, like agriculture, health and infrastructure. Improved weather information can also help to protect lives.
- The UK is supporting **Future Climate for Africa (FCFA**) research programme which aims to enhance the scientific understanding and prediction of climate variability and change in Africa and, at the same time, is working with stakeholders to bring this information into use in adaptation planning. FCFA includes 11 pilot studies across sub-Saharan Africa that are using climate information to inform decisions, including infrastructure development, climate-smart agriculture, and urban and national planning.

Absorb

- The UK is a major contributor to **African Risk Capacity (ARC)** which strengthens African governments' understanding of drought risk and enables them to buy insurance that will pay out after harvest failures due to droughts. Senegal, Mauritania and Niger received payments totalling $26.5 million after poor rains in 2014, providing food aid, animal fodder and other assistance to 1.3 million people. Malawi received a payment of $8.1 million in 2016, which they have used for emergency cash transfers to affected people and to replenish the national strategic grain reserve. Seven countries are eligible for insurance this year.
- **Pacific Catastrophe Risk Assessment and Financing Initiative**: provides technical assistance and enables insurance for the Pacific Islands to protect against natural disasters such as cyclones and tsunamis thereby reducing their reliance on humanitarian aid. Tonga, Marshall Islands, Cook Islands, Vanuatu, and Samoa (625,000 people in total) are currently insured.

Contributing to international climate change adaptation funds

Pilot Programme for Climate Resilience (PPCR): the UK is the largest contributor to the $1.2 billion Pilot Programme for Climate Resilience (PPCR), one of the four Funds that sit under the CIFs. The PPCR assists governments with the integration of climate resilience into development planning, and pilots innovative public and private solutions to climate-related risks, primarily in Least Developed Countries or Small Island Developing States. For example, a $15.75 million project in Mozambique will develop climate resilient infrastructure to improve the ability of 8,200 farming families to withstand extreme weather events.

Least Developed Countries Fund (LDCF): the UK is also a long-standing contributor to the Least Developed Countries Fund (LDCF), which supports LDCs in developing their National Adaptation Programmes of Action (NAPAs) and funding the resultant programming. Through the most recent contribution of £30 million the UK is aiming to help nearly a million people become more resilient to climate change, and to bring approximately 200,000 hectares of land under more sustainable management. This was the fourth contribution that the UK has made to the LDCF – total contributions amount to £122 million since 2006. The LDCF has provided $8 million towards a project strengthening the climate resilience of vulnerable communities in Somalia. Outcomes so far include the construction of a sand dam which has stored enough water for 40,000 people and their livestock to survive through the prolonged drought period in the Bari region.

6.4.4 Halting deforestation

As well as being responsible for at least 12% of global GHG emissions, deforestation threatens the livelihoods of millions through rising desertification, soil erosion, flooding, and falling biodiversity. Through its 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 is working with ambitious developing country governments and private sector stakeholders to address market and governance failures linked to deforestation. The UK played a key role in brokering ambitious international and multi-stakeholder agreements, such as the New York Declaration on Forests in 2014 and the Leaders' Statement on Forests and Climate Change in Paris, 2015. The UK also works with private sector stakeholders through a range of initiatives including the BioCarbon Fund, the Partnership for Forests programme, and the eco. business Fund.

The UK ICF forests strategy aims to support progress towards halving global deforestation by 2020 and halting it by 2030. Together with Germany and Norway, the UK has pledged to collectively provide $5 billion between 2015 and 2020 to incentivise ambitious governments, companies and communities to protect the largest natural global carbon sinks. This will reduce greenhouse gas emissions, improve the livelihoods and climate resilience of forest-dependent people, and protect biodiversity, as well as providing other environmental benefits such as reducing desertification and flooding. Investment is targeted towards projects that improve forest governance and knowledge enhancement, pay for ecosystem services, boost biodiversity, promote climate smart agriculture and enable stronger community-led forest management, amongst other factors. The UK also supports public-private initiatives to promote zero deforestation supply chains, and innovative solutions to leverage private finance for sustainable forest and land-use.

The UK supports:

- sustainable climate-resilient growth;
- capacity building to improve governance, address land tenure, strengthen sustainable land-use, and promote the full and effective participation of indigenous peoples and local communities in programmes that reduce deforestation and forest degradation;
- the private sector to transform supply chains to become deforestation-free, and leverage significant private investment in forests and agriculture.

Through its ICF, the UK is supporting a number of bilateral and multilateral programmes, including the following examples, discussed in detail below:

The Forest Investment Programme (FIP) – part of the Climate Investment Funds, the FIP is a REDD+ mechanism that provides upfront financing for public and private investments in forestry and related sectors. The UK has contributed £223 million to the FIP. Its objectives include: (a) transformational change in developing countries' policies and practices; (b) piloting replicable models to generate learning on the link between investment and emission reduction, sustainable forest management (SFM), and enhanced carbon stocks; (c) leveraging additional resources to attain effective and sustained REDD+; (d) providing experience and lesson learning.

FIP grants and low-interest loans ($775 million), channeled through partner multilateral development banks (MDBs), are empowering countries to address the drivers of deforestation and forest degradation both inside and outside of the forest sector to achieve the triple win of being good for forests, good for development and good for the climate. FIP projects will result in an estimated reduction or avoidance of greenhouse gas (GHG) emissions of 11.17 $MtCO_2e$, more than 1.1 million people will receive livelihood co-benefits, and an area of 27.8 million hectares will be under improved management.

REDD+ is a framework agreed under the UNFCCC to *Reduce Emissions from Deforestation and forest Degradation* and enhance forest carbon stocks (+) in developing countries. It is aiming to demonstrate the potential of a new land-use paradigm that delivers large-scale forest protection alongside sustainable agricultural intensification.

The UK has committed £73 million to the **REDD for Early Movers (REM)** programme which is an accelerator for the most ambitious and committed countries to reduce emissions from deforestation. REM rewards programmes that are already successful in driving down deforestation trends, with finance re-invested in agreed activities to deliver further results. UK support focusses on Colombia's programme to achieve zero net deforestation in its Amazon region as well as programmes to decouple increases in production from forest loss in two leading Brazilian States – Acre and Mato Grosso.

The Forest Governance, Markets and Climate (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 to influence reforms in timber-producing countries where governance failures often result in illegal logging and neglect of rights to forest land and resources for those living in poverty. By reducing illegal logging these people 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 (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.

Partnership for Forests adds value to standing forests in Africa, Latin America, and Indonesia by incubating new investments in agroforestry and non-timber forest products, helping local people – often indigenous communities and smallholder farmers – connect to new markets and scale up production for their products. It can also target commodities that are driving large-scale deforestation by facilitating multi-stakeholder approaches and solutions which support implementation of zero-deforestation supply-chain commitments. The programme provides a mix of grants and technical assistance to project developers to bring projects aimed at creating deforestation-free commodity supply chains to commercial viability.

The Sustainable Rural Development project in Brazil will encourage small and medium sized farms to implement sustainable low carbon agriculture identified in the Brazilian Government's Plano ABC programme to avoid deforestation and restore degraded land in the Amazon and Atlantic Forests, expanding to the Cerrado next year. The programme aims to showcase best practices in implementing low carbon sustainable agriculture that protects and enhances the environment whilst increasing farming productivity and income.

The project supports farmers by:

- Improving access to information, such as demonstration farms and access to rural credit lines;
- Providing capacity building and technical assistance to support farmers to transition to low carbon technologies; and
- Financial incentives for farmers who successful in implementing of a low carbon agriculture management plan

The UK has invested £54.9 million into this project. The first phase aims to reduce deforestation by 16,500 hectares and restore 41,100 hectares. This will increase annual income per hectare 5-fold for 3,700 small and medium sized farms and will reduce emissions by 10.4 $MtCO_2e$ over 20 years.

6.4.5 Mobilising Private Finance

Mobilising private investment in climate action is crucial to meeting the global goal of limiting temperature increase to 2°C. However, there are a range of market barriers that prevent investments from happening at scale in developing countries. Climate finance can help to overcome these barriers by building capacity and capabilities in developing countries. Using public climate finance to help create the conditions to enable the investment needed is an

essential step in delivering on the Paris Agreement, and for this reason the UK's ICF tests new and innovative approaches that can be replicated and scaled up by the private sector.

The UK provides concessional or market-rate finance to help projects reach financial close and demonstrate profitability, with the aim of reducing real and perceived risks and costs of low-carbon investments. The UK also facilitates access to finance by strengthening local financial institutions and broadening types of finance available in developing country markets. Because low-carbon technologies like renewable energy are often capital-intensive at the beginning, they are particularly sensitive to the cost and availability of capital.

In seeking to mobilise private finance, the UK is using its ICF to:

- Mobilise private climate finance internationally that would not otherwise flow to countries, and seek to create a sustainable climate investment market;
- Mobilise private sector engagement and finance in specific sectors and technologies that experience difficulties in accessing private finance or which pose long term financial risks;
- Create a better understanding of private finance internationally to inform future climate finance policy and climate projects.

The UK supports a range of specific private finance investments – a full list is provided in Table 7.b of the CTF (attached in the annex). This includes, but is not limited to the following examples:

The Sustainable Infrastructure Programme – In 2017 the UK established the Sustainable Infrastructure Program (SIP) in Latin America in partnership with the Inter-American Development Bank. The purpose of the programme is to enable and accelerate the implementation of the Nationally Determined Contributions in Latin America, initially Brazil, Colombia, Mexico and Peru, focusing on supporting and catalysing private sector investments in low carbon infrastructure.

The UK will provide up to £177.5 million from its ICF budget over 5 years to provide technical and financial support. This can include technical assistance to governments to help them shape their regulatory frameworks in a way that is attractive to private investors, support the development of local capital markets, while also investing in a few demonstration projects to show commercial viability.

UK Climate Investments – UK Climate Investments LLP has been mandated to invest in up to £200 million of UK ICF in low carbon projects in emerging markets during its pilot phase (2015-2018). The Investment Mandate requires UKCI to make equity investments into renewable energy and energy efficiency projects in India and Sub-Saharan Africa. Through investing in a minority equity stake, UKCI aims to leverage additional private equity and debt investment into the projects.

The central objectives of the pilot are:

- Use a private sector actor to have a demonstration effect, build a successful track record and prove commerciality of low carbon investments to the broader market by making a strong return on investment; and
- Achieve better value for money by more effectively and nimbly interacting with the private sector.

UKCI's first investment in India was alongside a UK solar developer in a partnership platform to fund the development, acquisition and ownership of large scale solar power generation assets in India.

The Renewable Energy Performance Platform (REPP) – The REPP seeks to mobilise private sector development activity and investment in small and medium scale renewable energy projects (up to 25MW) in sub-Saharan Africa. REPP aims to increase the number of sound 'bankable' smaller renewable energy projects by assisting project proponents throughout the project development stage, by financing Technical Assistance, drawing on existing risk mitigation instruments such as political risk insurance and providing results-based finance where necessary. The UK has committed £48 million for 2015 to 2020.

The **Climate Public Private Partnership (CP3)** is a £130 million programme that aims to support clean energy and demonstrate the commercial viability of investments in climate related businesses in emerging markets. By anchoring two private equity funds – i.e. providing committed investment into these funds to help attract additional investors – the programme mobilised private climate finance of $279 million and kick-started the largest private equity climate fund in Asia. The funds have so far invested in 68 businesses and renewable energy developers across developing countries in Asia, Africa and South and Central America. CP3 is expected to avoid 57.4m tonnes of CO_2 equivalent over its lifetime (to 2026).

The eco.business Fund – The UK has invested £20 million into the eco.business Fund, which is a private-public partnership currently operating in Costa Rica, Ecuador, Nicaragua and El Salvador. The Fund promotes business and consumption practices that contribute to biodiversity conservation and the sustainable use of natural resources. By leveraging and de-risking investment from private sector donors the Fund will protect around 32,500 hectares of biodiverse forest and deliver 280,000 tonnes of carbon dioxide savings. Within five years public sector finance in the eco.business Fund is projected to reach $147 million, bringing in private sector funding of $314 million.

6.4.6 Carbon Pricing

The UK government considers that carbon pricing is crucial to support and raise the ambition needed to tackle climate change. Carbon pricing can provide a cost effective and technology-neutral way of reducing emissions, and is a key focus for mobilising the private sector towards the achievement of the Paris Agreement goals. It is for this reason that the UK continues to promote the use of pricing instruments both domestically and internationally. Since 2005 the UK has been a participant in the EU Emissions Trading System (EU ETS), the world's largest system, and has been an active proponent of reform to help make it as effective as possible.

Internationally, the UK continues to support carbon pricing through a portfolio of programmes aimed at building capacity and piloting new approaches. Below are some examples:

- The UK has invested £7 million since 2011 in the $127 million World Bank managed **Partnership for Market Readiness (PMR)** fund, supporting 19 countries to design and put in place domestic initiatives such as carbon taxes or ETSs. This is done through the provision of grants to allow countries to implement Market Readiness proposals. The PMR supports Brazil, for example, to explore various carbon pricing instruments by carrying out analytical studies on alternative policy design options, assessing their impacts, and building modelling capacity.
- The UK is improving access to carbon finance in least developed countries through the **World Bank's Carbon Initiative for Development (Ci-Dev).** Ci-Dev works in some of the poorest countries in Africa to prepare them to participate in the international carbon market while providing clean energy for households and communities. The program enables local developers to put their ideas into practice, and helps build capacity as needed, for example by aggregating many small projects at household or community level and calculating the carbon that has been saved in order to get a payment incentive. The UK has committed £49 million.

- In 2016, the UK contributed £60m to the new **Transformative Carbon Asset Facility.** The purpose of the TCAF is to support countries with sizeable mitigation potential to scale up their ambition as they implement their Nationally Determined Contributions under the Paris Agreement. Programmes are intended to showcase innovative methodologies for using carbon pricing at scale, to allow the host country to deliver greater emission reduction ambition than in their current Nationally Determined Contributions. Almost 90% of the funding will be spent on results-based purchases of emission reductions from supported programmes. Other donors in the TCAF are currently Norway, Sweden, Switzerland, Canada and Germany.

In 2015 the Paris Agreement reiterated the importance of carbon markets in meeting international commitments by establishing a new framework for voluntary cooperation to enable countries to go further on their mitigation ambition. These provisions will help make the UK vision for the future of the global carbon market a reality by providing the foundations to facilitate bottom-up cooperation while creating the necessary top-down structures, including key rules to avoid double counting of units.

6.5 Steps taken by government to promote, facilitate and finance transfer of technology and capacity building to developing countries

The world needs increasing energy supplies to sustain economic growth and development. However, energy resources are under pressure and CO_2 emissions from today's energy use are already changing the climate. It is necessary 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.

Understanding that lesson sharing enhances programming, the ICF will continue to strengthen its Monitoring, Evaluation and Learning Program to support the generation and use of evidence and knowledge from across the portfolio.

These lessons are captured in publicly available evaluations. The NAMA Facility published their mid-term evaluation report earlier this year – highlighting that there are 'ample opportunities for learning and replication' across their portfolio. Another program, The Carbon Capture and Storage Trust Fund, used their evaluation of activities in the first phase of the program (released April 2016) to propose an evaluation framework for the second phase in order to effectively capture lessons.

The UK has also funded a Special initiative under the Climate Investment Funds focussed on Evaluation and Learning. The initiative supports learning based on evaluative and evidence-based activities within the CIF at different levels, including the project, program, thematic, and portfolio/fund levels. Within the initiative there are demand driven evaluations of CIFs programmes, portfolio level evaluations and a transformational change learning partnership involving multiple stakeholders including CIFs project staff, donors, and representative from multilateral climate funds.

The UK provides the majority of its funding through trusted delivery partners. This leads to complex delivery chains from its fund through to the final recipient. The UK does not systematically track indicators for technology transfer and capacity building programmes. The UK undertakes annual reviews of all of its programmes and these will include support provided for technology transfer and capacity building programmes. This enables progress to be tracked against project milestones and the UK publishes this information on the Development Tracker website.

6.5.1 Steps taken by government to promote, facilitate and finance transfer of technology to developing countries

In the annexed table 8 of the CTF (annexed), examples of 'hard' technology have been reported.

The Clean Technology Fund (CTF), is one example of UK support for technology transfer. The CTF, to which the UK is the largest contributor (providing £701 million), has demonstrated and deployed low carbon technologies at scale across 21 countries. Examples include supporting the first generation of utility scale Concentrated Solar Power (CSP) plants to be built in developing countries, with the plant in South Africa now providing power to 80,000 people and winning a Momentum for Change award from the UNFCCC. CTF finance for the Noor CSP complex in Morocco has helped to bring down technology costs and overall CTF has supported around a fifth of global CSP deployment to date. The fund has dramatically scaled up geothermal development across multiple countries, as well as a wide range of other renewable and clean transport technologies.

The UK participates in a wide range of multilateral and bilateral initiatives through which it supports low carbon development and building capacity for resilience. Examples of these include:

1) **Carbon Capture, Usage and Storage (CCUS):** Since 2012, the UK has provided £60 million to support developing countries to build up the technical and institutional knowledge necessary to enable the deployment of **Carbon Capture, Usage and Storage (CCUS) technologies**.

   The UK is extending this support by £10 million in 2017-2018.CCUS development and deployment is crucial for meeting the 2°C target set out under the Paris Agreement. The UK recently completed an evidence review of the global evidence base on CCUS, which highlights that globally, 12-14% of cost-effective decarbonisation needs to come from CCUS in order to meet the 2°C target.

   The programme aims to raise the level of technical understanding of CCUS within key developing countries, leading to the establishment of the necessary policy frameworks and incentive structures to support CCUS demonstration and ultimately accelerate the deployment of CCUS.

2) **Capacity Building and Transparency:** As agreed by COP21, the Capacity Building Initiative for Transparency (CBIT) was established by the Global Environment Facility (GEF) in 2015 to support developing countries to meet new reporting requirements under the enhanced transparency framework of the Paris Agreement. The UK is the largest donor to CBIT to date, committing £10 million in International Climate finance and £1 million from the Scottish Government.

3) **The Asian Development Bank (ADB)'s Clean Energy Fund** was set up to improve energy access, energy security and the transition to low-carbon technologies through cost-effective investments. The UK's contribution of £10 million is specifically used to fund the technical assistance elements of the fund.

4) **Climate Innovation Centres Programme:** The UK funded Global Network of Climate Innovation Centres programme provides funding to the World Bank's Climate Technology Programme (CTP) to support the design, implementation, and international coordination of Climate Innovation Centres (CICs) in developing countries. The programme assists local entrepreneurs develop innovative technology and business solutions to domestic energy, resource and environmental challenges.

The UK also supports CICs in Ethiopia and Vietnam through bi-lateral programmes, while there are additional non-DFID supported CICs in South Africa, the Caribbean, Ghana and Morocco. The programme helps gather evidence on climate technology innovation in developing countries, enabling national CICs to respond to technology trends.

6.6 Securing policy commitments to accelerate low carbon technology deployment through multilateral initiatives

The UK has 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:

- **Mission Innovation** – the UK is a leading member of Mission Innovation, an international initiative which aims to dramatically accelerate clean energy innovation to make clean energy widely affordable;
- **Sustainable Energy for All (SE4All)** – The UK supports Sustainable Energy for All (SE4All), which monitors delivery of Sustainable Development Goal 7 (SDG7). SDG7 seeks to achieve Universal access to modern energy services for all by 2030 by:
  - Doubling the share of renewable energy in the global energy mix
  - Doubling the global rate of improvement in energy efficiency
- **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 development and deployment, both in OECD and major non-OECD countries. The UK funds various IEA Technology Collaboration Programmes (TCPs) relating to low carbon energy, and the UK has active engagement in the IEA's Renewable Energy Working Party. The UK has announced that it will make a leading £8 million contribution to the IEA's new Clean Energy Transitions Programme, which will provide key emerging economies with cutting technical assistance on the energy transition.
- **International Renewable Energy Agency (IRENA)** – The UK supports IRENA's mission to promote widespread and sustainable use of renewable energy through its role as: a centre of excellence for energy transformation, a global voice for renewables, a network hub for international collaboration, and a source of support and advice. The UK has been an IRENA Council member for 2016-2017 and has helped to drive forward IRENA's medium-term strategy which is consistent with UK government objectives for decarbonisation.
- **Clean Energy Ministerial (CEM) –** the CEM is a forum to promote and share lessons learned from policies and programmes that advance clean energy technology. The UK is a member of a number of the CEM's initiatives, such as the initiative on Super-Efficient Equipment and Appliance Deployment. The UK also contributed funding towards the new CEM Secretariat hosted at the IEA;
- **International Partnership for Energy Efficiency Co-operation (IPEEC)** – IPEEC is a forum to allow major economies to co-operate and collaborate on all aspects of energy efficiency policy. IPEEC's work is undertaken through a series of Task Groups and the UK actively participates in a number of these Groups, including those working on appliance standards, buildings, finance and data. The UK also contributes funding to support the work of the IPEEC Secretariat.

6.7 Other actions to accelerate the alignment of finance flows with low greenhouse gas and climate resilient development

The Paris Agreement's Article 2.1c commits Parties to collectively align finance flows with low greenhouse gas and climate resilient development. This will require a transformation beyond public finance alone, including greater action to develop carbon markets, remove policy misalignments, establish green finance capabilities, build in-country capacity, and integrate climate resilience into national development planning. The OECD has estimated that the additional $0.6 trillion needed to make global infrastructure investment climate compatible from 2016-30[24] will likely be offset over time by fuel savings resulting from low-emission technologies and infrastructure. The key challenge will be mobilising this additional investment.

It is for this reason that the UK's ICF places a strong emphasis on transformational change, through targeted investment in innovative projects and technologies with the potential to be scaled up and replicated. The UK also undertakes a number of activities which more indirectly enable developing country ambition by helping to attract finance for climate action. A selection of these activities is listed below.

6.7.1 Helping developing countries to attract investment

The UK supported the inaugural **Climate Finance Accelerator (CFA)** initiative, a catalytic intervention designed to address the demand for turning countries' Nationally Determined Contributions (NDCs) into finance plans with pipelines of investment-grade projects. The CFA fast tracks the translation of countries' NDCs into finance plans to attract necessary investment by matching government, finance and capital market players from the selected countries of Colombia, Mexico, Nigeria and Vietnam with project and green finance experts from the City of London. This transaction-oriented platform brought together policy makers and private sector financiers to identify financing propositions for projects that align with NDC priorities. The dialogue between these two engaged constituencies included strengthening enabling environments for scaling up climate action and creating action plans for developing NDC financing plans. The CFA builds countries' capacities to engage with the private sector whilst accelerating NDC financing propositions to an investable level.

The NDC Partnership programme, to which the UK contributes, aims to help turn NDCs into specific strategies and measures. It raises ambition globally by enhancing cooperation and support for the successful implementation of NDCs and related Sustainable Development Goal (SDG) commitments, with the ultimate goal of reaching climate-resilient and low carbon growth. The NDC Partnership is a way for countries, intergovernmental organisations, civil society and the private sector to align their plans and actions to achieve the NDCs. It will provide guidance on identifying possible sources of finance, useful tools, and key data to those who need it whilst also providing a way for sharing lessons and experiences in responding to the challenging and complex need to implement the NDCs.

Promoting International Green Finance – the UK's policy leadership in green finance, including by co-chairing the G20 Green Finance Study Group[25] and through endorsing the recommendations of the Financial Stability Board's Task Force on Climate-related Financial Disclosures, helps contribute to the global growth in green finance and increase the flow of finance for low carbon, climate resilient investment. The first offshore green bond issued by an Indian entity and the first green bond issued by a Chinese bank were listed on the London Stock Exchange and $20bn of green bonds are currently listed in London, comprising 59 bonds in seven currencies. The UK Government works with the City of London Green Finance Initiative

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[24] OECD (2017), *Investing in Climate, Investing in Growth,* OECD Publishing, Paris.

[25] This is now the G20 Sustainable Finance Board's Task Force on Climate-related Financial Disclosures.

(a market development group bringing together market participants, academics and civil society) to develop international partnerships. Partnerships with China and Brazil, which involve bringing private sectors from those countries together with UK partners to share knowledge and expertise, make policy recommendations to government and engage in joint work. Further partnerships are planned with India and Mexico.

6.7.2 Removing policy distortions and accelerating the energy transition

In addition to its financial support for **carbon pricing initiatives** and domestic carbon pricing policy, the UK is committed to ensuring that the global carbon pricing system is cemented in environmental integrity and helps increase alignment and participation while opening up policy options for countries to become more ambitious over time. In this respect, in 2016 the UK joined the 18 other signatories of the Ministerial Declaration on Carbon Markets, thus committing to work to ensure the development of high standards for the environmental integrity of the international market mechanisms of the post-2020 period. In September 2017, the UK joined 25 other national and subnational governments to endorse a joint statement pledging to strengthen action on climate change through renewed cooperation on carbon markets.

At COP23, the UK and Canada launched the **Powering Past Coal Alliance,** a global alliance uniting governments, businesses and organizations in taking action to accelerate clean growth and climate protection through the rapid phase-out of traditional coal power. The alliance aims to bring together over 50 national and sub-national governments as well as businesses that are committed to phasing out unabated coal. The UK has already committed to phase out unabated coal-fired electricity as part of its domestic energy policies to reduce greenhouse gases. However, the UK recognises the need to accelerate the international transition from burning coal to using cleaner power sources, and is offering technical and practical help globally to accelerate this transition through UK ICF support to the Clean Technology Fund and International CCUS programme amongst others.

The UK also supports the phasing out of fossil fuel subsidies which, along with the establishment of carbon markets, is essential for enabling cost-effective climate action. The UK has been a key proponent of initiatives to phase out these subsidies through the G20 and other fora.

6.8 Monitoring & Evaluation, Transparency and how the UK has applied lessons learnt from its ICF to ensure project quality

The UK's ICF benefits from an extensive monitoring and evaluation system, which makes use of 16 Key Performance Indicators to assess ICF performance against intended outcomes. The UK's approach to monitoring & evaluation was recognised by the UK's Independent Commission on Aid Impact review of UK ICF, which noted its role in helping UK ICF and the multilateral climate funds become more effective. The UK is seeking to further strengthen this approach through programme specific monitoring and evaluation activities and through the **ICF Monitoring, Evaluation and Learning (MEL) programme** at portfolio level. Complementing the work at programme level, the MEL programme will support the generation and use of evidence and knowledge from across the UK's ICF. It will produce results and evidence of the UK's ICF achievements and effectiveness to support continual improvements in project selection and design, and inform the design of future funds and programmes.

The UK's results reporting framework ensures that the scrutiny the UK applies to determining in-house results is reflected in its external reporting. This includes ensuring that, where appropriate, all activities make a clear assessment of actual costs and evidence in determining climate specificity and additionality in estimating private finance mobilised through the UK's public finance. The UK is committed to further developing the evidence base on how public finance and policy measures can attract private finance, including through helping to fund

and participate in the OECD Research Collaborative for Tracking Private Finance. And the UK is committed to the avoidance of double counting, having played a key role in developing the Technical Working Group methodology used to enable OECD-CPI analysis of aggregate mobilisation of private finance.

The UK also works closely with the OECD in reporting climate finance, including through the use of Rio-Markers. In addition the UK tracks climate finance in order to meet annual reporting requirements under Article 16 of the EU GHG Monitoring Mechanism Regulation (MMR).

The UK's ICF approach to monitoring & evaluation is enabling us to learn lessons from the successes and failures of ICF projects, and to improve our approach over time.

6.9 Bilateral and regional contributions related to the implementation of the convention: Financial Contributions to the Global Environment Facility

	£ million	US$ million
	2014-2016	2014-2016
Global Environment Facility (GEF)	105.0	149.55

Notes:
1. Figures indicate total contribution to the Global Environment Facility, and not just the climate-specific elements.
2. Exchange rate used is £1 = US$1.4243. This is the average of the annual rates on 31/12 of 2014, 2015 and 2016.
3. The 2013 contribution of £52.5m was not available at the time of submission for the UK's 6th National Communication.

Annex 2: Common Tabular Format Tables (CTF) supporting the UK's third biennial report to the UNFCCC

Table 1

Emissions trends: Summary

GREENHOUSE GAS EMISSIONS	*Base year[a]*	*1990*	*1991*	*1992*	1993	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*Change from base to latest reported year*
	kt CO_2 eq																											*(%)*
CO_2 emissions without net CO_2 from LULUCF	595,297.38	595,297.38	603,513.43	588,190.30	573,587.60	568,639.37	559,783.11	581,701.35	556,475.79	560,479.67	553,175.90	560,581.68	569,954.50	553,849.20	565,146.38	566,740.01	563,637.43	561,885.71	553,544.55	539,840.65	488,856.02	507,469.96	464,758.59	484,226.39	473,699.57	433,370.55	415,721.50	-30.17
CO_2 emissions with net CO_2 from LULUCF	598,519.96	598,519.96	605,632.93	589,328.53	574,416.10	569,187.46	560,403.11	581,381.90	555,755.91	558,922.05	552,154.78	558,789.77	567,257.30	550,061.01	561,173.03	562,057.80	558,438.66	555,876.92	547,022.39	532,459.32	481,466.10	499,940.19	457,094.21	477,299.55	465,540.03	424,352.78	406,808.20	-32.03
CH_4 emissions without CH_4 from LULUCF	135,330.83	135,330.83	136,118.24	135,749.43	134,106.29	127,260.34	128,817.93	128,049.03	125,550.81	122,062.63	116,494.46	111,019.80	106,059.75	103,596.93	98,461.93	94,124.79	89,347.49	86,253.02	83,019.77	77,270.39	72,370.18	68,225.88	65,336.28	62,398.42	57,191.79	54,357.60	52,590.23	-61.14
CH_4 emissions with CH_4 from LULUCF	135,347.45	135,347.45	136,137.10	135,764.04	134,122.07	127,275.81	128,847.75	128,071.44	125,577.15	122,083.56	116,511.03	111,051.97	106,091.62	103,629.16	98,522.12	94,158.08	89,388.50	86,289.33	83,065.69	77,305.28	72,413.28	68,266.12	65,372.03	62,461.56	57,223.69	54,390.09	52,616.66	-61.12
N_2O emissions without N_2O from LULUCF	48,865.15	48,865.15	49,068.43	44,634.42	40,550.27	40,838.94	39,494.99	39,225.19	39,381.82	39,404.37	29,478.45	29,191.38	27,640.54	25,840.86	25,638.54	26,345.50	25,364.40	24,505.61	24,314.43	23,770.04	22,093.91	22,493.48	21,437.32	21,301.62	21,263.69	21,905.12	21,704.94	-55.58
N_2O emissions with N_2O from LULUCF	51,326.06	51,326.06	51,506.85	47,047.47	42,951.26	43,226.26	41,877.78	41,585.70	41,728.29	41,732.06	31,791.11	31,441.89	29,815.38	27,946.95	27,707.15	28,326.08	27,290.58	26,373.09	26,133.14	25,520.13	23,796.94	24,161.71	23,084.43	22,942.03	22,849.15	23,464.24	23,223.15	-54.75
HFCs	14,391.43	14,391.43	14,991.05	15,597.63	16,505.66	17,593.37	19,095.98	20,249.18	23,104.50	20,074.40	11,465.64	9,882.92	10,890.79	11,387.39	12,829.42	11,919.34	13,151.49	14,074.84	14,532.71	15,029.24	15,649.90	16,511.59	14,947.17	15,472.66	15,796.32	15,981.74	15,963.56	10.92
PFCs	1,651.53	1,651.53	1,385.14	690.35	602.73	611.40	596.94	596.36	503.12	493.73	473.96	596.79	485.59	408.23	356.61	433.85	385.15	387.67	287.84	266.25	197.33	287.71	416.94	255.06	318.74	278.31	327.23	-80.19
Unspecified mix of HFCs and PFCs	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, NE	NO, NE	NO, NE	NO, NE	NO	NO	0.00
SF_6	1,279.06	1,279.06	1,318.54	1,358.25	1,182.90	1,223.44	1,264.37	1,305.70	1,280.08	1,328.72	1,497.70	1,817.67	1,454.10	1,495.23	1,320.77	1,116.78	1,056.02	882.91	835.78	682.84	592.61	686.49	607.31	588.61	493.30	476.54	457.48	-64.23
NF_3	0.42	0.42	0.48	0.55	0.63	0.73	0.83	0.96	1.10	1.27	1.46	1.69	1.03	1.03	0.95	0.59	0.29	0.29	0.28	0.27	0.26	0.27	0.30	0.33	0.36	0.40	0.44	5.64
Total (without LULUCF)	796,815.80	796,815.80	806,395.30	786,220.93	766,536.08	756,167.59	749,054.14	771,127.77	746,297.22	743,844.79	712,587.57	713,091.94	716,486.30	696,578.86	703,754.61	700,680.85	692,942.28	687,990.04	676,535.37	656,859.68	599,760.21	615,675.37	567,503.92	584,243.08	568,763.78	526,370.27	506,765.38	-36.40
Total (with LULUCF)	802,515.91	802,515.91	810,972.08	789,786.82	769,781.36	759,118.47	752,086.76	773,191.25	747,950.16	744,635.77	713,895.68	713,582.71	715,995.81	694,928.99	701,910.06	698,012.51	689,710.70	683,885.05	671,877.84	651,263.33	594,116.41	609,854.08	561,522.38	579,019.79	562,221.61	518,944.11	499,396.72	-37.77
Total (without LULUCF, with indirect)	NA	NA	NA	NA	NA	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 (with LULUCF, with indirect)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	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	2012	2013	2014	2015	Change from base to latest reported year
	kt CO_2 eq																											
1. Energy	609,731.92	609,731.92	620,375.02	604,570.10	588,950.18	574,630.56	565,994.13	585,262.38	560,126.12	562,617.11	552,690.88	559,526.35	569,198.81	552,826.65	560,942.52	560,909.59	557,351.83	555,732.18	544,925.89	532,759.19	486,744.01	503,708.14	461,515.90	481,262.47	467,555.28	427,390.54	409,799.39	-32.79
2. Industrial processes and product use	66,538.07	66,538.07	64,758.87	60,350.33	56,974.00	60,285.38	60,825.90	62,921.71	64,129.84	60,734.70	42,719.52	40,584.46	38,804.99	36,693.89	39,354.68	40,502.43	39,715.39	38,905.16	41,263.77	39,396.93	32,789.69	35,547.03	32,010.19	32,326.58	34,392.92	34,137.89	33,595.50	-49.51

3. Agriculture	53,574.19	53,574.19	53,619.34	53,533.61	52,422.34	52,823.34	52,875.75	53,286.30	52,825.26	52,279.57	51,712.32	49,949.48	47,363.76	47,091.08	47,230.05	47,214.91	46,405.39	45,982.00	45,282.40	44,362.37	44,156.64	44,426.10	44,323.16	43,825.66	44,088.11	44,991.00	44,902.99	-16.19
4. Land Use, Land-Use Change and Forestry	5,700.11	5,700.11	4,576.79	3,565.89	3,245.27	2,950.88	3,032.62	2,063.48	1,652.94	790.99	1,308.11	490.77	-490.48	-1,649.87	-1,844.54	-2,668.34	-3,231.58	-4,104.99	-4,657.53	-5,596.35	-5,643.80	-5,821.29	-5,981.53	-5,223.29	-6,542.18	-7,426.16	-7,368.66	-229.27
5. Waste	66,971.62	66,971.62	67,642.06	67,766.88	68,189.56	68,428.30	69,358.37	69,657.38	69,215.99	68,213.41	65,464.86	63,031.65	61,118.74	59,967.24	56,227.35	52,053.92	49,469.67	47,370.70	45,063.31	40,341.19	36,069.87	31,994.11	29,654.66	26,828.37	22,727.47	19,850.84	18,467.49	-72.42
6. Other																												
Total (including LULUCF)	802,515.91	802,515.91	810,972.08	789,786.82	769,781.36	759,118.47	752,086.76	773,191.25	747,950.16	744,635.77	713,895.68	713,582.71	715,995.81	694,928.99	701,910.06	698,012.51	689,710.70	683,885.05	671,877.84	651,263.33	594,116.41	609,854.08	561,522.38	579,019.79	562,221.61	518,944.11	499,396.72	-37.77

Table 1 continued
Emissions trends: Carbon Dioxide

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	*Base year*[a]	*1990*	*1991*	*1992*	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*Change from base to latest reported year*
	kt																											*%*
1. Energy	567,583.58	567,583.58	577,768.72	562,512.52	548,865.52	541,837.99	532,242.73	553,227.79	530,163.00	535,199.69	528,117.48	536,811.18	547,826.87	532,283.89	542,164.46	542,552.74	540,846.09	540,166.42	530,009.98	518,536.82	473,008.27	490,069.65	448,313.12	467,792.87	455,308.07	415,535.94	398,328.62	-29.82
A. Fuel combustion (sectoral approach)	560,107.09	560,107.09	570,743.04	555,252.61	541,283.30	534,086.85	523,076.52	543,763.53	522,544.34	527,986.24	521,927.08	530,934.37	541,719.45	526,493.07	536,673.45	537,086.47	534,833.48	535,023.69	524,679.55	513,909.89	468,187.95	485,375.02	443,916.67	464,073.30	451,184.06	411,188.06	393,768.62	-29.70
1. Energy industries	235,822.84	235,822.84	233,603.85	222,445.75	206,393.15	204,573.12	202,121.81	203,936.89	191,272.19	196,951.19	187,667.77	198,553.36	208,691.28	207,081.28	214,759.41	212,871.89	213,628.60	220,001.42	214,799.43	209,188.70	186,102.67	192,960.97	178,903.46	190,390.87	177,783.43	152,844.65	132,959.65	-43.62
2. Manufacturing industries and construction	95,418.76	95,418.76	98,503.02	96,023.93	93,288.17	92,461.37	89,079.55	90,187.91	89,350.75	88,571.47	90,559.66	90,336.26	88,237.03	79,669.67	81,122.06	80,017.03	80,633.49	78,918.32	77,140.87	69,795.33	59,497.30	60,319.62	55,629.34	55,206.89	55,279.80	55,820.55	53,164.65	-44.28
3. Transport	114,252.40	114,252.40	113,486.33	114,921.10	116,091.62	116,572.26	115,708.90	120,303.38	121,846.59	121,470.61	122,566.38	121,870.92	122,030.94	124,471.77	124,253.03	125,741.63	126,913.05	126,826.41	128,051.80	122,724.85	118,236.88	116,701.39	115,120.55	114,633.32	113,698.40	115,134.74	117,362.94	2.72
4. Other sectors	109,328.27	109,328.27	120,857.42	117,775.05	121,369.43	116,520.28	112,280.08	125,530.36	116,444.10	117,798.96	117,983.63	117,257.53	119,838.30	112,213.72	113,376.77	115,403.17	110,819.53	105,818.58	100,940.97	108,951.51	101,374.00	112,502.29	91,515.25	101,323.07	102,137.08	85,368.85	88,296.70	-19.24
5. Other	5,284.82	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	2,838.83	3,458.96	3,746.49	3,249.50	2,977.10	2,890.76	2,748.07	2,519.16	2,285.35	2,019.27	1,984.68	-62.45
B. Fugitive emissions from fuels	7,476.49	7,476.49	7,025.68	7,259.90	7,582.22	7,751.15	9,166.22	9,464.26	7,618.66	7,213.46	6,190.40	5,876.80	6,107.41	5,790.82	5,491.01	5,466.27	6,012.60	5,142.73	5,330.43	4,626.92	4,820.32	4,694.64	4,396.45	3,719.57	4,124.01	4,347.88	4,560.00	-39.01
1. Solid fuels	1,698.56	1,698.56	1,312.14	1,122.56	1,022.21	791.77	737.42	552.48	629.34	294.79	214.74	192.99	198.95	194.12	185.41	228.21	161.26	192.03	246.25	324.95	239.61	296.62	379.66	148.51	278.35	436.08	434.28	-74.43
2. Oil and natural gas and other emissions from energy production	5,777.92	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	5,305.60	5,238.06	5,851.34	4,950.70	5,084.18	4,301.97	4,580.71	4,398.02	4,016.79	3,571.06	3,845.66	3,911.80	4,125.72	-28.60
C. CO_2 transport and storage	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
2. Industrial processes	24,525.61	24,525.61	22,213.80	22,195.79	21,990.30	24,146.94	24,721.43	25,700.47	24,029.45	23,400.63	23,363.47	22,190.49	20,579.19	19,963.01	21,260.94	22,552.10	21,331.38	20,323.10	21,930.47	19,958.68	14,271.11	15,853.35	14,769.69	14,984.12	16,810.79	16,405.29	15,918.36	-35.09
A. Mineral industry	9,803.78	9,803.78	8,050.66	7,544.13	7,578.60	8,656.07	8,746.75	9,068.82	9,392.84	9,567.66	8,970.73	8,848.78	8,426.04	8,457.49	8,505.74	8,782.46	8,744.22	8,716.30	9,009.27	7,848.91	5,680.34	5,984.19	6,344.35	6,061.58	6,430.13	6,562.12	6,638.00	-32.29
B. Chemical industry	6,764.97	6,764.97	7,251.99	7,232.26	7,203.67	7,476.83	7,520.65	7,505.75	6,677.34	6,787.95	7,183.80	6,607.79	6,295.44	6,106.83	6,384.21	6,416.65	6,217.58	5,723.63	6,416.93	5,429.05	4,844.13	5,185.43	4,575.82	5,222.72	4,757.87	4,183.51	4,582.71	-32.26
C. Metal industry	7,403.74	7,403.74	6,401.48	5,921.53	5,524.37	6,340.36	6,858.80	7,053.80	6,466.71	6,036.14	6,686.68	6,156.35	5,303.12	4,312.51	5,280.55	5,488.06	5,853.45	5,402.83	6,048.27	5,976.71	3,353.05	3,573.47	3,098.58	3,009.35	4,994.86	4,859.84	4,392.39	-40.67
D. Non-energy products from fuels and solvent use	553.12	553.12	509.67	1,497.86	1,683.65	1,673.67	1,595.24	2,072.10	1,492.56	1,008.87	522.27	577.57	554.59	1,086.18	1,090.44	1,864.92	516.13	480.34	456.01	704.02	393.59	1,110.26	750.94	690.47	627.92	799.82	305.26	-44.81
E. Electronic industry																												
F. Product uses as ODS substitutes																												
G. Other product manufacture and use	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
H. Other	IE, NE, NO	IE, NE, NO	IE, NE, NO	IE, NE, NO	IE, NE, NO	IE, NE, NO	IE, NE, NO	IE, NE, NO	IE, NE, NO	IE, NE, NO	IE, NE, NO	IE, NE, NO	IE, NE, NO	IE, NE, NO	IE, NE, NO	IE, NE, NO	IE, NE, NO	IE, NE, NO	IE, NE, NO	IE, NE, NO	IE, NE, NO	IE, NE, NO	IE, NE, NO	IE, NE, NO	IE, NE, NO	NE, NO, IE	NO, NE, IE	0.00
3. Agriculture	1,831.42	1,831.42	2,164.79	2,144.95	1,475.16	1,567.89	1,875.81	1,831.44	1,698.59	1,290.47	1,156.89	1,040.11	1,001.82	1,076.84	1,215.58	1,169.98	1,050.98	1,101.77	1,249.49	1,039.41	1,275.55	1,247.39	1,385.65	1,160.98	1,286.23	1,139.81	1,192.67	-34.88
A. Enteric fermentation																												
B. Manure management																												

C. Rice cultivation																												
D. Agricultural soils																												
E. Prescribed burning of savannas																												
F. Field burning of agricultural residues																												
G. Liming	1,576.48	1,576.48	1,922.21	1,929.47	1,270.83	1,397.07	1,693.71	1,651.80	1,502.97	1,152.43	995.17	908.09	830.57	841.35	1,041.26	915.20	820.38	873.99	920.77	834.61	976.51	938.15	1,032.53	832.92	1,037.08	786.46	769.30	-51.20
H. Urea application	252.19	252.19	239.83	212.76	201.63	168.15	179.45	176.98	192.93	135.35	159.04	129.35	168.63	232.87	171.70	252.12	227.94	225.23	326.22	202.14	296.44	306.61	350.51	325.68	246.79	350.96	420.90	66.90
I. Other carbon-containing fertilizers	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
J. Other	2.75	2.75	2.74	2.72	2.70	2.68	2.65	2.66	2.70	2.69	2.68	2.67	2.61	2.61	2.62	2.66	2.66	2.56	2.50	2.66	2.60	2.62	2.60	2.37	2.37	2.39	2.46	-10.46
4. Land Use, Land-Use Change and Forestry	3,222.58	3,222.58	2,119.50	1,138.23	828.50	548.09	620.00	-319.45	-719.87	-1,557.63	-1,021.12	-1,791.91	-2,697.20	-3,788.19	-3,973.35	-4,682.21	-5,198.77	-6,008.79	-6,522.16	-7,381.33	-7,389.92	-7,529.77	-7,664.38	-6,926.84	-8,159.54	-9,017.77	-8,913.30	-376.59
A. Forest land	-10,540.57	-10,540.57	-11,650.64	-12,272.28	-12,466.05	-12,677.10	-12,719.81	-13,340.83	-13,457.94	-14,096.65	-14,261.65	-14,618.53	-15,275.91	-15,707.79	-15,727.20	-15,675.03	-15,889.14	-16,242.15	-16,076.76	-16,850.27	-16,879.71	-16,491.39	-15,872.40	-14,273.43	-16,136.21	-16,554.91	-15,980.26	51.61
B. Cropland	15,122.71	15,122.71	15,091.01	14,980.74	15,159.65	15,188.81	15,471.64	15,373.09	15,395.57	15,451.53	15,524.44	14,981.16	14,686.53	14,375.36	14,066.71	13,849.55	13,529.81	13,362.84	13,005.28	12,896.29	12,903.41	12,692.82	12,549.97	12,418.21	12,186.41	11,926.08	11,782.74	-22.09
C. Grassland	-7,750.95	-7,750.95	-7,866.08	-7,982.84	-8,097.24	-8,209.35	-8,319.36	-8,426.42	-8,515.25	-8,635.06	-8,016.59	-7,550.02	-7,565.11	-7,702.23	-7,615.82	-7,867.17	-7,895.23	-8,255.03	-8,204.81	-8,349.29	-8,376.02	-8,449.34	-8,844.38	-8,940.81	-8,911.62	-9,155.59	-9,143.69	17.97
D. Wetlands	486.95	486.95	489.16	477.07	464.25	576.23	656.46	556.33	487.62	361.24	490.74	480.32	519.66	321.31	558.06	387.47	445.08	463.83	299.70	256.59	294.56	320.55	277.03	218.24	378.72	268.69	268.69	-44.82
E. Settlements	6,913.52	6,913.52	6,843.69	6,776.92	6,721.39	6,672.61	6,614.65	6,583.02	6,558.02	6,520.92	6,525.30	6,334.01	6,297.74	6,263.95	6,232.42	6,202.97	6,175.47	6,163.46	6,139.98	6,118.09	6,211.57	6,193.53	6,175.66	6,096.87	6,077.63	6,096.34	6,081.26	-12.04
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	NO	NO	NO	NO	NO	0.00
G. Harvested wood products	-1,009.08	-1,009.08	-787.65	-841.38	-953.51	-1,003.11	-1,083.58	-1,064.64	-1,187.90	-1,159.61	-1,283.36	-1,418.86	-1,360.10	-1,338.79	-1,487.53	-1,580.00	-1,564.76	-1,501.74	-1,685.56	-1,452.73	-1,543.74	-1,795.94	-1,950.26	-2,445.91	-1,754.49	-1,598.38	-1,922.04	90.47
H. Other	NA	NA	NA	NA	NA	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. Waste	1,356.77	1,356.77	1,366.12	1,337.05	1,256.63	1,086.54	943.14	941.65	584.75	588.88	538.07	539.90	546.62	525.47	505.40	465.19	408.99	294.43	354.61	305.74	301.10	299.57	290.14	288.43	294.49	289.51	281.85	-79.23
A. Solid waste disposal	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, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	0.00
B. Biological treatment of solid waste																												
C. Incineration and open burning of waste	1,356.77	1,356.77	1,366.12	1,337.05	1,256.63	1,086.54	943.14	941.65	584.75	588.88	538.07	539.90	546.62	525.47	505.40	465.19	408.99	294.43	354.61	305.74	301.10	299.57	290.14	288.43	294.49	289.51	281.85	-79.23
D. Waste water treatment and discharge																												
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
6. Other (as specified in the summary table in CRF)																												
Memo items:																												
International bunkers	24,035.53	24,035.53	23,796.52	25,612.32	26,695.71	26,648.45	28,093.13	30,153.20	32,261.84	35,294.43	34,682.35	36,754.59	36,199.25	34,125.49	35,855.24	39,535.23	42,587.71	45,445.76	44,761.77	45,623.36	43,348.85	40,657.94	43,191.45	40,838.33	41,092.86	41,534.58	40,737.65	69.49
Aviation	15,272.37	15,272.37	15,044.40	16,696.04	17,897.53	18,695.20	19,896.51	21,047.12	22,403.52	24,953.34	27,125.24	29,927.14	29,154.48	28,619.71	29,303.22	32,123.07	34,692.70	35,220.87	35,054.24	34,289.62	32,499.29	31,429.62	32,900.25	32,039.48	32,317.46	32,558.93	33,040.68	116.34
Navigation	8,763.16	8,763.16	8,752.12	8,916.28	8,798.18	7,953.25	8,196.62	9,106.08	9,858.32	10,341.10	7,557.11	6,827.45	7,044.77	5,505.78	6,552.01	7,412.16	7,895.01	10,224.89	9,707.53	11,333.74	10,849.56	9,228.31	10,291.21	8,798.85	8,775.40	8,975.65	7,696.98	-12.17
Multilateral operations	NE	NE	NE	NE	NE	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	2,973.70	2,973.70	3,146.55	3,331.31	3,691.20	5,234.19	5,709.52	6,260.31	6,262.88	6,191.82	6,579.99	6,639.61	7,343.80	7,788.17	9,019.31	10,204.22	11,860.55	12,381.14	12,907.72	15,847.36	17,263.89	20,576.91	20,799.50	22,150.45	26,673.82	30,933.37	35,958.28	1,109.21
CO_2 captured	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Long-term storage of C in waste disposal sites	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Indirect N_2O																												
Indirect CO_2	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	NE, NO	NE, NO	NE, NO	NO, NE	NO, NE	0.00

Total CO_2 equivalent emissions with land use, land-use change and forestry	598,519.96	598,519.96	605,632.93	589,328.53	574,416.10	569,187.46	560,403.11	581,381.90	555,755.91	558,922.05	552,154.78	558,789.77	567,257.30	550,061.01	561,173.03	562,057.80	558,438.66	555,876.92	547,022.39	532,459.32	481,466.10	499,940.19	457,094.21	477,299.55	465,540.03	424,352.78	406,808.20	-32.03
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00

Notes

a - UNFCCC base year for the UK is 1990
Abbreviations: NO = not occurring, NA= not applicable, NE = not estimated, IE= included elsewhere

Table 1 continued
Emissions trends: Methane

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	*Base year*[a]	*1990*	*1991*	*1992*	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*Change from base to latest reported year*
													kt															*%*
1. Energy	1,492.22	1,492.22	1,512.51	1,492.67	1,413.81	1,114.50	1,147.23	1,084.87	1,008.01	907.63	799.42	725.76	673.63	643.14	577.04	562.86	491.20	456.36	436.80	421.56	415.64	410.05	395.84	393.62	351.70	335.26	317.64	-78.71
A. Fuel combustion (sectoral approach)	125.35	125.35	130.61	122.69	125.54	114.75	98.53	100.27	91.68	87.58	86.95	78.99	77.24	70.16	65.37	62.95	58.28	54.65	53.46	55.78	53.27	59.03	52.31	55.13	58.50	55.87	59.96	-52.16
1. Energy industries	8.12	8.12	8.21	8.32	8.49	9.67	9.77	10.19	10.03	10.66	11.45	10.84	11.85	12.64	12.01	12.35	12.41	10.80	10.87	10.86	11.16	11.42	10.21	9.77	9.47	9.98	12.07	48.60
2. Manufacturing industries and construction	4.52	4.52	4.63	4.65	4.30	4.54	4.31	4.23	4.01	3.80	3.74	3.53	3.48	3.40	3.51	3.69	3.44	3.43	3.40	3.22	3.03	3.38	3.43	3.28	3.33	3.85	3.97	-12.07
3. Transport	50.14	50.14	49.40	48.44	45.57	41.29	37.21	35.37	32.61	29.59	27.36	24.76	21.77	19.62	17.32	15.61	14.38	13.05	11.66	10.49	7.98	7.07	6.40	5.77	5.17	4.92	4.70	-90.64
4. Other sectors	62.42	62.42	68.25	61.16	67.06	59.14	47.14	50.37	44.94	43.44	44.32	39.78	40.05	34.41	32.43	31.22	27.96	27.29	27.42	31.12	31.01	37.08	32.19	36.25	40.47	37.05	39.17	-37.25
5. Other	0.15	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	0.07	0.06	0.06	0.06	-62.86
B. Fugitive emissions from fuels	1,366.87	1,366.87	1,381.91	1,369.98	1,288.27	999.75	1,048.70	984.60	916.34	820.05	712.46	646.77	596.39	572.98	511.67	499.91	432.92	401.71	383.34	365.78	362.37	351.02	343.53	338.49	293.20	279.39	257.68	-81.15
1. Solid fuels	873.07	873.07	897.83	890.36	829.10	550.96	602.52	557.61	534.51	455.34	377.12	324.44	288.14	283.20	233.32	209.56	154.76	139.90	113.44	113.70	109.95	102.27	97.98	98.67	68.18	67.28	55.38	-93.66
2. Oil and natural gas and other emissions from energy production	493.80	493.80	484.07	479.62	459.17	448.79	446.18	426.99	381.82	364.71	335.35	322.33	308.26	289.78	278.35	290.35	278.16	261.81	269.90	252.09	252.42	248.75	245.56	239.81	225.02	212.11	202.29	-59.03
C. CO_2 transport and storage																												
2. Industrial processes	11.27	11.27	10.91	11.48	10.30	11.80	9.72	10.76	9.28	7.31	6.56	6.14	5.95	6.02	6.82	5.97	5.16	5.22	5.63	4.36	4.71	4.88	4.41	4.80	5.08	5.00	3.32	-70.53
A. Mineral industry																												
B. Chemical industry	8.55	8.55	8.52	9.13	8.08	9.44	7.34	8.46	6.99	5.12	4.51	4.28	4.14	4.30	5.00	4.16	3.59	3.27	3.69	2.94	3.68	4.05	3.60	4.00	4.17	4.04	2.45	-71.30
C. Metal industry	1.48	1.48	1.38	1.45	1.46	1.51	1.54	1.53	1.56	1.49	1.47	1.27	1.23	1.13	1.20	1.20	1.05	1.11	1.05	0.99	0.76	0.56	0.57	0.65	0.73	0.76	0.66	-55.02
D. Non-energy products from fuels and solvent use	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	NO, IE	0.00
E. Electronic industry																												
F. Product uses as ODS substitutes																												
G. Other product manufacture and use	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
H. Other	1.24	1.24	1.01	0.90	0.76	0.86	0.85	0.77	0.73	0.71	0.58	0.59	0.58	0.59	0.62	0.61	0.52	0.83	0.88	0.43	0.27	0.27	0.25	0.16	0.18	0.20	0.20	-83.63
3. Agriculture	1,317.85	1,317.85	1,302.77	1,302.42	1,296.36	1,304.17	1,293.29	1,313.28	1,295.32	1,299.43	1,293.36	1,247.92	1,178.97	1,156.37	1,164.23	1,172.59	1,157.59	1,149.50	1,135.97	1,108.24	1,091.64	1,097.75	1,092.27	1,089.22	1,087.17	1,107.33	1,111.38	-15.67
A. Enteric fermentation	1,120.78	1,120.78	1,107.89	1,109.80	1,108.72	1,115.49	1,107.40	1,124.69	1,106.82	1,111.23	1,110.63	1,073.98	1,014.55	996.54	1,007.42	1,014.62	1,002.93	994.76	982.80	958.80	944.17	950.83	946.30	944.12	941.15	959.26	962.91	-14.09

B. Manure management	177.79	177.79	176.87	176.36	176.73	177.74	174.98	178.00	177.71	177.17	171.57	163.12	153.95	149.65	148.29	149.46	146.11	145.24	143.55	140.08	138.49	138.34	137.48	137.20	138.17	140.10	140.68	-20.87
C. Rice cultivation	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
D. Agricultural soils	NE	NE	NE	NE	NE	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. Prescribed burning of savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
F. Field burning of agricultural residues	8.21	8.21	6.93	5.19	0.11	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	
G. Liming																												
H. Urea application																												
I. Other carbon-containing fertilizers																												
J. Other	11.07	11.07	11.08	11.06	10.81	10.93	10.91	10.58	10.79	11.02	11.15	10.82	10.47	10.18	8.52	8.50	8.55	9.50	9.62	9.36	8.98	8.58	8.49	7.89	7.85	7.97	7.79	-29.59
4. Land use, land-use change and forestry	0.66	0.66	0.75	0.58	0.63	0.62	1.19	0.90	1.05	0.84	0.66	1.29	1.27	1.29	2.41	1.33	1.64	1.45	1.84	1.40	1.72	1.61	1.43	2.53	1.28	1.30	1.06	59.03
A. Forest land	0.13	0.13	0.22	0.06	0.10	0.08	0.67	0.35	0.47	0.27	0.04	0.15	0.21	0.18	0.16	0.20	0.38	0.38	0.34	0.32	0.28	0.14	0.18	0.87	0.22	0.24	NO, NE, IE, NA	
B. Cropland	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	NO, NE, IE, NA	0.00	0.00	0.00	0.00	0.00	-47.86
C. Grassland	0.40	0.40	0.40	0.40	0.40	0.40	0.41	0.41	0.43	0.41	0.42	1.09	1.02	1.06	2.20	1.08	1.21	1.01	1.43	1.01	1.25	1.28	1.04	1.52	0.92	0.88	0.87	120.74
D. Wetlands	NO, NE, NA	NO, NE, NA	NO, NE, NA	NO, NE, NA	NO, NE, NA	NO, NE, NA	NO, NE, NA	NO, NE, NA	NO, NE, NA	NO, NE, NA	NO, NE, NA	NO, NE, NA	NO, NE, NA	NO, NE, NA	NO, NE, NA	NO, NE, NA	NO, NE, NA	NO, NE, NA	NO, NE, NA	NO, NE, NA	NO, NE, NA	NO, NE, NA	NO, NE, NA	NO, NE, NA	NO, NE, NA	NO, NE, NA	NO, NE, NA	0.00
E. Settlements	0.14	0.14	0.13	0.12	0.12	0.13	0.12	0.13	0.15	0.16	0.20	0.04	0.04	0.04	0.04	0.04	0.05	0.06	0.06	0.07	0.19	0.20	0.20	0.14	0.14	0.18	0.18	33.40
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	NO	NO	NO	NO	NO	0.00
G. Harvested wood products																												
H. Other	NA	NA	NA	NA	NA	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. Waste	2,591.90	2,591.90	2,618.53	2,623.41	2,643.79	2,659.95	2,702.47	2,713.05	2,709.41	2,668.14	2,560.45	2,460.98	2,383.84	2,338.34	2,190.39	2,023.57	1,919.96	1,839.04	1,742.39	1,556.65	1,382.82	1,216.35	1,120.93	1,008.30	843.72	726.71	671.27	-74.10
A. Solid waste disposal	2,417.36	2,417.36	2,443.94	2,445.84	2,466.15	2,484.18	2,530.59	2,538.27	2,532.79	2,492.72	2,381.66	2,278.55	2,234.55	2,190.46	2,044.79	1,870.30	1,763.04	1,678.14	1,575.68	1,392.04	1,225.50	1,055.82	955.89	844.67	679.33	553.95	491.97	-79.65
B. Biological treatment of solid waste	0.22	0.22	0.30	0.36	0.42	0.48	0.79	1.11	1.49	2.93	3.56	4.36	6.88	7.58	8.31	11.21	14.58	17.44	20.74	20.59	24.01	28.66	32.58	33.27	35.28	39.84	42.02	18,690.68
C. Incineration and open burning of waste	5.49	5.49	5.35	5.17	4.63	3.61	3.52	3.67	0.89	0.88	0.97	0.90	0.91	0.93	1.01	0.83	0.79	0.80	0.76	0.70	0.60	0.44	0.44	0.42	0.37	0.36	0.36	-93.40
D. Waste water treatment and discharge	168.83	168.83	168.94	172.05	172.59	171.68	167.57	170.00	174.25	171.62	174.25	177.17	141.50	139.38	136.28	141.24	141.55	142.66	145.21	143.32	132.72	131.44	132.01	129.93	128.74	132.55	136.92	-18.90
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
6. Other (as specified in the summary table in CRF)																												
Total CH_4 emissions with CH_4 from LULUCF	5,413.90	5,413.90	5,445.48	5,430.56	5,364.88	5,091.03	5,153.91	5,122.86	5,023.09	4,883.34	4,660.44	4,442.08	4,243.66	4,145.17	3,940.88	3,766.32	3,575.54	3,451.57	3,322.63	3,092.21	2,896.53	2,730.64	2,614.88	2,498.46	2,288.95	2,175.60	2,104.67	-61.12
Memo items:																												
Aviation	0.28	0.28	0.23	0.22	0.21	0.19	0.19	0.19	0.19	0.19	0.17	0.15	0.12	0.11	0.11	0.11	0.11	0.11	0.11	0.10	0.09	0.08	0.09	0.08	0.09	0.09	0.09	-69.20
Navigation	0.14	0.14	0.14	0.14	0.14	0.12	0.13	0.14	0.15	0.16	0.12	0.11	0.11	0.09	0.10	0.12	0.12	0.16	0.15	0.18	0.17	0.14	0.16	0.14	0.14	0.14	0.12	-12.65
Multilateral operations	NE	NE	NE	NE	NE	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																												
CO_2 captured																												
Long-term storage of C in waste disposal sites																												
Indirect N_2O																												

Indirect CO_2	

Notes
a - UNFCCC base year for the UK is 1990
Abbreviations: NO = not occurring, NA= not applicable, NE = not estimated, IE= included elsewhere

Table 1 continued
Emissions trends: Nitrous Oxide

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	*Base year[a]*	*1990*	*1991*	*1992*	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*Change from base to latest reported year*
													kt															*%*
1. Energy	16.25	16.25	16.09	15.91	15.90	16.54	17.02	16.49	15.98	15.86	15.40	15.34	15.21	14.98	14.60	14.38	14.18	13.95	13.41	12.36	11.22	11.37	11.10	12.18	11.59	11.65	11.85	-27.11
A. Fuel combustion (sectoral approach)	16.11	16.11	15.95	15.76	15.75	16.38	16.82	16.28	15.80	15.69	15.23	15.19	15.05	14.84	14.48	14.25	14.03	13.82	13.28	12.25	11.11	11.26	10.95	12.05	11.49	11.54	11.73	-27.23
1. Energy industries	4.66	4.66	4.64	4.48	4.02	4.11	4.02	3.94	3.61	3.76	3.42	3.68	3.92	4.03	4.01	3.86	3.95	4.03	3.66	3.47	3.17	3.21	3.24	3.76	3.55	3.29	3.21	-31.06
2. Manufacturing industries and construction	3.64	3.64	3.51	3.50	3.50	3.65	3.65	3.61	3.60	3.57	3.54	3.50	3.51	3.50	3.51	3.72	3.62	3.61	3.62	3.37	2.69	2.68	2.33	2.71	2.19	2.42	2.48	-32.09
3. Transport	4.65	4.65	4.58	4.69	5.05	5.58	6.31	5.82	5.74	5.59	5.53	5.42	5.05	4.84	4.53	4.34	4.18	3.98	3.88	3.29	3.09	3.13	3.21	3.31	3.45	3.62	3.77	-18.83
4. Other sectors	3.00	3.00	3.10	2.98	3.06	2.92	2.72	2.81	2.75	2.68	2.65	2.51	2.49	2.37	2.33	2.24	2.19	2.10	2.01	2.04	2.06	2.16	2.09	2.20	2.23	2.15	2.21	-26.52
5. Other	0.16	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	0.08	0.07	0.06	0.06	-62.61
B. Fugitive emissions from fuels	0.14	0.14	0.14	0.15	0.16	0.16	0.20	0.20	0.18	0.17	0.17	0.15	0.15	0.15	0.13	0.13	0.15	0.12	0.13	0.11	0.12	0.10	0.15	0.13	0.10	0.11	0.12	-13.72
1. Solid fuels	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	0.00	0.00	0.00	0.00	0.00	-17.76
2. Oil and natural gas and other emissions from energy production	0.14	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	0.10	0.15	0.13	0.10	0.11	0.12	-13.71
C. CO_2 transport and storage																												
2. Industrial processes	81.91	81.91	82.47	67.85	55.15	55.08	50.01	49.66	50.27	51.18	19.31	19.94	17.60	11.03	11.46	14.53	12.29	10.42	11.87	11.24	6.58	7.00	3.89	3.04	2.84	2.92	2.84	-96.54
A. Mineral industry																												
B. Chemical industry	79.86	79.86	80.42	65.80	53.10	53.03	47.96	47.66	48.27	49.17	17.29	17.88	15.53	8.97	9.39	12.09	9.51	7.64	8.89	8.10	3.86	4.25	0.67	0.14	0.15	0.14	0.15	-99.81
C. Metal industry	0.06	0.06	0.05	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.05	0.05	0.04	0.05	0.05	0.05	0.05	0.05	0.04	0.03	0.03	0.03	0.03	0.04	0.04	0.03	-43.89
D. Non-energy products from fuels and solvent use	NO, NE, IE	NO, NE, IE	NO, NE, IE	NO, NE, IE	NO, NE, IE	NO, NE, IE	NO, NE, IE	NO, NE, IE	NO, NE, IE	NO, NE, IE	NO, NE, IE	NO, NE, IE	NO, NE, IE	NO, NE, IE	NO, NE, IE	NO, NE, IE	NO, NE, IE	NO, NE, IE	NO, NE, IE	NO, NE, IE	NO, NE, IE	NO, NE, IE	NO, NE, IE	NO, NE, IE	NO, NE, IE	NO, NE, IE	NO, NE, IE	0.00
E. Electronic industry																												
F. Product uses as ODS substitutes																												
G. Other product manufacture and use	1.99	1.99	2.00	1.99	1.99	1.99	1.99	1.94	1.94	1.96	1.96	2.00	2.02	2.02	2.02	2.39	2.73	2.74	2.93	3.10	2.69	2.71	3.18	2.87	2.65	2.74	2.65	33.13
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
3. Agriculture	63.08	63.08	63.37	63.18	62.21	62.59	62.64	62.49	62.90	62.09	61.15	59.43	56.67	57.40	56.74	56.14	55.08	54.17	52.46	52.41	52.32	52.80	52.45	51.79	52.43	54.25	53.44	-15.27
A. Enteric fermentation																												
B. Manure management	5.94	5.94	5.94	5.97	5.98	6.03	6.07	6.21	6.22	6.16	5.92	5.83	5.62	5.43	5.45	5.45	5.31	5.23	5.11	5.00	4.92	4.91	4.84	4.81	4.82	4.89	4.93	-16.95
C. Rice cultivation																												
D. Agricultural soils	56.48	56.48	56.81	56.64	55.79	56.12	56.13	55.86	56.24	55.49	54.79	53.19	50.65	51.58	50.94	50.34	49.43	48.58	47.00	47.06	47.07	47.58	47.30	46.68	47.30	49.06	48.21	-14.64
E. Prescribed burning of savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00

F. Field burning of agricultural residues	0.21	0.21	0.18	0.13	0.00	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
G. Liming																											
H. Urea application																											
I. Other carbon containing fertlizers																											
J. Other	0.45	0.45	0.44	0.44	0.44	0.44	0.44	0.42	0.43	0.43	0.44	0.42	0.40	0.39	0.35	0.35	0.35	0.35	0.35	0.34	0.33	0.32	0.32	0.31	0.31	0.31	0.30	-32.33
4. Land use, land-use change and forestry	8.26	8.26	8.18	8.10	8.06	8.01	8.00	7.92	7.87	7.81	7.76	7.55	7.30	7.07	6.94	6.65	6.46	6.27	6.10	5.87	5.71	5.60	5.53	5.50	5.32	5.23	5.09	-38.31
A. Forest land	1.35	1.35	1.32	1.28	1.27	1.25	1.27	1.22	1.20	1.17	1.14	1.13	1.11	1.08	1.05	1.04	1.02	0.99	0.96	0.91	0.87	0.84	0.85	0.86	0.81	0.79	0.73	-46.31
B. Cropland	3.42	3.42	3.41	3.40	3.40	3.39	3.38	3.38	3.37	3.37	3.36	3.18	3.01	2.86	2.70	2.56	2.43	2.30	2.18	2.07	1.97	1.90	1.84	1.79	1.74	1.69	1.64	-52.01
C. Grassland	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.08	0.08	0.09	0.19	0.10	0.11	0.10	0.14	0.11	0.13	0.14	0.13	0.18	0.12	0.12	0.12	252.98
D. Wetlands	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	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-92.85
E. Settlements	1.96	1.96	1.94	1.92	1.91	1.89	1.88	1.87	1.86	1.84	1.84	1.82	1.81	1.80	1.79	1.78	1.77	1.76	1.76	1.75	1.75	1.75	1.74	1.73	1.73	1.72	1.72	-12.28
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	NO	NO	NO	NO	NO	0.00
G. Harvested wood products																											
H. Other	NA	NA	NA	NA	NA	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. Waste	2.74	2.74	2.73	2.83	2.81	2.83	2.86	2.98	3.01	3.09	3.07	3.25	3.28	3.30	3.23	3.35	3.56	3.69	3.86	3.76	4.02	4.31	4.50	4.47	4.50	4.68	4.71	71.75
A. Solid waste disposal																											
B. Biological treatment of solid waste	0.01	0.01	0.02	0.02	0.02	0.03	0.05	0.07	0.09	0.18	0.21	0.26	0.41	0.45	0.49	0.67	0.87	1.04	1.23	1.22	1.41	1.66	1.87	1.88	1.94	2.13	2.19	16,584.18
C. Incineration and open burning of waste	0.10	0.10	0.10	0.10	0.11	0.10	0.10	0.11	0.10	0.18	0.19	0.19	0.19	0.20	0.20	0.20	0.20	0.20	0.19	0.17	0.18	0.20	0.20	0.18	0.18	0.17	0.17	67.35
D. Waste water treatment and discharge	2.63	2.63	2.61	2.72	2.68	2.71	2.71	2.81	2.82	2.73	2.67	2.79	2.67	2.65	2.54	2.49	2.50	2.46	2.43	2.36	2.43	2.45	2.44	2.41	2.38	2.37	2.35	-10.69
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
6. Other (as specified in the summary table in CRF)																											
Total direct N_2O emissions with N_2O from LULUCF	172.24	172.24	172.84	157.88	144.13	145.05	140.53	139.55	140.03	140.04	106.68	105.51	100.05	93.78	92.98	95.05	91.58	88.50	87.70	85.64	79.86	81.08	77.46	76.99	76.68	78.74	77.93	-54.75
Memo items:																											
Aviation	0.48	0.48	0.48	0.53	0.57	0.59	0.63	0.67	0.71	0.79	0.86	0.95	0.93	0.91	0.93	1.02	1.10	1.12	1.11	1.09	1.03	1.00	1.04	1.02	1.03	1.03	1.05	116.34
Navigation	0.22	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	0.28	0.27	0.23	0.26	0.22	0.22	0.22	0.19	-12.65
Multilateral operations	NE	NE	NE	NE	NE	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																											
CO_2 captured																											
Long-term storage of C in waste disposal sites																											
Indirect N_2O	14.38	14.38	13.95	13.68	12.90	12.36	11.77	11.31	10.47	10.29	9.69	9.47	9.34	8.85	8.70	8.48	8.46	8.19	7.85	7.12	6.26	6.17	5.81	5.92	5.66	5.29	5.12	-64.40
Indirect CO_2																											

Notes
a - UNFCCC base year for the UK is 1990
Abbreviations: NO = not occurring, NA= not applicable, NE = not estimated, IE= included elsewhere

Table 1 continued
Emissions trends: Fluorinated Gases

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	*Base year*[a]	*1990*	*1991*	*1992*	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*Change from base to latest reported year*
	kt																											*%*
Emissions of HFCs and PFCs - (kt CO_2 equivalent)	16,042.95	16,042.95	16,376.19	16,287.98	17,108.40	18,204.77	19,692.91	20,845.54	23,607.62	20,568.13	11,939.60	10,479.70	11,376.38	11,795.62	13,186.03	12,353.19	13,536.64	14,462.51	14,820.55	15,295.49	15,847.23	16,799.30	15,364.11	15,727.71	16,115.06	16,260.06	16,290.79	1.54
Emissions of HFCs - (kt CO_2 equivalent)	14,391.43	14,391.43	14,991.05	15,597.63	16,505.66	17,593.37	19,095.98	20,249.18	23,104.50	20,074.40	11,465.64	9,882.92	10,890.79	11,387.39	12,829.42	11,919.34	13,151.49	14,074.84	14,532.71	15,029.24	15,649.90	16,511.59	14,947.17	15,472.66	15,796.32	15,981.74	15,963.56	10.92
HFC-23	0.97	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	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-99.86
HFC-32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.03	0.04	0.06	0.09	0.11	0.14	0.17	0.20	0.24	0.28	0.33	0.39	0.44	0.49	0.55	0.62	0.69	3,782,427.13
HFC-41	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-43-10mee	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	0.00	0.00	0.01	0.01	0.02	0.02	0.03	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	100.00
HFC-125	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.06	0.11	0.18	0.27	0.36	0.46	0.54	0.64	0.74	0.82	0.97	1.03	1.10	1.17	1.36	1.25	1.34	1.41	1.45	1.48	4,278,773.52
HFC-134	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-134a	0.00	0.00	0.00	0.01	0.21	0.51	0.83	1.15	1.71	2.29	2.22	2.55	2.89	3.04	3.51	3.71	4.17	4.33	4.39	4.56	4.72	4.76	4.62	4.70	4.72	4.76	4.79	606,640.04
HFC-143	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-143a	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.07	0.12	0.19	0.27	0.36	0.44	0.51	0.58	0.66	0.71	0.77	0.83	0.86	0.89	0.92	0.68	0.69	0.70	0.68	0.62	1,232,526.20
HFC-152	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-152a	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.04	0.07	0.08	0.10	0.11	0.19	0.19	0.18	0.18	0.20	0.20	0.18	0.12	0.12	0.24	0.25	0.27	0.29	0.31	36,336,949.87
HFC-161	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-227ea	IE, NO	IE, NO	IE, NO	IE, NO	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.04	0.07	0.10	0.11	0.10	0.11	0.11	0.10	0.10	0.11	0.11	0.12	0.12	0.12	0.13	100.00
HFC-236cb	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-236ea	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-236fa	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-245ca	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-245fa	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00	0.01	0.01	0.02	0.04	0.06	0.07	0.07	0.08	0.09	0.07	0.07	0.07	0.07	0.07	0.07	0.08	0.08	100.00
HFC-365mfc	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00	0.01	0.02	0.04	0.07	0.11	0.13	0.14	0.15	0.16	0.10	0.10	0.10	0.10	0.10	0.11	0.11	0.12	100.00
Unspecified mix of HFCs(4) - (kt CO_2 equivalent)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
CF_4	0.18	0.18	0.15	0.07	0.06	0.05	0.04	0.05	0.04	0.04	0.04	0.05	0.04	0.03	0.02	0.03	0.02	0.02	0.02	0.02	0.01	0.02	0.03	0.01	0.01	0.01	0.01	-93.11
C_2F_6	0.03	0.03	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	-68.49
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	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.01	0.01	0.02	0.01	0.01	4,746.51
C_4F_{10}	NO	NO	NO	NO	NO	NO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NO	NO	NO	NO	NO	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	0.00	0.00	0.00	0.00	0.00	327.93
C_5F_{12}	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
C_6F_{14}	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
$C_{10}F_{18}$	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
c-C_3F_6	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Unspecified mix of PFCs(4) - (kt CO_2 equivalent)	13.45	13.45	13.45	13.52	33.58	60.45	87.32	67.00	25.97	18.00	7.39	9.62	4.21	6.43	1.56	2.52	3.08	2.52	1.53	0.33	0.32	1.08	2.44	2.38	3.95	2.08	3.58	-73.35
Unspecified mix of HFCs and PFCs - (kt CO_2 equivalent)	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, NE	NO, NE	NO, NE	NO, NE	NO, NE	NO, NE	0.00
SF_6	0.06	0.06	0.06	0.06	0.05	0.05	0.06	0.06	0.06	0.06	0.07	0.08	0.06	0.07	0.06	0.05	0.05	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.02	-64.23
NF_3	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	0.00	0.00	0.00	0.00	0.00	5.64

Notes
a - UNFCCC base year for the UK is 1990
Abbreviations: NO = not occurring, NA= not applicable, NE = not estimated, IE= included elsewhere

Table 2(a)

Description of quantified economy-wide emission reduction target: base year

		Comments
Base year/ base period Emission reductions target (% of 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 by 2020.
Emission reductions target (% of 1990)	20%	
Period for reaching target	BY-2020	

Table 2(b)

Description of quantified economy-wide emission reduction target: gases and sectors covered

Gases covered	Covered	Base Year
CO2	Yes	1990
CH4	Yes	1990
N2O	Yes	1990
HFCs	Yes	1990
PFCs	Yes	1990
SF6	Yes	1990
NF3	No	

Sectors covered	Covered
Energy	Yes
Transport	Yes
Industrial processes	Yes
Agriculture	Yes
LULUCF	No
Waste	Yes

Other sectors (specify)		
Other: Aviation	Yes	Aviation in the scope of the EU-ETS: CO2 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	Covered	GWP reference source	Comments
CO_2	Yes	IPCC AR4	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	Yes	IPCC AR4	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	Yes	IPCC AR4	as adopted in UNFCCC reporting guidelines for national GHG inventories of Annex I Parties and as adopted under the EU Monitoring Mechanism Regulation
HFCs	Yes	IPCC AR4	as adopted in UNFCCC reporting guidelines for national GHG inventories of Annex I Parties and as adopted under the EU Monitoring Mechanism Regulation
PFCs	Yes	IPCC AR4	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	Yes	IPCC AR4	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	NO	IPCC AR4	

Table 2(d)
Description of quantified economy-wide emission reduction target: approach to counting emissions and removals from the LULUCF sector

Role of LULUCF sector	
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 of market-based mechanisms	Comments
Possible scale of contributions of market-based mechanisms under the convention	0	The 2020 Climate and Energy Package allows Certified Emission Reductions (CERs) and Emission Reduction Units (ERUs) to be used for compliance purposes, subject to a number of restrictions in terms of origin and type of project and up to an established limit. In addition, the legislation foresees the possible recognition of units from new market mechanisms. Under the EU ETS the limit does not exceed 50% of the required reduction below 2005 levels. In the sectors not covered by the ETS, annual use shall not exceed to 3 % of each Member States' non-ETS greenhouse gas emissions in 2005. A limited number of Member States may use an additional 1%, from projects in LDCs or SIDS subject to conditions.
CERs	0	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 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.
AAUsb	0	AAUs for the period 2013-2020 have not yet been determined. The EU expects to achieve its 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 time-period of the Convention target is from 1990-2020, no carry-over units will be used to achieve the 2020 target.
Other mechanism units under the Convention (specify)	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 place in 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: market-based mechanisms under the Convention

	Possible scale of contributions of market-based mechanisms	Comments
	0	The 2020 Climate and Energy Package allows Certified Emission Reductions (CERs) and Emission Reduction Units (ERUs) to be used for compliance purposes, subject to a number of restrictions in terms of origin and type of project and up to an established limit. In addition, the legislation foresees the possible recognition of units from new market mechanisms. Under the EU ETS the limit does not exceed 50% of the required reduction below 2005 levels. In the sectors not covered by the ETS, annual use shall not exceed to 3 % of each Member States' non-ETS greenhouse gas emissions in 2005. A limited number of Member States may use an additional 1%, from projects in LDCs or SIDS subject to conditions.

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 emissions reductions 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 implementation*	*Brief Description*	*Start Year of Implementation*	*Implementing Entity or Entities*	*Greenhouse Gas Saving ($ktCO_2$ eq)*				
									2015	2020	2025	2030	2035
New Energy Supply policies,[1]*	Energy supply	CO_2, (CH_4, N_2O)	To increase the proportion of low carbon (Nuclear, CCS) and renewables electricity generation	Regulatory, Economic	Various	Grouped savings produced by a selection of post-2009 energy supply policies as indicated in this table with a label '[1]'.	2002	Department for Business, Energy & Industrial Strategy (BEIS), Office of Gas and Electricity Markets (Ofgem)	12,952	36,170	42,863	43,240	47,279
EU Emissions Trading System*	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	It sets an emissions target (cap) for installations covered by the system (across the EU), with the carbon market determining the carbon price, and therefore where emissions can be reduced most cheaply. It guarantees that total emissions in the sectors covered will not exceed the cap set, and in doing so drives investments in low-carbon technologies, leading to cutting emissions of carbon dioxide (CO2) and other greenhouse gases at least cost.	2005	European Commission, Department for Business, Energy & Industrial Strategy (BEIS)	IE	IE	IE	IE	IE
Large Combustion Plant Directive*	Energy supply, Business	CO_2, (CH_4, N_2O)	To improve air quality by limiting industrial emissions of nitrogen oxides, sulphur dioxide and dust. This indirectly acts to mitigate GHG emission by reducing the use of high carbon (coal) generation in the electricity supply industry.	Regulatory	Expired	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. Has now been replaced by the Industrial Emissions Directive.	2007	Department for Food, Environment and Rural Affairs (DEFRA)	IE	IE	IE	IE	IE
Additional renewables in generation (Renewable Energy Strategy),[1]*	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 Renewable Obligation (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 for Business, Energy & Industrial Strategy (BEIS), Office of Gas and Electricity Markets (Ofgem)	IE	IE	IE	IE	IE
Feed in Tariffs (FITS)*	Energy supply	CO_2, (CH_4, N_2O)	Encourage small-scale, low carbon generation	Regulatory, Economic	Implemented	Feed-in Tariffs (FITs) support organisations, businesses, communities and individuals to generate low-carbon electricity using small-scale (5 MW or less total installed capacity) systems. Electricity suppliers are obliged to pay the regulated tariffs to eligible generators.	2010	Department for Business, Energy & Industrial Strategy (BEIS)	IE	IE	IE	IE	IE

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									2015	2020	2025	2030	2035
Industrial Emissions Directive (as it applies to Large Combustion Plant)*	Energy supply, Business	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	As transposed into UK law, the IED replaced the LCPD from 1 January 2016 with similar although more stringent provisions set out in chapter III of the Industrial Emissions Directive (2010/75/EU) (IED). Those provisions already apply in respect to any plant newly permitted since 7 January 2013. Three compliance routes were available to generating plants; to abate emissions and comply with more stringent limits by 2020; to comply with less stringent limits but face a 1,500 hour per year load factor constrain; or to close by 2023.	2016	Department for Food, Environment and Rural Affairs (DEFRA)	IE	IE	IE	IE	IE
Capacity Mechanism,[1]*	Energy supply	CO_2, (CH_4, N_2O)	To increase the proportion of low carbon (Nuclear, CCS) and renewables electricity generation	Economic	Adopted	Part of the government's Electricity Market Reform package, the Capacity Market ensures that sufficient capacity is available to meet peak demand, encouraging construction and use of new low carbon generation capacity	2017	Department for Business, Energy & Industrial Strategy (BEIS)	IE	IE	IE	IE	IE
Contract for Difference (CfD) (2014-2020),[1]*	Energy supply	CO_2, (CH_4, N_2O)	To increase the proportion of low carbon (Nuclear, CCS) and renewables electricity generation	Economic	Implemented	Offers Contracts for Difference (CfDs) in the electricity generation market for low carbon and renewable sources, CfDs will replace Renewable Obligation Certificates (ROCs) which are due to be phased out from 2017. Current policy offers CfD for new capacity through auctions should Government's choose to hold them. There is also a bilateral negotiation underway for Hinkley point C Nuclear plant.	2014	Department for Business, Energy & Industrial Strategy (BEIS)	IE	IE	IE	IE	IE
Contract for Difference (CfD) (2021-2035)	Energy supply	CO_2, (CH_4, N_2O)	To increase the proportion of low carbon (Nuclear, CCS) and renewables generation	Economic	Planned	Planned continuation of Contracts for Difference (CfDs) for new low carbon capacity after 2020.	2021	Department for Business, Energy & Industrial Strategy (BEIS)	IE	IE	IE	IE	IE
Carbon Price Floor,[1]*	Energy supply	CO_2, (CH_4, N_2O)	To reduce the use of emissions intensive fossil fuels and increase the use of renewables in electricity generation	Economic	Implemented	The Carbon Price Floor (CPF) is designed to further reduce the use of emission-intensive fossil fuels and increase the proportion of electricity generation and supply from low carbon sources	2013	Department for Business, Energy & Industrial Strategy (BEIS)	IE	IE	IE	IE	IE

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									2015	2020	2025	2030	2035
Building Regulations Part L (2002+2005/6)*	Business, Public, Residential	CO_2, (CH_4, N_2O)	Improve energy efficiency of buildings	Regulatory	Implemented	Building Regulations set minimum energy performance standards for new buildings and when people carry out controlled 'building work' to existing properties including extensions, conversions and certain categories of renovation and replacement windows and boilers.	2002	Department for Communities and Local Government (DCLG)	8,801	10,140	7,708	5,110	2,733
Building Regulations 2010 Part L*	Business, Public, Residential	CO_2, (CH_4, N_2O)	Improve energy efficiency of buildings	Regulatory	Implemented	Building Regulations set minimum energy performance standards for new buildings and when people carry out controlled 'building work' to existing properties including extensions, conversions and certain categories of renovation and replacement windows and boilers.	2010	Department for Communities and Local Government (DCLG)	3,232	5,382	6,376	4,832	3,772
Building Regulations 2013 Part L*	Business, Public, Residential	CO_2, (CH_4, N_2O)	Improve energy efficiency of buildings	Regulatory	Implemented	Building Regulations set minimum energy performance standards for new buildings and when people carry out controlled 'building work' to existing properties including extensions, conversions and certain categories of renovation and replacement windows and boilers.	2013	Department for Communities and Local Government (DCLG)	22	88	100	95	84
Products Policy (Implemented)*	Business, Public, Residential, Industrial Processes	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	The EU Ecodesign Directive and the Energy Labelling Framework Regulation respectively operate by setting minimum performance and information requirements for energy using products placed to take the least efficient products off the market and to give consumers clear information to make informed purchasing decisions. This is implemented through product specific EU regulations.	2008	Department for Business, Energy & Industrial Strategy (BEIS)	5,923	5,593	3,082	1,631	485
Products Policy (Adopted)*	Business, Public, Residential, Industrial Processes	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	The EU Ecodesign Directive and the Energy Labelling Framework Regulation respectively operate by setting minimum performance and information requirements for energy using products placed to take the least efficient products off the market and to give consumers clear information to make informed purchasing decisions. This is implemented through product specific EU regulations.	2017	Department for Business, Energy & Industrial Strategy (BEIS)	-	83	132	128	65

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									2015	2020	2025	2030	2035
Renewable Heat Incentive*	Business, Residential	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	The Non-Domestic Renewable Heat Incentive (RHI) provides financial incentives to increase the uptake of renewable heat by businesses, the public sector and non-profit organisations. Eligible installations receive quarterly payments for 20 years based on the amount of heat generated. The Domestic RHI is a government financial incentive to promote the use of renewable heat. Eligible installations receive quarterly payments for seven years for the amount of renewable heat it is estimated their system produces.	2011	Department for Business, Energy & Industrial Strategy (BEIS)	1,491	2,401	2,444	2,418	1,014
Renewable heat incentive (planned funding)	Business, Residential	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	Planned	The Non-Domestic Renewable Heat Incentive (RHI) provides financial incentives to increase the uptake of renewable heat by businesses, the public sector and non-profit organisations. Eligible installations receive quarterly payments for 20 years based on the amount of heat generated. The Domestic RHI is a government financial incentive to promote the use of renewable heat. Eligible installations receive quarterly payments for seven years for the amount of renewable heat it is estimated their system produces.	2017	Department for Business, Energy & Industrial Strategy (BEIS)	-	2,132	2,589	2,600	2,609
Smart Metering*	Energy supply, Business, Residential	CO_2, (CH_4, N_2O)	Reduce consumption of electricity and gas though provision of better management information.	Information	Implemented	The smart metering programme will replace 53 million meters with smart electricity and gas meters in all domestic properties, and smart or advanced meters in smaller non domestic sites in Great Britain by the end of 2020. Smart meters will deliver consumers with near-real time information on their energy consumption to help them control energy use, and avoid wasting energy and money. It will deliver energy networks with better information upon which to manage and plan current activities. Smart meters will also assist the move towards smart grids which support sustainable energy supply and will help reduce the total energy needed in the system.	2012	Department for Business, Energy & Industrial Strategy (BEIS)	327	2,058	2,021	1,851	1,744

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									2015	2020	2025	2030	2035
Carbon Trust measures*	Business, Public	CO_2, (CH_4, N_2O)	Improve energy efficiency in buildings	Information, Education	Expired	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 organisations of all sizes.	2002	Carbon Trust	1,615	353	66	-	-
CRC Energy Efficiency Scheme*	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	The Carbon Reduction Commitment (CRC) is a mandatory UK-wide emissions trading scheme (launched in 2010). It 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. It covers 1800-1900 large users of energy across the business and public sector. The scheme is split into phases. Phase 1 ran from 1 April 2010 until 31 March 2014. Phase 2 runs from 1 April 2014 until 31 March 2019. In the 2016 Spring Budget, the Chancellor announced the closure of the CRC after Phase 2 (i.e. following the 2018/19 compliance year).	2010	Department for Business, Energy & Industrial Strategy (BEIS), Environment Agency (EA). Devolved Administrations.	572	972	909	-	-
Climate Change Levy (CCL)	Energy supply, Business, Public	CO_2, (CH_4, N_2O)	To incentivise businesses to reduce their energy consumption	Economic, Regulatory	Implemented	The main rates of the CCL are intended to incentivise businesses to reduce their energy consumption. Eligible energy-intensive industries may pay reduced main rates of CCL through CCAs, or be exempt from the CCL for mineralogical/metallurgical processes.	2001	Department for Business, Energy & Industrial Strategy (BEIS)	IE	IE	IE	IE	IE
CCL Budget 2016 Changes	Energy supply, Business, Public	CO_2, (CH_4, N_2O)	To incentivise businesses to reduce their energy consumption	Economic, Regulatory	Adopted	Budget 2016 announced that CCL rates will increase from April 2019, moving to an electricity-to-gas ratio of 2.5:1 compared to the previous 2.9:1 ratio. In the longer term, the government intends to rebalance the rates further, reaching a ratio of 1:1 by 2025. The changes in CCL between 2019 and 2025, as well as the rates from 2025 onwards, have not yet been announced.	2019	Department for Business, Energy & Industrial Strategy (BEIS)	-	689	1,035	841	780

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Energy Company Obligation*	Residential	CO_2, (CH_4, N_2O)	To improve the energy efficiency of residential and commercial buildings and address fuel poverty.	Economic, Regulatory	Expired	The Energy Company Obligation (ECO) is a statutory obligation on energy suppliers with over 250,000 domestic customers and delivering over a certain amount of electricity or gas to make reductions in carbon emissions or achieve heating cost savings in domestic households. ECO focuses on insulation measures, and also heating improvements to low income and vulnerable households. It ran until March 2017. ECO initially ran to Mar 15 (also known as 'ECO1'), although was extended in April 2014 to March 2017('ECO2').	2013	Department for Business, Energy & Industrial Strategy (BEIS), Large Energy Suppliers	856	665	622	596	577
Energy Company Obligation Extension*	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 2015 Spending Review announced that ECO will be replaced with a new, lower cost scheme that will run for 5 years (to March 2022) and will tackle the root causes of fuel poverty. The 5 year extension will take place in the two phases, with the ECO Extension (April 2017 - Sept 2018) acting as a bridge between the expired ECO scheme and the new fuel poverty focussed scheme, ECO 3, which will run from Oct 2018 to March 2022.	2017	Department for Business, Energy & Industrial Strategy (BEIS), Large Energy Suppliers	-	204	188	189	187
Energy Company Obligation 3*	Residential	CO_2, (CH_4, N_2O)	To improve the energy efficiency of residential and commercial buildings and address fuel poverty.	Economic, Regulatory	Planned	The 2015 Spending Review announced that ECO will be replaced with a new, lower cost scheme that will run for 5 years (to March 2022) and will tackle the root causes of fuel poverty. The 5 year extension will take place in the two phases, with the ECO Extension (April 2017 - Sept 2018) acting as a bridge between the expired ECO scheme and the new fuel poverty focussed scheme, ECO 3, which will run from Oct 2018 to March 2022.	2018	Department for Business, Energy & Industrial Strategy (BEIS), Large Energy Suppliers	-	374	467	457	452

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									2015	2020	2025	2030	2035
Warm Front*	Residential	CO_2, (CH_4, N_2O)	Tackling fuel poverty, improving energy efficiency for poorer households.	Economic	Expired	Warm Front installed heating and insulation measures to make homes warmer and more energy efficient for private sector households in England vulnerable to fuel poverty. The scheme offered 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 for Business, Energy & Industrial Strategy (BEIS), Devolved Administrations, Carillion Energy Services.	332	247	251	262	259
EEC1, EEC2 (2002- 2008) & Baseline Carbon Emissions Reductions Target (CERT) (2008-2010)*	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	Expired	Energy Efficiency Commitment I (EEC I): GB wide regulation that 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 incentivising their customers to install energy-efficiency measures in homes. 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) – GB regulation that required all domestic energy suppliers with a customer base in excess of 50,000 domestic customers to make savings in the amount of CO2 emitted by householders.	2002	Department for Business, Energy & Industrial Strategy (BEIS), Office of Gas and Electricity Markets (Ofgem). Large domestic energy suppliers.	4,627	2,987	2,476	2,293	2,258
Carbon Emissions Reduction Target (CERT) Uplift and Extension (2010-12)*	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	Expired	CERT extension - increased the targets originally set under CERT by 20% and required domestic energy suppliers with a customer base in excess of 50,000 (later increased to 250,000) to make savings in the amount of CO2 emitted by householders. The extension also refocused subsidy towards insulation measures and away from electricity saving measures such as low energy lighting - and introduced a super priority group (households in receipt of certain means-tested benefits) to make energy reductions in low income and vulnerable households.	2010	Department for Business, Energy & Industrial Strategy (BEIS), Office of Gas and Electricity Markets (Ofgem). Larger Energy Suppliers.	1,914	1,680	1,420	1,317	1,247

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Community Energy Saving Programme (CESP)*	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	Expired	Community Energy Saving Programme (CESP) - area based regulation that targeted households across Great Britain, in areas of low income, to improve energy efficiency standards, and reduce fuel bills. CESP was funded by an obligation on larger energy suppliers and also the larger, electricity generators.	2009	Department for Business, Energy & Industrial Strategy (BEIS), Office of Gas and Electricity Markets (Ofgem). Larger Energy Suppliers.	132	102	73	63	54
Energy Performance of Buildings Directive (EPBD)*	Business, Public, Residential	CO_2, (CH_4, N_2O)	Encourage uptake of energy efficiency measures	Regulatory, Information	Expired	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) Energy Performance Certificates (EPCs) are required when any building is sold, rented out or constructed, and after refurbishment when construction work is undertaken to a building and the modifications change the number of parts designed or altered for separate use and include the provision or extension of any fixed services for heating, hot water, air-conditioning and mechanical ventilation. EPCs give information on a building's energy efficiency in a sliding scale from 'A' (very efficient) to 'G' (least efficient)	2007	Department for Communities and Local Government (DCLG) and the Devolved Administrations.	751	564	442	379	333
Energy Performance of Buildings Directive (EPBD) Recast 2010*	Public	CO_2, (CH_4, N_2O)	Encourage uptake of energy efficiency measures	Regulatory, Information	Adopted	Extension of the EPBD requirement for public buildings to display Energy Performance Certificates to include buildings over 250m2 from 9 July 2015.	2015	Department for Communities and Local Government (DCLG) and the Devolved Administrations.	-	-	-	-	-
Energy Performance of Buildings Directive (EPBD) 2017 Cost Optimal Review and Nearly Zero Energy Buildings (NZEB) (2018 and 2020)	Business, Public, Residential	CO_2, (CH_4, N_2O)	Encourage uptake of energy efficiency measures	Regulatory, Information	Planned	"The Government is required to report to the European Commission by June 2017 to demonstrate that UK building standards for energy performance remain 'cost optimal'.	2013	Department for Business, Energy & Industrial Strategy (BEIS), Large Energy Suppliers	856	665	622	596	577

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									2015	2020	2025	2030	2035
Private Rented Sector (PRS) Energy Efficiency Regulations*	Business, Residential	CO_2, (CH_4, N_2O)	Improve energy efficiency of private rented property	Regulatory, Information	Implemented	From the 1 April 2018 there will be a requirement for any properties rented out in the private rented sector to have a minimum energy performance rating of E on an Energy Performance Certificate (EPC). The regulations will come into force for new lets and renewals of tenancies with effect from 1 April 2018 and for all existing tenancies on 1 April 2020 (1 April 2023 for non-domestic properties). It will be unlawful to rent a property which breaches the requirement for a minimum E rating, unless there is an applicable exemption.	2016	Department for Business, Energy & Industrial Strategy (BEIS)	1	452	427	281	178
Public Sector Energy Efficiency Loans Scheme*	Public	CO_2, (CH_4, N_2O)	To address funding barriers to achieving energy efficiency in the Public sector	Economic	Implemented	The Public Sector Energy Efficiency Loans Scheme, managed by Salix Finance Ltd, provides interest-free loans in England to public sector organisations for energy efficiency schemes. These loans are intended to provide the capital cost of energy efficiency retrofit work and other measures to be installed. These loans have a payback period of five years (eight for schools) during which the repayments are met with the energy bill savings from the energy efficiency measures. Thus, once the loan has been paid off, the organisations continue to benefit from energy savings for the lifetime of these measures. This funding is then recycled once it has been returned to the Scheme and once again loaned out. BEIS provides the most amount of funding to the Scheme but there is also some funding from Scotland, Wales and the Department for Education.	2004	Department for Business, Energy & Industrial Strategy (BEIS). Administered by the Carbon Trust.	174	297	398	331	215
Small and Medium Enterprises (SME) Loans*	Business	CO_2, (CH_4, N_2O)	To address funding barriers to achieving energy efficiency by the small and medium enterprises (SMEs)	Economic	Expired	The Carbon Trust provided interest free loans of £3,000 - £400,000 for small and medium sized businesses to invest in energy efficiency equipment and renewable technologies. These loans were designed so that in most cases the forecast reduction in energy costs would be similar to the total repayment amount.	2004	Department for Business, Energy & Industrial Strategy (BEIS). Administered by the Carbon Trust.	121	80	31	-	-

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Climate change agreements (CCA) *	Business, Industrial processes	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 discount from the Climate Change Levy in return for meeting targets for energy reductions. From 2013 these are a 90% discount for electricity and a 65% discount for other fuels. From 2019 this will increase to a 93% discount for electricity and 78% discount for other fuels.	2013	Department for Business, Energy & Industrial Strategy (BEIS). Industry Associations.	IE	IE	IE	IE	IE
Energy Savings Opportunity Scheme (ESOS)*	Business, Public	CO_2, (CH_4, N_2O)	To encourage the uptake of energy saving opportunities.	Regulatory/ Information	Implemented	A mandatory energy assessment scheme for all large undertakings (non-SMEs) in response to requirements contained Article 8 of the EU Energy Efficiency Directive (2012/27/EU). Organisations which employ 250 or more people, or employ fewer than 250 people but have both an annual turnover exceeding £38.9m and an annual balance sheet total exceeding £33.4m, must measure their total energy consumption and carry out audits of the energy used by their buildings, industrial processes and transport to identify cost-effective energy saving measures, by 5 December 2015 and every four years thereafter. It is estimated that around 10,000 organisations will participate in the scheme.	2014	Department for Business, Energy & Industrial Strategy (BEIS). Environment Agency.	-	716	572	509	455
Heat Networks Investment Project*	Residential	CO_2	To increase the volume of heat networks built through providing central Government funding	Economic	Adopted	The Heat Networks Investment Project (HNIP) capital investment programme is expected to support up to 200 projects by 2021 through grants and loans and other mechanisms and to lever in up to wider investment, reducing bills, cutting carbon and forming a key part of wider urban regeneration in many locations.	2017	Department for Business, Energy & Industrial Strategy (BEIS)	-	-63	-88	-96	43
Rail Electrification*	Transport	CO_2, (CH_4, N_2O)	To reduce travel times, costs and fossil fuel emissions	Economic	Implemented	Major programme of rail electrification underway to replace older diesel trains with modern, low-emission electric trains.	2013	Department for Transport (DfT), Network Rail	-	197	242	264	284

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									2015	2020	2025	2030	2035
Renewable Transport Fuel Obligation, (RTFO) - current 5% by volume*	Transport	CO_2	Reduce the fossil carbon content of transport fuels	Regulatory	Implemented	The RTFO set a phased 5% target for biofuel use by diesel and petrol suppliers to be achieved by 2014. Targets are by volume rather than by energy. Implements the EU Renewables Directive (2009/28/EC).	2007	Department for Transport (DfT)	2,385	2,344	2,228	2,150	2,112
Renewable Transport Fuel Obligation, (RTFO) - Increase target to meet RED	Transport	CO_2	Reduce the fossil carbon content of transport fuels	Regulatory	Planned	To set enhanced targets for biofuel use by diesel and petrol suppliers to be achieved by 2020. Implements the EU Renewables Directive (2009/28/EC) as amended by Directive (2015/1513).	2009	Department for Transport (DfT)	-	5,818	5,587	5,400	5,297

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									2015	2020	2025	2030	2035
Car Fuel Efficiency Policies*	Transport	CO_2, (CH_4, N_2O)	Improve fuel efficiency and reduce CO2 emissions of cars	Regulatory, Information, Voluntary Agreement	Implemented	EC Regulation 443/2009 sets fuel efficiency targets for new cars to be achieved by 2015 and 2020. The regulation translates a fleet average CO2 tailpipe emissions target for new vehicles sold into the EU market into specific targets for individual manufacturers according to the mass of their fleet. Heavy fines are imposed for non-compliance. The 2021 target is for a fleet average of 95g CO2/km across the single market, with a transition period where 95% of a manufacturer's fleet must meet the 95g target by 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 CO2 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. Measures to support the uptake of ultra low emission vehicles include the Plug-in Car and Plug-in Van Grants towards ultra-low emission vehicle (ULEV) cars and vans, as well as various tax incentives including lower rates for Vehicle Excise Duty and Company Car Tax. EV infrastructure is directly supported through the Workplace Charging Scheme grants for EV charge points for employees and fleets, the Electric Vehicle Home charge Scheme grants towards home EV charge points and the On-street Residential Charging Scheme. Highways England have committed £15m to ensure EV charge points are available every 20 miles on the Strategic Road Network.	2012	Department for Transport (DfT)	821	4,882	11,255	17,297	22,448

Name of Mitigation Action	*Sectors affected*	*GHG affected*	*Objective and or activity affected*	*Type of Instrument*	*Status of implementation*	*Brief Description*	*Start Year of Implementation*	*Implementing Entity or Entities*	*Greenhouse Gas Saving ($ktCO_2$ eq)*				
									2015	2020	2025	2030	2035
Van Fuel Efficiency Policies*	Transport	CO_2, (CH_4, N_2O)	Improve fuel efficiency and reduce CO2 emissions of light goods vehicles	Regulatory, Information, Voluntary Agreement	Implemented	EC Regulation 510/2011 sets fuel efficiency targets for new Light Commercial Vehicles (LCV) 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. The regulation translates a fleet average CO2 tailpipe emissions target for new vehicles sold into the EU market into specific targets for individual manufacturers according to the mass of their fleet. Heavy fines are imposed for non-compliance. The 2020 target is for a fleet average of 147g CO2 / km and represents a reduction of 19% from the 2012 average. Measures include the Plug-in Car and Plug-in Van Grants towards ultra-low emission vehicle (ULEV) cars and vans, as well as various tax incentives including lower rates for Vehicle Excise Duty and Company Car Tax. EV infrastructure is directly supported through the Workplace Charging Scheme grants for EV charge points for employees and fleets, the Electric Vehicle Home charge Scheme grants towards home EV charge points and the On-street Residential Charging Scheme. Highways England have committed £15m to ensure EV charge points are available every 20 miles on the Strategic Road Network.	2012	Department for Transport (DfT)	223	908	2,300	3,795	5,353

Name of Mitigation Action	*Sectors affected*	*GHG affected*	*Objective and or activity affected*	*Type of Instrument*	*Status of implementation*	*Brief Description*	*Start Year of Implementation*	*Implementing Entity or Entities*	*Greenhouse Gas Saving ($ktCO_2$ eq)*				
									2015	2020	2025	2030	2035
HGV Fuel Efficiency Policies*	Transport	CO_2, (CH_4, N_2O)	Improve fuel efficiency and reduce CO2 emissions of heavy goods vehicles	Regulatory, Information, Voluntary Agreement	Implemented	EC Regulation 661/2009 sets minimum requirements and introduces 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, which encourages members to record, report and reduce emissions from freight. The Mode Shift Revenue Support scheme encourages modal shift from road to rail or inland waterway where the costs are higher than road, and where there are environmental benefits to be gained. It currently helps to remove around 800,000 lorry journeys a year from Britain's roads. A similar scheme, Waterborne Freight Grant, can provide assistance with the operating costs associated with coastal or short sea shipping.	2012	Department for Transport (DfT), Transport Association.	1	551	1,121	1,124	1,118
HGV natural gas policy	Transport	CO_2, (CH_4, N_2O)	Fuel-switching	Economic, Research	Implemented	The Government has implemented measures to encourage alternatively fuelled HGVs including through reduced fuel duty rates for road fuel gases, and increasing rewards for renewable gaseous fuels under the Renewable Transport Fuel Obligation. We have recently consulted on proposed legislative amendments which would further increase support for renewable transport fuels suitable for heavy goods vehicles. The Government has helped operators establish and run fleets of alternatively fuelled HGVs through the Low Carbon Truck Trial. £11.3m funding has been provided, via competition, to part fund and test around 370 commercial vehicles, with most using a gas or dual fuel system (diesel and gas), and to develop refuelling infrastructure. Savings for this policy are captured within HGV fuel efficiency policies.	2012	Department for Transport (DfT)	IE	IE	IE	IE	IE

Name of Mitigation Action	*Sectors affected*	*GHG affected*	*Objective and or activity affected*	*Type of Instrument*	*Status of implementation*	*Brief Description*	*Start Year of Implementation*	*Implementing Entity or Entities*	*Greenhouse Gas Saving ($ktCO_2$ eq)*				
									2015	2020	2025	2030	2035
PSV Fuel Efficiency Policies*	Transport	CO_2, (CH_4, N_2O)	Improve fuel efficiency and reduce CO2 emissions of buses	Regulatory, Information, Voluntary Agreement	Implemented	The Green Bus Fund (GBF) allowed bus companies and local authorities in England to compete for funds to help them buy new low carbon emission buses. The four rounds of the fund, which ran from 2009- 2014, added around 1250 Low Carbon Emission Buses onto England's roads. The GBF has now been replaced by the Low Emission Bus Fund (LEBS) which offered £30m for bus operators and local authorities across England and Wales to bid for low emission buses and supporting infrastructure. This scheme funding is open from 2016-2019 and the successful bidders were announced in July 2016, adding more than 300 extra low emission buses to fleets.	2006/07	Department for Transport (DfT)	47	88	142	251	312
Local Sustainable Transport Fund*	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	£600m of capital and revenue funding between 2011 and 2015 to support sustainable travel investments by Local Government. The projects include promoting public transport, encouraging uptake of cycling and walking, and raising awareness of the alternative transport modes available to commuters and residents Awards were made through competitive bidding processes. Since then revenue central Government has made funding of £65m (2015/16) and £20m((p.a. 2016/17 to 2019/20)) available for similar schemes.	2011	Department for Transport (DfT), Local government.	1,034	931	523	328	197
Agricultural Action Plan*	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.	1,000	2,429	3,197	3,197	3,197
Agri- Tech Strategy*	Agriculture	CH_4, N_2O	Reduce emissions from farming	Economic	Implemented	Co-funded by industry and addressing industry priorities. Funding is split been projects - "the Agri-Tech Catalyst" – and new Centres of Agricultural Innovation. These technologies can contribute to agricultural efficiency and reduce GHG emissions.	2014	Department for Food, Environment and Rural Affairs (DEFRA), Department of Business, Innovation and Skills (BIS)	IE	IE	IE	IE	IE

Name of Mitigation Action	*Sectors affected*	*GHG affected*	*Objective and or activity affected*	*Type of Instrument*	*Status of implementation*	*Brief Description*	*Start Year of Implementation*	*Implementing Entity or Entities*	*Greenhouse Gas Saving ($ktCO_2$ eq)*				
									2015	2020	2025	2030	2035
Nitrates Action Plan*	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
Catchment Sensitive Farming*	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
Soils For Profit*	Agriculture	N_2O	Soil protection	Education	Expired	Provides on farm reviews and training on soils manures and nutrients. The programme closed in 2013.	2009	Natural England (NE).	IE	IE	IE	IE	IE
Environmental Stewardship (Entry Level Schemes and Higher Level Stewardship)*	Agriculture	N_2O	Biodiversity and resource protection	Economic	Implemented	Provides income foregone support under Pillar 2 of the Common Agricultural Policy (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
Waste measures*	Waste	CH_4	There are a number of waste measures whose overarching objective is to increase recycling/ reuse and reduce harmful disposal. These include the Waste Framework Directive (2008/98/EC), Landfill Directive (1999/31/EC), Waste Incineration Directive (2000/76/EC) and the UK Landfill Tax, an escalating tax on biodegradable waste.	Fiscal, regulatory	Implemented	There are a number of waste measures with the aim of increasing recycling/ reuse and reduce harmful disposal. The Waste Framework Directive (2008/98/EC): is the general framework of waste management requirements and sets rules governing the separate collection of waste. The Landfill Directive (1999/31/EC): sets rules governing the disposal of waste to landfill, The UK Landfill Tax: a tax on waste sent to landfill. There are other waste measures targeting other waste streams, such as the Waste Incineration Directive (2000/76/EC). The overall effect is reducing environmental impacts of waste, such as landfilling biodegradable waste and its associated CH4 emissions.	Various (earliest 1996)	Department for Food, Environment and Rural Affairs (DEFRA)	IE	IE	IE	IE	IE

Name of Mitigation Action	*Sectors affected*	*GHG affected*	*Objective and or activity affected*	*Type of Instrument*	*Status of implementation*	*Brief Description*	*Start Year of Implementation*	*Implementing Entity or Entities*	*Greenhouse Gas Saving ($ktCO_2$ eq)*				
									2015	2020	2025	2030	2035
Ozone Depleting Substances Regulation*	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 by-product but increased their use as a substitute.	Regulatory	Implemented	This regulation implements obligations under the Montreal Protocol and EU Regulations (2037/2000/ EC and 1005/2009/EC) on ozone depleting substances. With the exemption of some critical use exemptions, CFCs and halon use is banned and HCFC use was banned from 2015. Most ozone depleting substances are potent greenhouse gases, so reductions in their use both protects the ozone layer and provides some GHG emissions mitigation.	2001	Department for Food, Environment and Rural Affairs (DEFRA)	IE	IE	IE	IE	IE
Fluorinated GHG Regulation*	Industrial processes	HFCs, PFCs, SF_6	Implementation 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.	2007	Department for Food, Environment and Rural Affairs (DEFRA)	-	-	-	-	-
F-gas regulation 2014*	Industrial processes	HFCs, PFCs, SF_6	Implementation of F-Gas Regulation (EC 517/2014) to reduce emissions of fluorinated greenhouse gases.	Regulatory	Adopted	Introduced an 80% phase down in the quantities of F gases that can be placed on the EU market delivered via a gradually reducing quota system; a number of bans on the use of certain F gases in some new equipment; a ban on the use of very high GWP HFCs for the servicing of certain types of refrigeration equipment; some strengthening of obligations in 2006 Regulation related to leak checking, repairs, F gas recovery and technician training.	2015	Department for Food, Environment and Rural Affairs (DEFRA)	-	4,569	8,470	12,343	14,458
Recent forestry policies*	LULUCF	CO_2, CH_4, N_2O	Increase afforestation	Regulatory, Economic, Voluntary Agreement, Information	Implemented	Grouped savings produced by a selection of post-2009 forestry policies as indicated in this table with a label '2'.	Various	Forestry Commission, Department for Food, Environment and Rural Affairs (DEFRA)	-	-178	-111	10	148
Woodland Carbon Code*[2]	LULUCF	CO_2	Increase rate of afforestation	Voluntary Agreement, Information	Implemented	Woodland Carbon Code (UK coverage): voluntary standard for forest carbon projects to attract private finance to woodland expansion.	2011	Forestry Commission	IE	IE	IE	IE	IE
Woodland Carbon Fund*[2]	LULUCF	CO_2	Increase rate of afforestation	Voluntary Agreement, Information	Implemented	Exchequer-funded grant to support the creation of large-scale productive woodlands which also enhance natural capital.	2016	Forestry Commission	IE	IE	IE	IE	IE

Name of Mitigation Action	*Sectors affected*	*GHG affected*	*Objective and or activity affected*	*Type of Instrument*	*Status of implementation*	*Brief Description*	*Start Year of Implementation*	*Implementing Entity or Entities*	*Greenhouse Gas Saving ($ktCO_2$ eq)*				
									2015	2020	2025	2030	2035
Revised UK Forestry Standard*	LULUCF	CO_2, CH_4, N_2O	Enhance removals and reduce emissions through woodland creation and sustainable forest management.	Regulatory, Information	Implemented	Revised (2017) national standard for sustainable forest management to include a new guideline on climate change, covering both adaptation and mitigation.	2017	Forestry Commission	IE	IE	IE	IE	IE
Forestry Act, Felling Licence Regulations and Environmental Impact (Forestry) regulations*	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
Grown in Britain*	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
Rural Development Programme*[2]	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
Woodland Creation Planning Grant*[2]	LULUCF	CO_2	Strategy to increase wood fuel supply for renewable heat.	Information, Education, Economic	Implemented	Grant to support the planning of large-scale productive woodlands, compliant with the UK Forestry Standard.	2015	Forestry Commission	IE	IE	IE	IE	IE
Wood fuel Implementation Plan*	LULUCF	CO_2	Strategy to increase wood fuel supply for renewable heat.	Information, Education, Economic	Expired	Initiative to develop supply chains, including through support for harvesting/processing and woodland access, to increase wood fuel supply from existing woodland.	2011	Forestry Commission	IE	IE	IE	IE	IE

* Indicates that a mitigation action has been included in the 'with measures' projection.

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(a)II

Progress in achievement of the quantified economy-wide emission reduction targets – further information on mitigation actions relevant to the counting of emissions and removals from the land use, land-use change and forestry sector in relation to activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol[a,b,c]

GREENHOUSE GAS SOURCE AND SINK ACTIVITIES	*Base year[d]*	*Net emissions/removals*					*Accounting Parameters[h]*	*Accounting Quantity[i]*
		2013	*2014*	*2015*	*2016*	*Total[g]*		
		(kt CO_2 eq)						
A. Article 3.3 activities								
A.1. Afforestation/reforestation		-400.01	-774.72	-1,252.83		-2,427.56		-2,427.56
Excluded emissions from natural disturbances(5)		NA	NA	NA		NA		NA
Excluded subsequent removals from land subject to natural disturbances(6)		NA	NA	NA		NA		NA
A.2. Deforestation		1,339.15	1,248.06	1,381.58		3,968.79		3,968.79
B. Article 3.4 activities								
B.1. Forest Management						-57,503.55		-10001.55
Net emissions/removals		-19,504.76	-19,337.00	-18,661.79		-57,503.55		
Excluded emissions from natural disturbances(5)		NO	NO	NO		NO		NO
Excluded subsequent removals from land subject to natural disturbances(6)		NO	NO	NO		NO		NO
Any debits from newly established forest (CEF-ne)(7),(8)		NO	NO	NO		NO		NO
Forest management reference level (FMRL)(9)							-8268.00	
Technical corrections to FMRL(10)							-7566.00	
Forest management cap[l]							223914.53	-10001.55
B.2. Cropland management (if elected)	15224.97	13,645.11	13,410.77	13,292.41		40,348.28		-5326.64
B.3. Grazing land management (if elected)	-7487.25	-6,376.38	-6,428.92	-6,492.34		-19,297.65		3164.11
B.4. Revegetation (if elected)		NA	NA	NA		NA		NA
B.5. Wetland drainage and rewetting (if elected)		NE	NE	NE		NE		NE

Note: 1 kt CO2 eq equals 1 Gg CO2 eq.

Abbreviations: CRF = common reporting format, LULUCF = land use, land-use change and forestry, NA= not applicable, NO= not occurring, NE= not estimated

a Reporting by a developed country Party on the information specified in the common tabular format does not prejudge the position of other Parties with regard to the treatment of units from market-based mechanisms under the Convention or other market-based mechanisms towards achievement of quantified economy-wide emission reduction targets.

b Developed country Parties with a quantified economy-wide emission reduction target as communicated to the secretariat and contained in document FCCC/SB/2011/INF.1/Rev.1 or any update to that document, that are Parties to the Kyoto Protocol, may use table 4(a)II for reporting of accounting quantities if LULUCF is contributing to the attainment of that target.

c Parties can include references to the relevant parts of the national inventory report, where accounting methodologies regarding LULUCF are further described in the documentation box or in the biennial reports.

d Net emissions and removals in the Party's base year, as established by decision 9/CP.2.

e All values are reported in the information table on accounting for activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol, of the CRF for the relevant inventory year as reported in the current submission and are automatically entered in this table.

f Additional columns for relevant years should be added, if applicable.

g Cumulative net emissions and removals for all years of the commitment period reported in the current submission.

h The values in the cells "3.3 offset" and "Forest management cap" are absolute values.

i The accounting quantity is the total quantity of units to be added to or subtracted from a Party's assigned amount for a particular activity in accordance with the provisions of Article 7, paragraph 4, of the Kyoto Protocol.

j In accordance with paragraph 4 of the annex to decision 16/CMP.1, debits resulting from harvesting during the first commitment period following afforestation and reforestation since 1990 shall not be greater than the credits accounted for on that unit of land.

k In accordance with paragraph 10 of the annex to decision 16/CMP.1, for the first commitment period a Party included in Annex I that incurs a net source of emissions under the provisions of Article 3 paragraph 3, may account for anthropogenic greenhouse gas emissions by sources and removals by sinks in areas under forest management under Article 3, paragraph 4, up to a level that is equal to the net source of emissions under the provisions of Article 3, paragraph 3, but not greater than 9.0 megatonnes of carbon times five, if the total anthropogenic greenhouse gas emissions by sources and removals by sinks in the managed forest since 1990 is equal to, or larger than, the net source of emissions incurred under Article 3, paragraph 3.

l In accordance with paragraph 11 of the annex to decision 16/CMP.1, for the first commitment period of the Kyoto Protocol only, additions to and subtractions from the assigned amount of a Party resulting from Forest management under Article 3, paragraph 4, after the application of paragraph 10 of the annex to decision 16/CMP.1 and resulting from forest management project activities undertaken under Article 6, shall not exceed the value inscribed in the appendix of the annex to decision 16/CMP.1, times five.

Section 11 of the UK national inventory report has further details on accounting methodologies.

LULUCF is not covered by the joint EU quantified economy-wide emission target therefore this sector is not accounted for in the assessment of progress towards achievement of the target.

Table 4(b) – Reporting on progress[a,b,c]

Units of market based mechanisms			*Year*	
			2015	*2016*
Kyoto Protocol units[d,e]	*Kyoto Protocol units*	*(number of units)*	NO	NO
		(kt CO2 eq)	2,003,378.41	NO
	AAUs	*(number of units)*		NO
		(kt CO2 eq)	2,003,378.41	NO
	ERUs	*(number of units)*	NO	NO
		(kt CO2 eq)	NO	NO
	CERs	*(number of units)*	NO	NO
		(kt CO2 eq)	NO	NO
	tCERs	*(number of units)*	NO	NO
		(kt CO2 eq)	NO	NO
	lCERs	*(number of units)*	NO	NO
		(kt CO2 eq)	NO	NO
Other units[d]	*Units from market-based mechanisms under the Convention*	*(number of units)*		
		(kt CO2 eq)		
	Units from other market-based mechanisms	*(number of units)*		
		(kt CO2 eq)		
	The 2020 Climate and Energy Package allows Certified Emission Reductions (CERs) and Emission Reduction Units (ERUs) to be used for compliance purposes, subject to a number of restrictions in terms of origin and type of project and up to an established limit. In addition, the legislation foresees the possible recognition of units from new market mechanisms. Under the EU ETS the limit does not exceed 50% of the required reduction below 2005 levels. In the sectors not covered by the ETS, annual use shall not exceed to 3 % of each Member States' non-ETS greenhouse gas emissions in 2005. A limited number of Member States may use an additional 1%, from projects in LDCs or SIDS subject to conditions.	*(number of units)*		
		(kt CO2 eq)		
Total		*(number of units)*	NO	NO
		(kt CO2 eq)	2,003,378.41	NO

Notes:

Abbreviations: AAUs = assigned amount units, CERs = certified emission reductions, ERUs = emission reduction units, lCERs = long-term certified emission reductions, tCERs = temporary certified emission reductions, NO =not occurring.

Note: 2015 is the latest reporting year.

a Reporting by a developed country Party on the information specified in the common tabular format does not prejudge the position of other Parties with regard to the treatment of units from market-based mechanisms under the Convention or other market-based mechanisms towards achievement of quantified economy-wide emission reduction targets.

b For each reported year, information reported on progress made towards the emission reduction target shall include, in addition to the information noted in paragraphs 9(a-c) of the reporting guidelines, on the use of units from market-based mechanisms.

c Parties may include this information, as appropriate and if relevant to their target.

d Units surrendered by that Party for that year that have not been previously surrendered by that or any other Party.

e In 2015 there were a significant number of AAUs retired as part of the compliance procedure for the first Kyoto Protocol true-up period.

LULUCF is not covered by the joint EU quantified economy-wide emission target therefore this sector is not accounted for in the assessment of progress towards achievement of the target.

Table 5
Summary of key variables and assumptions used in the projection analysis[a]

	Historical[b]											*Projected[a]*			
Key Underlying assumptions	*1990*	*1995*	*2000*	*2005*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*	*2020*	*2025*	*2030*	*2035*
UK GDP growth rate (per cent/per annum)	0.7%	2.5%	3.7%	3.0%	1.9%	1.5%	1.3%	1.9%	3.1%	2.2%	1.8%	1.9%	2.1%	2.3%	2.3%
UK population growth (per cent/per annum)	0.3%	0.3%	0.3%	0.8%	0.8%	0.8%	0.7%	0.6%	0.8%	0.8%	0.7%	0.6%	0.6%	0.5%	0.4%
UK households growth (per cent/per annum)	1.0%	0.7%	0.7%	0.8%	0.8%	0.7%	0.7%	0.9%	1.0%	1.0%	1.0%	0.9%	0.8%	0.7%	0.6%
Crude oil (Brent 1 month) ($/bbl, 2017 prices)	42.4	26.1	39.6	68.1	89.4	121.7	120.9	115.4	103.2	55.9	45.8	57.0	69.0	80.0	80.0
Gas (NBP) (p/therm, 2017 prices)	NE	NE	24.9	50.7	47.0	61.4	64.8	72.0	52.1	44.5	35.6	43.0	55.0	67.0	67.0
Coal (CIF ARA) ($/tonne, 2017 prices)	77.8	68.3	50.0	75.7	102.9	133.7	99.3	86.8	78.2	58.0	57.0	65.0	77.0	88.0	88.0
EU ETS carbon price (£/tCO2, 2017 prices)	NO	NO	NO	15.3	13.8	12.4	6.5	4.0	5.0	5.8	4.5	4.6	13.2	39.4	39.4
Electricity generation carbon price (£/tCO2, 2017 prices)	NO	NO	NO	15.3	13.8	12.4	6.5	8.0	13.7	22.3	22.8	22.2	23.5	39.4	95.7
Pound Sterling to US Dollars exchange rate ($ per £)	1.786	1.578	1.515	1.819	1.546	1.603	1.585	1.564	1.648	1.529	1.354	1.296	1.313	1.313	1.313
Pound Sterling to Euro exchange rate (€ per £)	NO	NO	1.642	1.463	1.166	1.153	1.234	1.178	1.241	1.378	1.223	1.146	1.140	1.140	1.140

Notes:
[a] Parties should include key underlying assumptions as appropriate.
[b] Parties should include historical data used to develop the greenhouse gas projections reported.
Abbreviations: NE = not estimated, NO = not occurring.

Table 6(a)

IInformation 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[1]	*1990*	*1995*	*2000*	*2005*	*2010*	*2015*	*2020*	*2030*
Sector									
Energy									
Transport									
Industry/industrial processes									
Agriculture									
Forestry/LULUCF									
Waste management/waste									
Other (specify)									
Energy Supply [2]	279,103.1	279,103.1	239,158.1	222,220.7	232,297.4	208,085.9	145,537.4	87,553.8	75,618.1
Business [2]	114,606.7	114,606.7	112,466.4	116,510.8	110,104.6	95,136.6	84,914.1	76,168.5	59,960.9
Industrial Processes [2]	59,950.0	59,950.0	50,856.9	27,134.7	20,648.3	12,671.3	12,705.6	10,013.7	9,030.3
Transport [2]	123,029.3	123,029.3	123,272.6	127,847.1	131,742.9	121,265.8	121,033.8	117,135.8	109,398.6
Residential [2]	80,394.9	80,394.9	81,964.8	89,051.4	86,083.9	87,884.3	66,669.9	66,849.8	71,719.5
Public [2]	13,496.9	13,496.9	13,276.9	12,110.8	11,174.2	9,746.7	8,088.0	6,977.0	7,536.8
Agriculture [2]	59,309.8	59,309.8	58,745.9	55,225.4	51,466.4	48,940.5	49,405.8	46,862.9	44,583.8
LULUCF [2]	5,700.1	5,700.1	3,032.6	490.8	-3,231.6	-5,821.3	-7,368.7	-11,081.2	-6,711.0
Waste [2]	66,925.1	66,925.1	69,312.4	62,991.0	49,424.4	31,944.2	18,410.8	13,922.6	11,229.0
Gas									
CO_2 Emissions including Net CO_2 from LULUCF	598,520.0	598,520.0	560,403.1	558,789.8	558,438.7	499,940.2	406,808.2	333,799.8	314,229.7
CO_2 excluding Net CO_2 from LULUCF	595,297.4	595,297.4	559,783.1	560,581.7	563,637.4	507,470.0	415,721.5	346,464.0	322,856.7
CH_4 Emissions including Net CH_4 from LULUCF	135,347.5	135,347.5	128,847.8	111,052.0	89,388.5	68,266.1	52,616.7	46,817.1	41,210.2
CH_4 excluding Net CH_4 from LULUCF	135,330.8	135,330.8	128,817.9	111,019.8	89,347.5	68,225.9	52,590.2	46,785.3	41,183.6
N_2O Emissions including Net N_2O from LULUCF	51,326.1	51,326.1	41,877.8	31,441.9	27,290.6	24,161.7	23,223.1	22,050.2	21,929.2
N_2O excluding Net N_2O from LULUCF	48,865.2	48,865.2	39,495.0	29,191.4	25,364.4	22,493.5	21,704.9	20,499.0	20,039.8
HFCs	14,391.4	14,391.4	19,096.0	9,882.9	13,151.5	16,511.6	15,963.6	11,096.9	4,311.0
PFCs	1,651.5	1,651.5	596.9	596.8	385.1	287.7	327.2	257.0	257.0
SF_6	1,279.1	1,279.1	1,264.4	1,817.7	1,056.0	686.5	457.5	381.8	428.7
Total with LULUCF	**802,515.9**	**802,515.9**	**752,086.76**	**713,582.71**	**689,710.70**	**609,854.08**	**499,396.72**	**414,402.8**	**382,365.8**
Total without LULUCF	**796,815.8**	**796,815.8**	**749,054.1**	**713,091.9**	**692,942.3**	**615,675.4**	**506,765.4**	**425,484.1**	**389,076.8**

Note
1. Base year of 1990
2. National communication sectors
Numbers are reported on UNFCCC coverage and as such will not precisely match nationally published equivalents

Table 7
Provision of public financial support: summary information in 2015

2015	*Domestic currency (£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	1,582.4	318.4	170.2	12.7		2,415.9	486.2	259.9	19.4	
Multilateral climate change funds		120.0	120.0				183.2	183.2		
Other multilateral climate change funds		198.4	50.2	12.7			303.0	76.7	19.4	
Multilateral financial institutions, including regional development banks	1,527.4					2,331.9				
Specialised United Nations bodies	55.0					84.0				
Total contributions through bilateral, regional and other channels		336.5	395.7	20.7			513.7	604.2	31.7	
Total	**1,582.4**	**654.9**	**566.0**	**33.5**		**2,415.9**	**999.9**	**864.1**	**51.1**	

Notes
The UK has reported the core contributions it has made to the listed multilaterals, plus some other contributions. These contributions are to the core budget and the UK cannot specify these as climate specific.
2015 Exchange rate $1 = £0.655 (source: Annual exchange rates for DAC donor countries).
2016 Exchange rate $1 = £0.741 (source: Annual exchange rates for DAC donor countries).
The UK has reported climate specific contributions through multilateral channels, where the channel has a clear climate purpose for example the Green Climate Fund and the Climate Investment Funds.
Our contributions through other channels are identified as climate specific as they are funded from dedicated ring fences of climate finance with clear climate change objectives. The business cases for these programmes are scrutinised to ensure they comply with these objectives.
The UK has categorised spend to multilaterals and bilaterals as 'provided'. The reported finance is the amount recorded as spent for UK Government budgetary purposes. Therefore we do not account for spend that has been pledged or committed for future years, but we do account for spend using promissory notes. These represent a legal promise for the UK to provide to total value of the promissory note, to the note's recipient.
The UK has reported annual spend from its International Climate Fund (ICF) and climate specific ODA eligible spend from the Foreign and Commonwealth Office (FCO) Prosperity Fund.
The UK is providing new levels of climate finance in addition to historic levels of ODA; the provision of climate finance is not resulting in a diversion of wider development spend.
The UK has increased its annual climate finance expenditure from £587m in 2009 to £1254m in 2015, this is an increase of 114%. Alongside this increase, the UK's overall ODA spend increased from £7.2bn in 2009 to £12.2bn in 2015, in line with growth in GNI (the UK is a 0.7 donor). New climate finance is, therefore, provided in addition to a growing overall aid budget.
The UK has provided the majority of it's climate finance via grants. The exceptions to this are the two bilateral contributions that are marked as equity.
All of reported UK climate finance is ODA. As part of our return, the UK has reported reflows of climate finance for example due to programmes closing down or no longer requiring UK finance. These reflows count as negative ODA and therefore affect the overall spend totals. We have grouped these reflows under the appropriate thematic area in order to properly account for their impact on the reported spend.
The UK has reported the same sector for each programme as per its overall ODA reporting to the OECD-DAC that took place earlier in the year.

Table 7
Provision of public financial support: summary information in 2016

2016	*Domestic currency (£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	1,426.8	145.8	122.0	0.0		1,925.5	196.7	164.6		
Multilateral climate change funds		91.3	121.0				123.1	163.3		
Other multilateral climate change funds		54.5	1.0				73.5	1.3		
Multilateral financial institutions, including regional development banks	1,426.8					1,925.5				
Specialised United Nations bodies										
Total contributions through bilateral, regional and other channels		371.0	411.0	0.9			500.7	554.7	1.2	
Total	**1,426.8**	**516.8**	**533.0**	**0.9**		**1,925.8**	**697.4**	**719.2**	**1.2**	

Notes
The UK has reported the core contributions it has made to the listed multilaterals, plus some other contributions. These contributions are to the core budget and the UK cannot specify these as climate specific.
2015 Exchange rate $1 = £0.655 (source: Annual exchange rates for DAC donor countries).
2016 Exchange rate $1 = £0.741 (source: Annual exchange rates for DAC donor countries).
The UK has reported climate specific contributions through multilateral channels, where the channel has a clear climate purpose for example the Green Climate Fund and the Climate Investment Funds.
Our contributions through other channels are identified as climate specific as they are funded from dedicated ring fences of climate finance with clear climate change objectives. The business cases for these programmes are scrutinised to ensure they comply with these objectives.
The UK has categorised spend to multilaterals and bilaterals as 'provided'. The reported finance is the amount recorded as spent for UK Government budgetary purposes. Therefore we do not account for spend that has been pledged or committed for future years, but we do account for spend using promissory notes. These represent a legal promise for the UK to provide to total value of the promissory note, to the note's recipient.
The UK has reported annual spend from its International Climate Fund (ICF) and climate specific ODA eligible spend from the Foreign and Commonwealth Office (FCO) Prosperity Fund.
The UK is providing new levels of climate finance in addition to historic levels of ODA; the provision of climate finance is not resulting in a diversion of wider development spend.
The UK has increased its annual climate finance expenditure from £587m in 2009 to £1254m in 2015, this is an increase of 114%. Alongside this increase, the UK's overall ODA spend increased from £7.2bn in 2009 to £12.2bn in 2015, in line with growth in GNI (the UK is a 0.7 donor). New climate finance is, therefore, provided in addition to a growing overall aid budget.
The UK has provided the majority of it's climate finance via grants. The exceptions to this are the two bilateral contributions that are marked as equity.
All of reported UK climate finance is ODA. As part of our return, the UK has reported reflows of climate finance for example due to programmes closing down or no longer requiring UK finance. These reflows count as negative ODA and therefore affect the overall spend totals. We have grouped these reflows under the appropriate thematic area in order to properly account for their impact on the reported spend.
The UK has reported the same sector for each programme as per its overall ODA reporting to the OECD-DAC that took place earlier in the year.

Table 7a
Provision of public financial support: contribution through multilateral channels in 2015

Donor funding	*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*	*Energy, Transport, Industry, Agriculture, Forestry, Water and sanitation, Cross-cutting, Other, Not applicable*
	Domestic currency (£m)	*USD ($m)*	*Domestic currency (£m)*	*USD ($m)*					
Total contributions through multilateral channels	1,582.40	2,415.89	488.69	746.09					
Multilateral climate change funds			488.69	746.09					
1. Global Environment Facility									
2. Least Developed Countries Fund									
3. Special Climate Change Fund									
4. Adaptation Fund									
5. Green Climate Fund			240.00	366.41	Provided	ODA	Grant	Cross-cutting	Unspecified
6. UNFCCC Trust Fund for Supplementary Activities									
7. Other multilateral climate change funds			248.69	379.68					
Climate Investment Funds			71.99	109.91	Provided	ODA	Grant	Cross-cutting	Power generation
Climate Investment Funds – Clean Technology Fund			157.80	240.92	Provided	ODA	Grant	Mitigation	Energy generation and supply
Climate Development Knowledge Network			18.90	28.85	Provided	ODA	Grant	Cross-cutting	General environmental protection
Multilateral financial institutions, including regional development banks	1,527.40	2,331.92							

Donor funding	*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*	*Energy, Transport, Industry, Agriculture, Forestry, Water and sanitation, Cross-cutting, Other, Not applicable*
	Domestic currency (£m)	*USD ($m)*	*Domestic currency (£m)*	*USD ($m)*					
1. World Bank	1,228.00	1,874.81			Provided	ODA	Grant/Loan (£160m)	Cross-cutting	
2. International Finance Corporation									
3. African Development Bank	217.50	332.06			Provided	ODA	Grant	Cross-cutting	
4. Asian Development Bank	50.00	76.34			Provided	ODA	Grant	Cross-cutting	
5. European Bank for Reconstruction and Development									
6. Inter-American Development Bank	2.10	3.21			Provided	ODA	Grant	Cross-cutting	
7. Other	29.80	45.50							
Other	29.80	45.50			Provided	ODA	Grant	Cross-cutting	
Specialized United Nations bodies	55.00	83.97							
1. United Nations Development Programme	55.00	83.97							
Other	55.00	83.97			Provided	ODA	Grant	Cross-cutting	
2. United Nations Environment Programme									
3. Other									

Note:
Abbreviations: ODA = official development assistance, OOF = other official flows, USD = United States dollars.

Table 7a
Provision of public financial support: contribution through multilateral channels in 2016

Donor funding	*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*	*Energy, Transport, Industry, Agriculture, Forestry, Water and sanitation, Cross-cutting, Other, Not applicable*
	Domestic currency (£m)	*USD ($m)*	*Domestic currency (£m)*	*USD ($m)*					
Total contributions through multilateral channels	1,426.81	1,925.52	267.95	361.61					
Multilateral climate change funds			267.95	361.61					
1. Global Environment Facility			21.00	28.34	Provided	ODA	Grant	Cross-cutting	Not applicable
2. Least Developed Countries Fund			30.00	40.49	Provided	ODA	Grant	Adaptation	Not applicable
3. Special Climate Change Fund									
4. Adaptation Fund									
5. Green Climate Fund			161.72	218.25	Provided	ODA	Grant	Cross-cutting	Not applicable
6. UNFCCC Trust Fund for Supplementary Activities									
7. Other multilateral climate change funds			55.23	74.53					
Global Green Growth Insitute			4.73	6.38	Provided	ODA	Grant	Cross-cutting	Not applicable
Climate Investment Funds- Clean Technology Fund			50.50	68.15	Provided	ODA	Grant	Mitigation	Energy generation and supply

Donor funding	*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*	*Energy, Transport, Industry, Agriculture, Forestry, Water and sanitation, Cross-cutting, Other, Not applicable*
	Domestic currency (£m)	*USD ($m)*	*Domestic currency (£m)*	*USD ($m)*					
Multilateral financial institutions, including regional development banks	1,426.81	1,925.52							
1. World Bank	1,157.16	1,561.62			Provided	ODA	Grant/Loan		Not applicable
2. International Finance Corporation									
3. African Development Bank	207.93	280.61			Provided	ODA	Grant		Not applicable
4. Asian Development Bank	50.00	67.48			Provided	ODA	Grant		Not applicable
5. European Bank for Reconstruction and Development									
6. Inter-American Development Bank	2.36	3.18			Provided	ODA	Grant		Not applicable
7. Other	9.36	12.63							
Other	9.36	12.63			Provided	ODA	Grant		Not applicable
Specialized United Nations bodies									
1. United Nations Development Programme									
Climate Investment Funds									
2. United Nations Environment Programme									
Climate Investment Funds									
3. Other									

Note:
Abbreviations: ODA = official development assistance, OOF = other official flows, USD = United States dollars.

Table 7b
Provision of public financial support: contribution through bilateral, regional and other channels 2015

Recipient country/region/project/programme	*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, Water and sanitation, Cross-cutting, Other, Not applicable*	
	Domestic currency (£m)	*USD ($m)*						
CDC Programme of Support in Africa and South Asia (2015-2018)	120.0	183.2	Provided	ODA	Equity	Cross cutting	Banking and financial services	To enable CDC to scale up its activity of investing and lending to support the building of businesses throughout Africa and South Asia, to create jobs and make a lasting difference to people's lives in some of the world's poorest places. Investment is important to support the growth of the private sector which is critical for economic development and poverty reduction. The overall budget for this programme is £740 million and is detailed in the business case. Due to the programme developing over a period of time, the current budget info is published to the development tracker in stages to assist the complex management of this programme. Therefore the current budget will change from £544 million to £740 million to include recently approved capital amendments and does not represent a change to the overall programme budget.
Productive Safety Net Programme Phase 4	48.1	73.4	Provided	ODA	Grant	Cross cutting	Agriculture	To reduce hunger, improve livelihoods and reduce the risk of famine in rural Ethiopia by (i) providing cash and food transfers, livelihoods advice and access to microfinance to 1.2 million extremely poor Ethiopians and (ii) creating local infrastructure which reverses environmental degradation and improves access to markets and basic services. 85% of participant households receive transfers as wages for labour on public works projects (including 32,000 km of hillside terraces, 3,000 km of rural roads and 400 new or expanded schools); while the remainder (the elderly, those with disabilities, and pregnant women) receive cash and / or food without a labour requirement. This programme contributes towards national and international development goals and DFID's own targets for reducing poverty and hunger and for building household resilience to climate change and other shocks.

Recipient country/region/project/programme	*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, Water and sanitation, Cross-cutting, Other, Not applicable*	
	Domestic currency (£m)	*USD ($m)*						
Providing Humanitarian Assistance in Sahel Emergencies (PHASE)	33.8	51.6	Provided	ODA	Grant	Adaptation	General environmental protection	To provide humanitarian assistance to vulnerable people in the Sahel and help them to cope with future disasters. This will be linked to the seasonal calendar and work alongside longer-term resilience programmes to reduce the long term demand for humanitarian assistance in the Sahel, and will be delivered through NGO and multilateral partners.
Forest Governance, Markets and Climate	30.3	46.2	Provided	ODA	Grant	Cross cutting	Forestry	To build on high impact current work and help create the foundations for effective use of finance to reduce emissions from deforestation while ensuring that DFID's poverty reduction goals are addressedBenefit poor people by putting in place the governance and market reforms that reduce illegal logging and deforestation, building on past high impact work on this issue.A global programme that benefits poor forest-dependent people by supporting governance and market reforms aimed at reducing the illegal use of forest resources and promoting sustainable growth in developing countries.
Building Resilience and Adaptation to Climate Extremes and Disasters	20.8	31.8	Provided	ODA	Grant	Adaptation	General environmental protection	To help up to 10 million people, especially women and children, in developing countries cope with extreme climate and weather events such as droughts, cyclones and floods (climate extremes). This will be achieved by doing three things. By making grants to civil society organisations to scale up proven technologies and practices in the Sahel, sub-Saharan Africa and South Asia that help people withstand, and more quickly recover, from climate extremes. By identifying the best ways of doing this, and share this knowledge globally to increase the programme's overall impact. By supporting national governments to strengthen their policies and actions to respond to climate extremes. These will all contribute to the Millennium Development Goals on the eradication poverty and hunger, and environmental sustainability, and also respond to the Humanitarian and Emergency Response Review recommendation that DFID should integrate the threat from climate change into a Disaster Risk Reduction.

Recipient country/region/project/programme	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, Water and sanitation, Cross-cutting, Other, Not applicable	
	Domestic currency (£m)	USD ($m)						
Livelihoods and Food Security Trust Fund for Burma (NUTSEM)	19.5	29.8	Provided	ODA	Grant	Adaptation	Agriculture	To increase food availability and incomes of 1-1.5 million target beneficiariesTo increase livelihoods' resilience and nutrition of 2.5 million peopleTo improve the incomes and nutrition status of over 1.63 million poor people in Burma by promoting resilient livelihoods and food security food security through agricultural commercialisation and climate smart agriculture, financial inclusion, business and skills development, and targeted nutrition support to mothers and children in the 'One thousand day' window between conception and a child's second birthday.
Managing Climate Risks for Urban Poor	19.0	29.1	Provided	ODA	Grant	Adaptation	Other multisector	This programme will help cities plan for and invest in reducing the impacts of weather-related changes and extreme events, through a partnership with the Rockefeller foundation and the Asian Development Bank, on 2 million urban poor and vulnerable people in 25 medium-sized cities in 6 Asian countries (initially Pakistan, Bangladesh, India, Vietnam, Indonesia) by improving planning processes so that they consider climate change risks, for developing and funding new investment and infrastructure opportunities, and for knowledge and lesson sharing by 2018.
Solar Nigeria Programme	18.6	28.3	Provided	ODA	Grant	Mitigation	Energy generation, renewable sources	To improve the welfare outcomes of the currently underserved communities in Lagos state and Northern Nigeria by making a significant financial contribution towards the solar power electrification of public institutions, such as schools and hospitals. The intervention is expected to, by year 2020, ensure improved welfare outcomes for more than 2.8 million people using domestic solar photovoltaic (PV) systems, with 190,000 school pupils and 4.7 million clinic patients benefiting from public institutions with PV systems, create more than 3000 jobs and ensure greater effectiveness of DFID's other health and educational sector intervention in Nigeria.

Recipient country/region/project/programme	*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, Water and sanitation, Cross-cutting, Other, Not applicable*	
	Domestic currency (£m)	*USD ($m)*						
Strengthening Humanitarian Preparedness for Effective Response	18.0	27.5	Provided	ODA	Grant	Cross cutting	Disaster prevention and preparedness	strengthen national systems for disaster management in 11 high risk areas (Afghanistan, Burma, Nigeria, Pakistan, the Philippines, Chad, Madagascar, Central America, Central Asia, African Great Lakes and the Syria region). This will include building and strengthening national early warning systems and communication channels. It will also develop a common understanding of risk that becomes the focus of national/ regional planning.
Productive Social Safety Net Programme	18.0	27.5	Provided	ODA	Grant	Adaptation	Other social infrastructure and services	To support the scale up of the Productive Social Safety Net which will reach 1 million households, and these households are the poorest 15%. through the provision of conditional Cash Transfers, Green Public Works and Livelihood Enhancement. This programme will aim to improve the opportunities available to the poorest communities by reducing the depth of income poverty, improving food consumption and increasing their resilience to climate-related shocks. DFID will also support central government to develop and strengthen systems and institutions to deliver more comprehensive social protection provision that can respond to any future economic, food or climate shocks in Tanzania.
Enhancing resilience in Karamoja Uganda	17.6	26.8	Provided	ODA	Grant	Adaptation	Agriculture	To increase the resilience of targeted communities to climate extremes and weather events. The programme will support 700,000 people to cope with the effects of climate change, this includes: 200,000 people with improved food security through participation in public works programmes; 6,000 agro-pastoralists and pastoralists with access to improved animal nutrition; and 175,000 children under five and pregnant and lactating women treated for malnutrition and with improved access to water by March 2017.

Recipient country/region/project/programme	*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, Water and sanitation, Cross-cutting, Other, Not applicable*	
	Domestic currency (£m)	*USD ($m)*						
Hunger Safety Net Programme	15.7	24.0	Provided	ODA	Grant	Cross cutting	General environmental protection	To reduce poverty, hunger and vulnerability by providing the poorest households in Kenya's arid and semi-arid lands with cash transfers. This contributes to our MDGs by preventing 720,000 people from becoming poorer and help them to increase their expenditure on food, health, education and wider livelihood opportunities by 2017.
Support to the Global Agriculture and Food Security Programme (GAFSP)	15.6	23.8	Provided	ODA	Grant	Cross cutting	Agriculture	To improve agricultural productivity in developing countries and to increase farmers' access to markets whilst increasing the economic resilience of poor people globally.
East Africa Geothermal Energy (EA-Geo)	15.3	23.4	Provided	ODA	Grant	Cross cutting	Energy generation, renewable sources	The project will increase investment in geothermal power in East Africa. It will reduce the risk of exploratory test drilling, leading to increased investor confidence in under exploited East Africa geothermal energy. It will also improve geothermal strategy, policy and regulations that facilitate investments.
Global Green Growth Institute (GGGI)	10.0	15.3	Provided	ODA	Grant	Cross cutting	Unallocated/ unspecified	This programme will provide practical support to implement high quality green growth policies in developing countries. It will also improve knowledge and evidence on green growth policies and their implementation across developing countries.
Climate High-Level Investment Programme	9.9	15.2	Provided	ODA	Grant	Cross cutting	General environmental protection	To invest in activities which will build climate resilience and promote low carbon growth in Ethiopia. This will help 1.5 million people to cope with the effects of climate change by 2015, help Ethiopia to protect livelihoods, services, infrastructure and energy supplies from the effects of climate change, and establish its green growth path.
The Water Security Programme	9.0	13.7	Provided	ODA	Grant	Adaptation	General environmental protection	To increase the resilience of poor people to climate change through secure and sustainable access to water resources. We will work with the Global Water Partnership and World Bank Water Partnership Programme to support increased investment in the information, institutions and infrastructure required to deliver water security.

Recipient country/region/project/programme	*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, Water and sanitation, Cross-cutting, Other, Not applicable*	
	Domestic currency (£m)	*USD ($m)*						
Scaling up of the Energy and Environment Partnership with Southern and East Africa	8.7	13.3	Provided	ODA	Grant	Cross cutting	General environmental protection	Greater access to clean energy services achieved through fast tracking of renewable energy project demonstration and deployment, including through technology learning, donor coordination and private sector investment.
PIDG: Core Support to Private Infrastructure Development Group	8.5	13.0	Provided	ODA	Grant	Cross cutting	Energy generation, renewable sources	Increased responsible private sector participation in sustainable infrastructure in poorer developing countries through increased flows of private capital & expertise.This will benefit an additional 105.1 million people by the end of 2015.
On Grid Small Scale Renewable Energy in Uganda	7.6	11.6	Provided	ODA	Grant	Mitigation	Energy generation, renewable sources	To improve the environment for private investment in Uganda's renewable energy sector by supporting the construction of at least 15 on-grid small scale power plants. This will increase Uganda's energy production by circa 20%, mobilise up to £240 million in private finance and stabilise Uganda's power sector finances by saving approximately $260m to 2.7bn during the period 2013-35, and lead to greenhouse gas emission savings of between 1 and 10 $MtCO_2e$.
Enhancing Community Resilience Programme	7.6	11.5	Provided	ODA	Grant	Cross cutting	General environmental protection	To achieve sustainable disaster-resilient communities through community-based best practices, public awareness and policy change.
Arid Lands Support Programme	7.5	11.4	Provided	ODA	Grant	Cross cutting	Agriculture	To improve the coping strategies for over 500,000 of the poorest people in Northern Kenya (Turkana, Wajir, Mandera and Marsabit counties) to help them to adapt to climate change and improve their livelihoods. The programme will also provide opportunities to support the poorest during drought, provide benefits for livestock insurance, increase average real value of assets owned by households, and will allow 64,000 beneficiaries to become less poor relative to non-beneficiaries in the four counties.

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Programme of Support to Agriculture in Rwanda	7.1	10.9	Provided	ODA	Grant	Cross cutting	Agriculture	To sustainably increase the agricultural productivity of poor farmers by transforming Rwandan agriculture from a subsistence-based to a more commercial-based sector that accelerates agricultural growth. This will help address challenges that may limit agriculture productivity, reduce the rate at which poverty is falling, increase inequality and hamper improvements in food security and malnutrition. The programme will result in increased agricultural productivity, food security and incomes of poor households and contributes towards the MDG's by helping to eradicate extreme poverty and hunger and; promoting gender equality and empowering women.
Provision of finance to the Rwanda Fund for Climate Change and Environment	7.0	10.8	Provided	ODA	Grant	Cross cutting	Forestry	To improve climate adaptation and low carbon development by providing finance to the Rwanda Fund for Climate Change and Environment from the UK International Climate Fund. This will benefit 15,000 people to cope better with climate change impacts, 2,000 people gain access to clean energy especially in rural areas, protect 1,200 hectares of land against soil erosion, create 2000 green jobs as well as mobilise £8 million of additional finance from the private sector by July 2015. This contributes towards the MDG on environmental sustainability and ensuring an effective response to the impacts of climate change, thus securing current and future development gains as well as protection of the livelihoods of the poorest people.
Regional Transboundary Water Resources Programme – Phase 3	6.3	9.6	Provided	ODA	Grant	Cross cutting	General environmental protection	To improve governance of shared water resources in Southern Africa, by sustainably improving local water-management capability and supporting development of key water infrastructure. This will indirectly benefit populations in the 13 shared river basins of the SADC region, in which 95 million people reside, through more equitable sharing of water resources, reduced vulnerability to flooding, improved access to drinking water, as well as reducing risk of conflict and better food security. These outcomes will contribute to MDG 1 ("Eradicate Extreme Poverty and Hunger") and MDG7 ("Ensure Environmental Sustainability").

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International Forestry Knowledge (KnowFor)	6.2	9.5	Provided	ODA	Grant	Cross cutting	Forestry	Uptake of international forestry knowledge, evidence and tools for international forestry policy and practice.
Climate Proofing Growth and Development in South Asia	5.6	8.5	Provided	ODA	Grant	Adaptation	Government and civil society, general	Integrate climate change into development planning, budgeting and delivery in national and sub-national governments in Afghanistan, Bangladesh, India, Nepal and Pakistan, by strengthening planning, budgeting and delivery mechanisms, building awareness and capacity of stakeholders, providing technical and some implementation support, helping leverage domestic finance and actively sharing knowledge by 2018.
Providing Clean Energy to the Rural Poor of Bangladesh	5.4	8.3	Provided	ODA	Grant	Mitigation	General environmental protection	Climate change mitigation and access to clean energy to improve the livelihoods of rural poor in off-grid areas in Bangladesh.
Kenya Essential Education Programme	5.4	8.2	Provided	ODA	Grant	Cross cutting	General environmental protection	To increase access, retention and improve the quality of education of 300,000 children in primary schools. Contributing to 38,000 more children enrolled and staying in schools within the arid lands and urban slums, a 3% improvement in learning achievements in the early grades and a 10% reduction in teacher absenteeism by 2015. Activities will contribute to the MDGs of universal primary education and gender equity through improvements in the accessibility, affordability and quality of education for Kenyan children.To support 980,000 Kenyan children improve their reading and writing skills and 200,000 of the most marginalised children in Kenya to access better quality schools and to improve their ability to cope with the effects of climate change. Activities will contribute to the MDGs of universal primary education and gender equity through improvements in the accessibility, affordability and quality of education for Kenyan children.

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Improving Rural Access in Tanzania	5.4	8.2	Provided	ODA	Grant	Adaptation	Transport and storage	To provide support to the local government infrastructure developmentTo provide support to local government infrastructure by improving access to markets by reducing transport costs. This will lead to an increase in rural income to 45,000 households by 2015. This contributes towards MDG by providing agricultural growth and underpinning strong economic development in Tanzania.
Strategic Partnership between BRAC, DFID and AusAID to support BRAC in delivering progress towards the MDGs in Bangladesh and to support its Institutional Development	5.1	7.8	Provided	ODA	Grant	Adaptation	General environmental protection	Supporting BRAC's Development Programme in providing basic Health-care Services, Education, Water and Sanitation and Improving the Livelihoods of the poorest and most marganilised people in Bangladesh.
South Asia Water Governance Programme (SAWGP)	4.8	7.3	Provided	ODA	Grant	Adaptation	Water and sanitation	To improve the management of water within and between South Asian countries, reducing poverty by enabling adaptation to climate change and reducing the risk of conflict over water resources. By 2018, 500 million people living in river basins will benefit from improved water management by reducing their risk of exposure to flooding and drought and enhancing regional security by improving cooperation between governments.
ESPA – Eco System Services for Poverty Alleviation	4.5	6.8	Provided	ODA	Grant	Cross cutting	General environmental protection	To understand why ecosystems are becoming degraded and how to reverse this and to ascertain what institutional changes need to be put in place for ecosysyem management to improve for the benefit of the poor.
Strengthening Adaptation and Resilience to Climate Change in Kenya Plus (StARCK+)	4.3	6.6	Provided	ODA	Grant	Cross cutting	General environmental protection	To achieve transformational change by helping Kenya to scale up private sector innovation and investment in low carbon and adaptation products, services and assets (e.g. clean energy, sustainable agriculture, water management, weather forecasting). Enabling this change will require targeted support to critical aspects of climate change governance, and stimulation of civil society demand. This contributes to the UK Government's International Climate Fund (ICF) commitments and will benefit 828,000 people able to cope with the effects of climate change and 17,600 people with improved access to clean energy.

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Sustainable Energy for Women and Girls (SEWG)	3.9	6.0	Provided	ODA	Grant	Cross cutting	General environmental protection	Programme aims to shift clean energy markets and delivery systems towards improving the health, safety and economic opportunities of low income girls and women in developing countries, principally in DFID and International Climate Fund (ICF) priority countries in Africa.
Private Sector Energy Efficiency	3.8	5.9	Provided	ODA	Grant	Cross cutting	General environmental protection	To reduce energy consumption, avoid greenhouse gas emissions and increase investment in companies benefitting from the programme by providing remote advice and funding energy audits and strategies for South Africa businesses by 31 March 2015.
Green Mini Grids – Tanzania	3.8	5.8	Provided	ODA	Grant	Mitigation	Heating, cooling and energy distribution	To support project preparation and leverage private investment in Green Mini-Grids (GMGs) in Tanzania.
Zimbabwe Resilience Building Fund Programme(ZRBF)	3.5	5.3	Provided	ODA	Grant	Adaptation	General environmental protection	To improve the resilience capacity of households affected by climatic shocks and trends through inclusive economic development. The programme will have a risk financing mechanism to make timely, appropriate and predictable funding available for communities that experience large scale humanitarian shocks. The program will also build evidence to improve the policy environment and stimulate service provision to enhance household and community resilience.
Carbon Market Finance for Africa (CMF-Africa)	3.4	5.2	Provided	ODA	Grant	Cross cutting	Heating, cooling and energy distribution	The project will transform the use of Clean Development Mechanism and other carbon market finance in Africa, for increased access to small scale, low carbon energy applications in rural areas. This will be through demonstrating the practical use and financial viability of innovative “standardised baselines” and new approaches to bundle small scale CDM projects (programmatic approaches).

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Comprehensive Programme on Spatial Planning and Low Carbon Development in Papua	3.4	5.2	Provided	ODA	Grant	Cross cutting	Forestry	Strengthened spatial and development plans and government supported actions on low carbon investment which will contribute towards ensuring environmental sustainability (MDG 7) and improved awareness among civil society about LCD and spatial planning.
Nepal Market Development Programme	3.1	4.7	Provided	ODA	Grant	Cross cutting	General environmental protection	To improve the incomes and growth for poor and disadvantaged people in key sub-sectors within agriculture and other rural markets.
Support for Refugees in Kenya (2012-2016)	3.0	4.6	Provided	ODA	Grant	Mitigation	General environmental protection	To provide essential humanitarian assistance for refugees in Kenya by ensuring improved access to clean water, sanitation, nutrition, health and protection services (e.g. police, secure accommodation for unaccompanied minors and victims of gender based violence) and sustainable climate change interventions. This will help save lives, relieve suffering, and maintain the dignity of refugees in Kenya in a sustainable way.
Climate Resilient Agriculture in Africa	2.9	4.5	Provided	ODA	Grant	Cross cutting	General environmental protection	Improved knowledge, policies and longer-term incentives to drive increased uptake of Climate Smart Agriculture (CSA) in Eastern and Southern Africa member states.
Future Proofing African Cities for Sustainable Growth	2.7	4.1	Provided	ODA	Grant	Cross cutting	General environmental protection	The UK's £4.915 million will fund a project to support at least 8 cities in Africa to become future proofed to climate, environment and natural resource challenges, so that they are inclusive and resilient, and have growing economies. It will help make cities work for the urban poor. It will conduct an in depth feasibility and scoping study and develop innovative tools to enable rapidly growing African cities to realise their potential as centres of growth and job creation; use research and evidence to develop targeted urban action plans; and will deliver research new research to fill data and evidence gaps to maximise sustainable economic growth.

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Northern Uganda: Transforming the Economy through Climate Smart Agribusiness (NU-TEC)	2.5	3.8	Provided	ODA	Grant	Cross cutting	Agriculture	To increase the resilience to climate change of poor farmers in Northern Uganda, and to increase their incomes. This will be achieved by working with agricultural businesses to supply farmers with cheaper, better and more varied agricultural inputs and services, and to create stronger markets for farmer produce. This will benefit 250,000 households in Northern Uganda, who will adopt new practices, products and markets that will make them more resilient to climate change, while 150,000 households will see measurable increases to income. This will contribute to the MDGs (and their successor targets) by reducing poverty in Uganda.
AGMIP – Agricultural Model Inter-Comparison and Improvement Project	2.3	3.5	Provided	ODA	Grant	Cross cutting	General environmental protection	To improve substantially the characterization of risk of hunger and world food security due to climate change and to enhance adaptive capacity in developing regions.DFID will fund the Sub-Saharan Africa and South Asia regional projects of a global initiative to improve crop and agricultural economic models to provide substantially improved assessments of climate impacts on the agricultural sector. The regional projects will improve the reliability and accessibility of assessments of impacts of climate change on agriculture in SUB-SAHARAN AFRICA and S.Asia and improved identification of potential adaptation strategies.
Reducing Maternal and Newborn Deaths in Kenya	2.2	3.4	Provided	ODA	Grant	Cross cutting	General environmental protection	To avert 4,000 maternal deaths and 5,500 neonatal deaths through nationwide life saving skills training for health professionals, and integrated health system strengthening in selected counties, 2013-2018.
Chars Livelihoods Programme 2	2.2	3.4	Provided	ODA	Grant	Adaptation	General environmental protection	To improve the food security, livelihoods and incomes of extremely poor people living on the Riverine Char Islands of North-Western Bangladesh.
Nepal Climate Change Support Programme	2.1	3.1	Provided	ODA	Grant	Adaptation	General environmental protection	To build capacity of the Government of Nepal to develop, cost, budget and implement adaptation measures at the local level aimed at mainstreaming climate change in key development sectors (agriculture, forestry, water and energy), including through public private partnerships.

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Kenya Health Programme	2.0	3.1	Provided	ODA	Grant	Cross cutting	Health, general	Support the Kenya Ministry of Health (MoH) and implementing partners to strengthen capacity for service delivery support systems and governance.
Africa Division funding to the African Agriculture Development Company (AgDevCo)	1.7	2.6	Provided	ODA	Grant	Adaptation	Agriculture	To evaluate and improve AgDevCo's facility to leverage private sector investment in Africa agribusiness and agricultural infrastructure and stimulate cross border trade in targeted countries, which will generate jobs and income for smallholder farmers and women. The evaluation is also to ensure accountability, demonstrate how funds are spent, and ensure value for money of DFID investments in AgDevCo by 2020.To support poverty reduction and increased food security through catalysing additional private sector investment in agribusiness and agricultural infrastructure and increasing agricultural cross border trade in targeted countries, generating jobs and income for smallholders.
Accountability in Tanzania Programme (ACT)	1.7	2.6	Provided	ODA	Grant	Cross cutting	General environmental protection	To increase the accountability and responsiveness of government to its citizens through a strengthened civil society.
Green Mini-Grids Africa Regional Facility for Market Preparation, Evidence and Policy Development	1.7	2.6	Provided	ODA	Grant	Cross cutting	Heating, cooling and energy distribution	The Green Mini-Grids regional facility will improve policy, evidence and market conditions to increase investment in green mini-grids across Africa.

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WISER – Weather and climate Information and SERvices for Africa	1.6	2.5	Provided	ODA	Grant	Cross cutting	General environmental protection	WISER will help at least 24 million people across Africa (focusing initially on East Africa (Ethiopia, Kenya, Tanzania, Uganda, Rwanda and Burundi) to be more resilient to natural disasters and climate change by 2030 by improving early warning systems (giving more time to prepare for heavy rains for example) as well as helping them make better decisions by knowing what the weather and climate is likely to be (enabling them to make better crop choices or alter planting times in farming, for example). We estimate that this will save over £190 million in terms of avoided damage to health, homes, livelihoods and infrastructure between now and 2030. The WISER programme will initially benefit the East African fishing and farming communities, as well as a wide range of African people, including young, old, men and boys and women and girls.
Philippines Reconstruction Programme	1.5	2.4	Provided	ODA	Grant	Cross cutting	General environmental protection	Enhanced resilience of vulnerable people to respond to, and recover from, exisiting climate variability and the impacts of climate change.
New Climate Economy Phase 2	1.5	2.3	Provided	ODA	Grant	Cross cutting	Government and civil society, general	Phase II of the New Climate Economy will build on the success of the report launched in September 2014 by focusing on engagement with key decision-makers in priority countries; catalysing action on a small number of targeted opportunities for change; and developing and communicating a new report that focuses on supporting global growth and poverty reduction while reducing carbon emissions through international collaboration.
Support to South Sudanese Refugees in Kenya (15/16)	1.5	2.3	Provided	ODA	Grant	Adaptation	General environmental protection	To support the provision of humanitarian assistance in order to save lives, avert suffering and maintain dignity of refugees who came to Kenya because of the crisis in South Sudan.
Low Carbon Support to the Ministry of Finance	1.5	2.2	Provided	ODA	Grant	Mitigation	Government and civil society, general	Supportive environment for low carbon investment established in Indonesia.

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Sustainable Crop Production Research for International Development (SCPRID)	1.4	2.2	Provided	ODA	Grant	Adaptation	Agriculture	The purpose of the project is to develop new science and technology to support the development of new crop varieties with more resistance to disease and pests and less vulnerable to abiotic shocks.
Climate Change Programme – Jolobayoo-O-Jibon	1.4	2.1	Provided	ODA	Grant	Cross cutting	General environmental protection	Climate change adaptation and risk reduction measures to protect and improve the lives and livelihoods of 15 million poor and vulnerable people by 2017.
Strategic Climate Institutions Programme	1.4	2.1	Provided	ODA	Grant	Cross cutting	General environmental protection	To build organisational and institutional capacity within Ethiopian Government, civil society and the private sector to 1) increase resilience of vulnerable people to current climate variability, 2) adapt to future climate change and 3) benefit from the opportunities for low carbon growth. This helps Ethiopia to meet its MDGs in a sustainable way, developing a Climate Resilient Green Economy.
Achieving Water Security in the Southern Agricultural Growth Corridor	1.4	2.1	Provided	ODA	Grant	Cross cutting	General environmental protection	To ensure economic growth and poverty eradication resulting from investment in agriculture is sustainable in the context of climate change.
Results, Evidence and Knowledge from the International Climate Fund	1.3	2.0	Provided	ODA	Grant	Cross cutting	General environmental protection	The purpose of the programme is to provide the evidence and learning to increase the effectiveness and measure the impact of the UK's international climate funding.
Climatescope – Clean Energy Investment Index	1.3	2.0	Provided	ODA	Grant	Mitigation	General environmental protection	To increase private investment in renewable energy projects in poorer countries by providing investors with concrete policy and financial information. Renewable energy is a cheaper solution than fossil fuels in many developing countries and by increasing the amount of renewable energy in developing countries this will encourage growth and allow businesses to prosper.
Research Programme Consortium on Leveraging Agriculture for Nutrition in South Asia (LANSA)	1.3	2.0	Provided	ODA	Grant	Adaptation	Agriculture	The LANSA programme makes a significant contribution to DFID's plans to scale up our engagement in nutrition.

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Forestry, Land-use and Governance in Indonesia	1.3	2.0	Provided	ODA	Grant	Mitigation	General environmental protection	To reduce greenhouse gas emissions and deforestation in Indonesia as part of the UK's efforts to avoid catastrophic climate change that would hit the very poorest first and set back global efforts at poverty reduction.
I2I – Innovative support for climate research – testing new, innovative approaches to address climate and environment development challenges	1.1	1.7	Provided	ODA	Grant	Cross cutting	General environmental protection	To develop and test new, innovative approaches to support research that addresses the needs of those without access to clean energy access, clean water and appropriate sanitation, or solutions to support adaptation to environmental changes. This includes testing the use of results-based financing, such as innovative prizes, and peer to peer financing, such as crowdfunding. The goal is to provide improved access to energy and water services for 12 million people through innovative, affordable technologies and business models for poor consumers by 2025.
African Risk Capacity (ARC)	1.1	1.7	Provided	ODA	Grant	Adaptation	Disaster prevention and preparedness	To support a parametric (index-based) weather risk insurance pool that will provide participating African countries with predictable, quick-disbursing funds with which to implement pre-defined contingency response plans in the case of a drought.
Improving governance of Land Use, Land-Use Change and Forestry in Indonesia	1.1	1.7	Provided	ODA	Grant	Cross cutting	General environmental protection	To improve governance of land use, land use change and forestry in Indonesia.
Support for priority actions to operationalise the Implementation Plan for Development Resilient to Climate Change in the Caribbean	1.0	1.6	Provided	ODA	Grant	Cross cutting	General environmental protection	To increase climate adaptation measures for the vulnerable poor in the CaribbeanTo increase regional, national and local climate adaptation measures for the vulnerable poor in the Caribbea.
Care Adaptation Learning Programme	1.0	1.6	Provided	ODA	Grant	Adaptation	Agriculture	Community based adaptation approaches for vulnerable communities incorporated into development policies and programmes in Ghana, Kenya, Mozambique and Niger with plans to replicate across Africa.

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Core Support to St Helena Capital Programme 2014-2017	1.0	1.6	Provided	ODA	Grant	Mitigation	Energy generation, renewable sources	The purpose of the project is to enable St Helena Government to implement its Capital Programme effectively delivering the majority of priority, high value infrastructure projects.
Dar Es Salaam Port Improvement Programme (preparatory Phase)	1.0	1.5	Provided	ODA	Grant	Cross cutting	Transport and storage	To increase Tanzania's trade competiveness by providing the Port of Dar es Salaam with essential infrastructure and efficiency enhancements. This will benefit Tanzania and neighbouring countries through improved market access. This will contribute towards our G8 commitment to cut bureaucracy at international borders by reducing port dwell time from 9 to 5 days by 2017.
Rural Access Programme 3	1.0	1.5	Provided	ODA	Grant	Adaptation	General environmental protection	To improve road access for 800,000 members of rural communities in the Western Region of Nepal, thereby improving economic opportunities and increasing access to markets and social services throughout the year. The project will lift 20,000 people out of poverty through access to work, skill trainings, and will promote equal opportunities for women. The project aims to contribute towards sustainable poverty reduction through investments in high value crops and will lay the foundations for private sector led development in the poorest region in the country.
Support for Energy Sector Analysis that influences global energy decision makers	1.0	1.5	Provided	ODA	Grant	Cross cutting	Energy generation, distribution and efficiency – general	Develping countries have adopted pro-poor low carbon development pathways in line with trajectories for a 2 degree world by 2020.

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PMEH – Pollution Management & Environmental Health	1.0	1.5	Provided	ODA	Grant	Cross cutting	General environmental protection	Research programme focusing on pollution and reducing its harmful impacts on poor people. DFID funding will improve the current level of knowledge on the links between pollution, human health and livelihoods and associated economic impacts in developing countries. The research will contribute to the development of innovative environmental remediation techniques and technological solutions to reduce levels of air, water and soil pollution in developing countries and mitigate impacts on public health.
Kenya – Strengthening Regional Economic Integration	1.0	1.5	Provided	ODA	Grant	Cross cutting	Transport and storage	To improve the pace of infrastructure development and enhance regional trade competitiveness, by delivering improvement to the managerial capacity and physical layout for cargo handling at the Port of Mombasa, and improved regulatory framework for trade. This will contribute to increased exports and regional trade in East Africa benefitting the regional population.
Strengthening Health Facilities in the Caribbean	1.0	1.5	Provided	ODA	Grant	Cross cutting	General environmental protection	To provide safer, greener health facilities in Belize, Dominica, Grenada, Guyana, Jamaica, St Lucia and Saint Vincent and the Grenadines to deliver care in disasters, generate operational savings and reduce disaster losses.
African Agriculture Technology (AATF) Phase III (2015-2020)	0.9	1.4	Provided	ODA	Grant	Adaptation	Agriculture	The expected impact of support to the proposed intervention is increased productivity of small-holder farmers in Sub-Saharan Africa. This impact will be achieved through two outcomes: a. Increased access/availability of appropriate agricultural technologies for small-holder farmers in targeted countries in Sub-Saharan Africa. b. A financially sustainable organisation/mechanism that is responsive to the needs of small-holder farmers in ensuring that market failures in the development and adoption of appropriate agricultural technologies continue to be addressed.

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Development of Geothermal Energy in Montserrat	0.9	1.4	Provided	ODA	Grant	Mitigation	Energy generation, renewable sources	To support the development of geothermal energy in Montserrat, by undertaking the exploratory drilling and testing of 3 geothermal wells.
UK Support to Increase Resilience to Natural Disasters in Nepal	0.9	1.3	Provided	ODA	Grant	Adaptation	Disaster prevention and preparedness	UK support will build resilience in Nepal by strengthening national systems for disaster risk management and response, increasing community-based earthquake readiness and improving preparedness for a national and international emergency response.
Transparency and Right to Information	0.8	1.2	Provided	ODA	Grant	Adaptation	General environmental protection	To increase transparency and accountability in Bangladesh by improving systems for management and proactive publication of official information that is relevant and accessible, timely and accurate, and by enabling state reformers, businesses and social activists to hold officials and decision makers answerable for their actions across a range of services including health, education, local government, climate finance and land administration.
Creation of the National Fund for Climate & Environment (FONERWA)	0.7	1.1	Provided	ODA	Grant	Cross cutting	General environmental protection	To help the Government of Rwanda achieve low carbon, climate resilient growth by providing technical assistance to help them manage FONERWA – a national fund for environment and climate change. This will help build national capacity for managing the fund by September 2015 and ensure that contributions to the fund are well-spent.
Strategic Climate Change Policy Fund	0.7	1.0	Provided	ODA	Grant	Mitigation	General environmental protection	The purpose of the project is to enable the Government of South Africa to prioritise cost effective and beneficial climate-change mitigation policy measures and interventions that contribute to and support the country's positive deviation from the Green House Gas emission "business as usual trajectory". The purpose of the project is to enable the Government of South Africa to prioritise cost effective and beneficial climate-change mitigation policy measures and interventions that contribute to and support the country's positive deviation from the Green House Gas emission "business as usual trajectory".

Recipient country/region/project/programme	*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, Water and sanitation, Cross-cutting, Other, Not applicable*	
	Domestic currency (£m)	*USD ($m)*						
Multi-Stakeholder Forestry Programme – Nepal	0.6	0.9	Provided	ODA	Grant	Cross cutting	General environmental protection	Nepal's forestry sector contributing to inclusive economic growth, poverty reduction and tackling climate change.
Strengthening knowledge and tools for climate change adaptation	0.6	0.9	Provided	ODA	Grant	Adaptation	General environmental protection	To help people adapt to the impacts of climate by strengthening knowledge on what works best, and to use this knowledge to develop new adaptation programmes and maximise the effectiveness of the UK's International Climate Fund (ICF) and its investments to help over 25 million people in developing countries cope with the impacts of climate change by 2015.
Investments in Forests and Sustainable Land Use	0.5	0.8	Provided	ODA	Grant	Cross cutting	Forestry	To support public-private partnerships that demonstrate how companies, communities, smallholders and governments can work collaboratively to reduce deforestation and benefit forest dependent communities.
CCMCC Promoting cooperation and avoiding conflict in managing the impacts of climate change	0.5	0.8	Provided	ODA	Grant	Cross cutting	General environmental protection	The aim of this project is to maximise benefits to poor people from international climate change finance. It will do this by generating evidence on the links between climate change and its impacts, and the likelihood of such impacts leading to either conflict or collaboration between and within communiteis. It will help find ways for policies and programmes to foster collaborative rather than conflictual approaches to managing the impacts of climate change at local, national and global levels.
Strengthening Emergency Preparedness and Response in Kenya (2014-2018)	0.5	0.7	Provided	ODA	Grant	Adaptation	General environmental protection	To enhance Kenya Red Cross' capacity to prepare and respond to disaster's, through providing a timely and effective response to small and medium disasters; ensuring overall response effectiveness is improved; maintaining the dignity of people affected by disasters in Kenya by providing direct support to over 3,400 men, women and children per year.

Recipient country/region/project/programme	*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, Water and sanitation, Cross-cutting, Other, Not applicable*	
	Domestic currency (£m)	*USD ($m)*						
Initial Design of the Climate Public Private Partnership (CP3)	0.4	0.7	Provided	ODA	Grant	Mitigation	General environmental protection	CP3 aims to demonstrate that climate friendly investments in developing countries, including in renewable energy, water, energy efficiency and forestry are not only ethically right but also commercially viable. It aims to attract new forms of finance such as pension funds and sovereign wealth funds into these areas by creating two commercial private equity funds of funds which will invest in subfunds and projects in developing countries, creating track records of investment performance which should in turn encourage further investments and accelerate the growth of investment in climate.
Multi-Year Humanitarian Support to Afghanistan	0.3	0.5	Provided	ODA	Grant	Cross cutting	Disaster prevention and preparedness	To provide support to the most vulnerable groups in Afghanistan to have access to timely, appropriate and cost-effective humanitarian aid, and have fewer life-critical needs.
CONGO – Improving Livelihoods and Land Use in Congo Basin Forests	0.3	0.5	Provided	ODA	Grant	Cross cutting	Forestry	To improve the the livelihoods of forest dependent communities and reduce deforestation in the Congo Basin by providing support to forest zoning, independent forest monitoring, civil society advocacy and the strengthening of legal frameworks for community forestry, as well as direct investments in community forest enterprises. The programme is expected to benefit 2.4 million beneficiaries (direct and indirect). The programme will also have a demonstration effect, building a body of evidence on Community Forestry in the Congo Basin.
Tanzania Climate Change Institutional Strengthening Programme	0.3	0.5	Provided	ODA	Grant	Cross cutting	General environmental protection	To improve Tanzania's access to climate finance and use it effectively to support climate change resilience and low carbon sustainable growth by securing international climate change funds both from multilaterals and bilaterals and by assessing targets annually which have been set in the National Climate Change Strategy.

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	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, Water and sanitation, Cross-cutting, Other, Not applicable	
	Domestic currency (£m)	USD ($m)						
Adaptation for Smallholder Agricultural Programme (ASAP)	0.3	0.4	Provided	ODA	Grant	Cross cutting	Agriculture	To provide knowledge and best practices to help over 6 million smallholder farmers in up to 43 countries adapt to climate change. Grants will be made to: build small scale water-harvesting, water storage and irrigation systems for farmers; provide farmers with improved seeds that are drought tolerant; help farmers access markets to sell their crops; to plant trees on farms and introduce soil and water conservation practices; and, enable farmers to access daily and seasonal weather forecasts (e.g. using text messages) so they know when best to plant and harvest crops.
Kenya Devolution Support Programme	0.2	0.4	Provided	ODA	Grant	Cross cutting	General environmental protection	The Kenyan Constitution, adopted by referendum in 2010, introduced far reaching devolution to 47 newly-established counties. Hopes are high that devolution will improve accountability and service delivery and contribute to poverty reduction. The purpose of this programme is to build and improve public services for Kenyan citizens, particularly focusing at the county level where poverty exists and where public service delivery is poor. The programme will improve the ability of county governments to better plan, deliver and monitor the delivery of public services. This includes working with county governments to strengthen public financial management systems (e.g. improving accounting, audit and procurement systems) to ensure that public money is effectively spent and can be accounted for. It also includes a focus on critical services for example health. The programme will help county governments to improve planning and allocation of budgets for health services and make sure these budge.
Green Mini-Grids Kenya	0.2	0.4	Provided	ODA	Grant	Cross cutting	Energy generation, renewable sources	Support for project preparation and leveraging of private investment in Green Mini-Grids (GMGs) in Kenya.

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	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, Water and sanitation, Cross-cutting, Other, Not applicable	
	Domestic currency (£m)	USD ($m)						
Building Urban Resilience to Climate Change in Tanzania	0.2	0.3	Provided	ODA	Grant	Adaptation	General environmental protection	To build urban resilience to current climate variability and future climate change in Tanzania's cities and towns through improved data and evidence, urban planning, and infrastructure provision for sustainable economic growth and development.
Renewable Energy and Adaptation Climate Technologies (Africa Climate Change Challenge Fund)	0.2	0.3	Provided	ODA	Grant	Cross cutting	Heating, cooling and energy distribution	To stimulate private sector investment in developing low cost, clean energy and climate change technologies and services, such as solar power, biomass energy, irrigation and crop insurance products for small holder farmers. Every business supported by REACT must demonstrate a positive impact on the rural poor through increased incomes, employment and productivity or by reducing costs. By 2015 REACT will have provided an additional 200,000 people with access to cheaper, cleaner energy technologies.
Adapt Environmental and Climate Resilience in Sudan	0.2	0.3	Provided	ODA	Grant	Adaptation	General environmental protection	To increase understanding and integration of climate resilience and environmental management into delivery, plans and policy in Sudan.
Rapid Response Facility on Climate Change	0.2	0.3	Provided	ODA	Grant	Mitigation	General environmental protection	To influence climate change policy in Indonesia by providing technical expertise to a range of government and non-government partners who are directly responsible or play a role in shaping policies and practices to help Indonesia meet its emission reduction targets.
Low Carbon Studies – research projects to support the development of the International Climate Fund	0.1	0.2	Provided	ODA	Grant	Mitigation	Energy generation, distribution and efficiency – general	This knowledge work will ensure the preparation of evidence based business cases and maximise results from low carbon ICF spend.
Bringing Energy to Off-Grid Households and Businesses (BRILHO) in Mozambique	0.1	0.2	Provided	ODA	Grant	Adaptation	General environmental protection	To increase domestic and business energy access through private sector innovation and investment, and government support, through supply of dispersed off-grid energy solutions and improved cook stoves.

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	Domestic currency (£m)	*USD ($m)*						
Assisting Public Institutions and Markets to Become Resilient to Effects of Climate Change in Tanzania (AIM for Resilience)	0.1	0.2	Provided	ODA	Grant	Cross cutting	General environmental protection	To enable the poorest and most vulnerable in Tanzanian society to become more resilient to climate change and to benefit from low carbon growth through the strengthening of the United Republic of Tanzania Public sector institutions to implement the national climate change strategy and adaptation plans. The programme will also support relevant sector Ministries to implement their sector resilience plans; support to building the capacity of the Tanzania Meteorological Agency to provide meteorological data management and providing efficient services to its customers; and seek to develop sustainable private sector markets. This programme is a central element of the UK International Climate Fund portfolio in Tanzania and will help maximise the return from the wider investments.
Climate Science to Reduce Disasters and Safeguard Investments	0.1	0.2	Provided	ODA	Grant	Adaptation	General environmental protection	a regional partnership in South Asia among the research community, its funders, and users foster a more coordinated and interactive climate research environment that supports good decision making.
Renewable Energy from Forests in the Miombo (REFORM)	0.1	0.2	Provided	ODA	Grant	Cross cutting	General environmental protection	The programme will support livelihoods and build resilience to climate chnage in East and Southern Africa through improved management of the Miombo woodlands.

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	Domestic currency (£m)	*USD ($m)*						
Results Based Financing for Low Carbon Energy Access	0.1	0.2	Provided	ODA	Grant	Cross cutting	Heating, cooling and energy distribution	To increase access to clean energy through the creation of an expanding market of green mini-grid installations in Africa serving rural villages unconnected to the main grid. This is expected to benefit around 1.3m people by 2018, while reducing carbon emissions by around 260,000 Tonnes of carbon dioxide, through supported private investment in the installation and operation of over 110 renewably-powered mini-grids (figures to be updated after Business Case completion). Electricity access for lighting, communications and productive uses creates jobs, enables studying at night and enhances public services (such as clinics) and public safety (eg through streetlighting). This project also addresses the post-2015 High Level Panel's recommendation on a development goal entitled Secure Sustainable Energy, which includes energy access and renewable energyThe Results-Based Financing for Low Carbon Energy Access Programme aims to accelerate access to sustainable energy services in developing countries. The funding generates and tests different forms of Results-Based Financing (RBF) mechanism, which aim to stimulate decentralised energy markets and to leverage private investment to increase access to clean energy products and services.
Flexible Fund – supporting businesses to get renewable energy innovations to scale in developing countries	0.1	0.1	Provided	ODA	Grant	Mitigation	General environmental protection	Facilitating sustainable development and reducing carbon emissions.
Water Security For Growth	0.1	0.1	Provided	ODA	Grant	Adaptation	General environmental protection	To improve water security in Tanzania contributing to economic development, through better water resource management and climate-sensitive infrastructure investment.
Monitoring and Evaluation Support Services-International Climate Fund financing	0.1	0.1	Provided	ODA	Grant	Cross cutting	General environmental protection	DFID (and DECC and DEFRA) for International Climate Fund Programmes can demonstrate robust procedures for monitoring and evaluating value for money across its development programmes.

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	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, Water and sanitation, Cross-cutting, Other, Not applicable	
	Domestic currency (£m)	USD ($m)						
Health and Climate Change	0.1	0.1	Provided	ODA	Grant	Adaptation	General environmental protection	Building resilience and preparedness of public health care systems in Southern Africa to climate change by investing in critical vulnerability assessment, research and evidence on the links between climate change and health, the preparedness and options for response by health care systems.
Increasing renewable energy and energy efficiency in the Eastern Caribbean	0.1	0.1	Provided	ODA	Grant	Cross cutting	General environmental protection	To increase the use of renewable energy and energy efficiency measures and to improve energy security in the Eastern Caribbean.
United Nations Secretary General's Action Agenda on Climate Change-Support in 2012-2014	0.1	0.1	Provided	ODA	Grant	Cross cutting	General environmental protection	Climate Change Support Team delivers its planned workplan and outputs help the Secretary General in making the political space and the essential case for countries to support a Global Legal Agreement by 2015.
Combating Infectious Diseases of Livestock(CIDLID)	0.0	0.1	Provided	ODA	Grant	Adaptation	Agriculture	TO SUPPORT BASIC AND STRATEGIC BIOLOGICAL AND BIOTECHNOLOGICAL RESEARCH IN ANIMAL HEALTH THAT CONTRIBUTES TO THE ACHIEVEMENT OF THE MDGS THROUGH GREATER UNDERSTANDING OF HOW TO COMBAT DISEASES OF DOMESTICATED LIVESTOCK THAT AFFECT THE LIVELIHOODS OF POOR PEOPLE.
Sustainable Urban Economic Development Programme (SUED)	0.0	0.1	Provided	ODA	Grant	Cross cutting	General environmental protection	To promote sustainable economic development that is inclusive of Kenya's urban and peri-urban poor by increasing private and public-private investment in climate resilient urban planning and infrastructure. The programme aims to reduce dependency on climate-sensitive livelihoods – incomes that are most vulnerable to climate change – and to support the diversification of jobs towards rural non-farm economies.
Energy Security and Resource Efficiency in Somaliland	0.0	0.1	Provided	ODA	Grant	Cross cutting	General environmental protection	To support Somaliland in diversifying its energy mix, enhancing resilience and facilitating an enabling institutional and regulatory environment for the expansion of access to electricity.
Strengthening International Waters Cooperation, Management and Development in sub-Saharan Africa	0.0	0.1	Provided	ODA	Grant	Adaptation	General environmental protection	To strengthen regional water security in Africa for sustainable and climate resilient development.

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	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, Water and sanitation, Cross-cutting, Other, Not applicable*	
	Domestic currency (£m)	*USD ($m)*						
Caribbean Renewable Energy and Energy Efficiency Improvement Projects	0.0	0.1	Provided	ODA	Grant	Mitigation	General environmental protection	To improve energy security in the Caribbean by providing access to finance for renewable energy and energy efficiency. This will increase the uptake of renewable energy, reduce fuel import bills and lower the cost of energy for households and businesses.
African Agricultural Technology Foundation (AATF) Phase 2 of DFID Funding, 2010–2013	0.0	0.0	Provided	ODA	Grant	Adaptation	Agriculture	AATF will facilitate public-private partnerships for the transfer, development, production and deployment of agricultural technology. AATF works closely with African farmers, scientists, businesses, NGOs to identify needs of poor farmers and to match these needs with available technologies with the aim of achieving sustainable improvements in agricultural productivity for small holder farmers in Sub Saharan Africa.
Delivering climate resilient Water, Sanitation and Hygiene in Africa and Asia	0.0	0.0	Provided	ODA	Grant	Adaptation	Water and sanitation	The proposed programme will allow us to respond effectively to identified needs and to demonstrate to other funders the types of infrastructural and management interventions that build resilience.
Degraded Land Mapping for Kalimantan and Papua provinces	0.0	0.0	Provided	ODA	Grant	Cross cutting	General environmental protection	To make decision makers (in public and private sector) implement policies to support socially equitable oil palm expansion onto low- carbon degraded land and reduce conversion of forested areas.
Cooperation in International Waters in Africa	0.0	0.0	Provided	ODA	Grant	Adaptation	Administrative costs of donors	To strengthen cooperative management and development of international waters within selected basins.
Building Resilience Through Asset Creation and Enhancement II – South Sudan (ICF Programme)	0.0	0.0	Provided	ODA	Grant	Cross cutting	Developmental food aid/ food security assistance	To reduce hunger gaps, improve long-term food security and mitigate conflict among 400,000 rural poor in five states of South Sudan. By working together for food or cash in return for assets, communities will develop and manage their resources against extreme climate damage and shocks. This will contribute to Sustainable Development Goals 1, 2, 13, 15 and 16 to end poverty and hunger; take action on climate; protect life on land and; promote peaceful and inclusive societies for sustainable development.

Recipient country/region/project/programme	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, Water and sanitation, Cross-cutting, Other, Not applicable	
	Domestic currency (£m)	USD ($m)						
Forest Carbon Partnership Facility-Carbon Fund (FCPF-C)	45.0	68.7	Provided	ODA	Grant	Cross cutting	Forestry policy and administrative management	The FCPF-C is a World Bank administered fund that is helping to build long-term reforms in forested countries that ultimately align incentives clearly towards sustainable forest management.
Reduction of emissions caused from deforestation and forest degradation – REDD+ early movers (REM)	30.4	46.4	Provided	ODA	Grant	Cross cutting	Forestry policy and administrative management	Supporting Colombia's Amazon Vision programme through REM which works with forest nations that have shown they are the most committed and ready to implement ambitious programmes to address deforestation.
Pollution Management and Environmental Health (PMEH)	12.5	19.1	Provided	ODA	Grant	Mitigation	Biosphere protection	Supporting air quality monitoring and promoting increased action to mitigate air pollution in developing countries.
Strategic Technical Assistance – Asian Development Bank Clean Energy Fund	5.0	7.6	Provided	ODA	Grant	Mitigation	Energy generation and supply	Supporting developing countries to build capacity for making large scale energy efficiency and renewables investments.
UK Climate Investments (UKCI)	3.2	4.9	Provided	ODA	Grant	Mitigation	Energy generation and supply	Joint venture with the UK Green Investment Bank to make equity investments in private sector renewable and energy efficiency projects in developing countries.
Renewable Energy Performance Platform (REPP)	2.8	4.3	Provided	ODA	Grant	Mitigation	Energy generation and supply	Supporting private sector investment in small to medium scale renewable energy projects, primarily in Africa.
CP3 – Asia Climate Partners	2.5	3.9	Provided	ODA	Equity	Mitigation	Energy generation and supply	An equity investment in a fund that seeks to demonstrate to private sector investors that climate friendly investments in developing countries are financially viable.
International 2050 Pathways partnerships	0.8	1.2	Provided	ODA	Grant	Mitigation	Energy research	Working directly with 10 developing country governments to help them build their own version of the UK's 2050 calculator. The calculator will also be developed to explore global scenarios, illustrating the impacts of these scenarios on climate change.
Due dilgence costs for International Climate Fund (ICF) spend	0.7	1.1	Provided	ODA	Grant	Cross cutting	Energy policy and administrative management	Expenditure on external legal advice, evaluation and auditing services to support programme spend through the ICF.

Recipient country/region/project/programme	*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, Water and sanitation, Cross-cutting, Other, Not applicable*	
	Domestic currency (£m)	*USD ($m)*						
Eco.Business Fund	20.0	30.5	Provided	ODA	Grant	Cross cutting	Agriculture and Forestry	Eco.Business fund – The eco.business Fund is structured as a public-private partnership (PPP). The eco.business Fund vision is the preservation and promotion of biodiversity through private enterprises in Latin America and the Caribbean.
FCO Prosperity Fund	12.7	19.4	provided	ODA	Grant	Cross-cutting	Environmental policy and administrative management	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.
Negative ODA flow	-7.7	-11.8	Provided	ODA	Returned money	Cross cutting	Forestry	A number of projects have returned ODA, until this money is respent is counts as negative ODA which we have recorded against the appropriate themes.
Negative ODA flow	-0.2	-0.4	Provided	ODA	Returned money	Adaptation	General environmental protection	A number of projects have returned ODA, until this money is respent is counts as negative ODA which we have recorded against the appropriate themes.
Negative ODA flow	-1.3	-1.9	Provided	ODA	Returned money	Adaptation	Water and sanitation	A number of projects have returned ODA, until this money is respent is counts as negative ODA which we have recorded against the appropriate themes.
Negative ODA flow	-1.4	-2.2	Provided	ODA	Returned money	Adaptation	General environmental protection	A number of projects have returned ODA, until this money is respent is counts as negative ODA which we have recorded against the appropriate themes.
Total contributions through bilateral, regional and other channels	**765.7**	**1168.9**						

Note
Monetary figures are rounded to the nearest (£/$)100,000.

Table 7b
Provision of public financial support: contribution through bilateral, regional and other channels 2016

Recipient country/region/project/programme	*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, Water and sanitation, Cross-cutting, Other, Not applicable*	
	Domestic currency (£m)	*USD ($m)*						
Productive Safety Net Programme Phase 4	58.3	78.6	Provided	ODA	Grant	Adaptation	Other social infrastructure and services	To reduce hunger, improve livelihoods and reduce the risk of famine in rural Ethiopia by (i) providing cash and food transfers, livelihoods advice and access to microfinance to 1.2 million extremely poor Ethiopians and (ii) creating local infrastructure which reverses environmental degradation and improves access to markets and basic services. 85% of participant households receive transfers as wages for labour on public works projects (including 32,000 km of hillside terraces, 3,000 km of rural roads and 400 new or expanded schools); while the remainder (the elderly, those with disabilities, and pregnant women) receive cash and/or food without a labour requirement. This programme contributes towards national and international development goals and DFID's own targets for reducing poverty and hunger and for building household resilience to climate change and other shocks.
Building Resilience and Adaptation to Climate Extremes and Disasters	30.6	41.3	Provided	ODA	Grant	Adaptation	General environmental protection	To help up to 10 million people, especially women and children, in developing countries cope with extreme climate and weather events such as droughts, cyclones and floods (climate extremes). This will be achieved by doing three things. By making grants to civil society organisations to scale up proven technologies and practices in the Sahel, sub-Saharan Africa and South Asia that help people withstand, and more quickly recover, from climate extremes. By identifying the best ways of doing this, and share this knowledge globally to increase the programme's overall impact. By supporting national governments to strengthen their policies and actions to respond to climate extremes. These will all contribute to the Millennium Development Goals on the eradication poverty and hunger, and environmental sustainability, and also respond to the Humanitarian and Emergency Response Review recommendation that DFID should integrate the threat from climate change into a Disaster Risk Reduction.

Recipient country/region/project/programme	*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, Water and sanitation, Cross-cutting, Other, Not applicable*	
	Domestic currency (£m)	*USD ($m)*						
Providing Humanitarian Assistance in Sahel Emergencies (PHASE)	17.9	24.2	Provided	ODA	Grant	Adaptation	General environmental protection	To provide humanitarian assistance to vulnerable people in the Sahel and help them to cope with future disasters, including strengthening early-warning mechanisms and disaster preparedness. This will be linked to the seasonal calendar and work alongside longer-term resilience programmes to reduce the long term demand for humanitarian assistance in the Sahel, and will be delivered through NGO and multilateral partners.
Africa Division funding to the African Agriculture Development Company (AgDevCo)	16.8	22.7	Provided	ODA	Grant	Adaptation	Agriculture	To evaluate and improve AgDevCo's facility to leverage private sector investment in Africa agribusiness and agricultural infrastructure. This includes increasing clean renewable energy capacity enabling climate change resilience and stimulating cross border trade in targeted countries, which will generate jobs and income for smallholder farmers and women. The evaluation is also to ensure accountability, demonstrate how funds are spent, and ensure value for money of DFID investments in AgDevCo by 2020.To support poverty reduction and increased food security through catalysing additional private sector investment in agribusiness and agricultural infrastructure and increasing agricultural cross border trade in targeted countries, generating jobs and income for smallholders.
Building Resilience in the Sahel through Adaptive Social Protection	15.4	20.8	Provided	ODA	Grant	Adaptation	Other social infrastructure and services	Build the evidence and justification for adaptive social protection in the Sahel by establishing national level systems that will build the resilience of vulnerable populations to climate change and can be scaled in a time of crisis.
Enhancing resilience in Karamoja Uganda	14.4	19.5	Provided	ODA	Grant	Adaptation	Agriculture	To increase the resilience of targeted communities to climate extremes and weather events. The programme will support 700,000 people to cope with the effects of climate change, this includes: 200,000 people with improved food security through participation in public works programmes; 6,000 agro-pastoralists and pastoralists with access to improved animal nutrition; and 175,000 children under five and pregnant and lactating women treated for malnutrition and with improved access to water by March 2017.

Recipient country/region/project/programme	*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, Water and sanitation, Cross-cutting, Other, Not applicable*	
	Domestic currency (£m)	*USD ($m)*						
Hunger Safety Net Programme	12.6	17.0	Provided	ODA	Grant	Adaptation	General environmental protection	To reduce poverty, hunger and vulnerability by providing the poorest households in Kenya's arid and semi-arid lands with cash transfers including in response to climate shocks such as droughts. This contributes to our MDGs by preventing 720,000 people from becoming poorer and help them to increase their expenditure on food, health, education and wider livelihood opportunities by 2017.
Strategic Partnership Arrangement II between DFID and BRAC	8.5	11.5	Provided	ODA	Grant	Adaptation	Basic education	To provide support to BRAC's development programmes to improve access to quality basic services (health, education, water and sanitation), help the poorest, most marginalised people across the whole of Bangladesh graduate from extreme poverty, support inclusive growth and help build effective formal and informal institutions. Climate finance will be integrated across BRAC's programmes to strengthen the resilience of BRAC's investments and the communities they serve. UK support will include: helping over 950,000 children (600,000 girls) gain a decent education; providing additional nutritional support to 11 million people (7 million women and girls); helping 5.7 million girls and women gain access to family planning services; providing at least 75,000 people with sustainable access to clean water and sanitation; supporting over 80,000 women to better cope with the effects of climate change; and lifting 240,000 women and their families (over 960,000 people) out of extreme poverty.
Livelihoods and Food Security Trust Fund for Burma (NUTSEM)	8.0	10.8	Provided	ODA	Grant	Adaptation	Agriculture	To increase food availability and incomes of 1–1.5 million target beneficiariesTo increase livelihoods' resilience and nutrition of 2.5 million peopleTo improve the incomes and nutrition status of over 1.63 million poor people in Burma by promoting resilient livelihoods and food security food security through agricultural commercialisation and climate smart agriculture, financial inclusion, business and skills development, and targeted nutrition support to mothers and children in the 'One thousand day' window between conception and a child's second birthday.

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Improving Rural Access in Tanzania	7.8	10.5	Provided	ODA	Grant	Adaptation	Transport and storage	To provide support to the local government infrastructure development by improving access to markets by reducing transport costs. This includes building more climate resilient structures to restore access for vulnerable communities, cut off by extreme weather events, and the development of National Guidelines for climate resilient rural roads and structures. This will lead to an increase in rural income to 45,000 households by 2015. This contributes towards MDG by providing agricultural growth and underpinning strong economic development in Tanzania.
South Asia Water Governance Programme (SAWGP)	6.9	9.3	Provided	ODA	Grant	Adaptation	Water and sanitation	To improve the management of water within and between South Asian countries, reducing poverty by enabling adaptation to climate change and reducing the risk of conflict over water resources. By 2018, 500 million people living in river basins will benefit from improved water management by reducing their risk of exposure to flooding and drought and enhancing regional security by improving cooperation between governments.
Multi-Year Humanitarian Programme in Pakistan	6.6	8.9	Provided	ODA	Grant	Adaptation	General environmental protection	Support for up to three million of the most vulnerable people affected by natural disaster and conflict. This will cover both immediate relief and early recovery interventions for shelter, food, non-food items, water and sanitation, livelihood and protection needs, depending on the emergency, including enhancing resilience of the beneficiary communities to climate extremes such as floods and droughts. This programme will also support developments in the UN and local civil society which are required for humanitarian responses to be more locally owned and effective in future, as well as effective monitoring and evaluation, targeted active research and piloting.

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Building Resilience Through Asset Creation and Enhancement II – South Sudan (ICF Programme)	6.1	8.3	Provided	ODA	Grant	Adaptation	Developmental food aid/ food security assistance	To reduce hunger gaps, improve long-term food security and mitigate conflict among 400,000 rural poor in five states of South Sudan. By working together beneficiaries earn food or cash in return for identifying and building community assets (such as irrigation ponds). This enables communities to develop and manage their resources against extreme climate damage and shocks. This will contribute to Sustainable Development Goals 1, 2, 13, 15 and 16 to end poverty and hunger; take action on climate; protect life on land and; promote peaceful and inclusive societies for sustainable development.
Climate Proofing Growth and Development in South Asia	6.0	8.1	Provided	ODA	Grant	Adaptation	Government and civil society, general	Integrate climate change into development planning, budgeting and delivery in national and sub-national governments in Afghanistan, India, Nepal and Pakistan.This will done by strengthening planning, budgeting, delivery mechanisms, building awareness and capacity of stakeholders through technical and some implementation support. It will help to mobilise domestic and International finance. Sharing lesssons and knowledge in South Asia is a key element of the project.
Nepal Local Governance Support Programme	5.4	7.3	Provided	ODA	Grant	Adaptation	General environmental protection	To improve governance and services at the local level in Nepal, benefitting 2 million households. This includes introducing simple anti-corruption measures (e.g. public audits) and providing the poorest and most excluded with tools to build their confidence to voice demands and hold officials to account. Parts of the programme will also ensure that Local Government's awareness and capacity on climate change adaptation, disaster resilience and environmentally friendly governance is improved.
The Water Security Programme	5.0	6.7	Provided	ODA	Grant	Adaptation	General environmental protection	To increase the resilience of poor people to climate change through secure and sustainable access to water resources. We will work with the Global Water Partnership, World Bank Water Partnership Programme and GIZ International Water Stewardship Programme to support increased investment in the information, institutions and infrastructure required to deliver water security.

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Rural Access Programme 3	4.7	6.3	Provided	ODA	Grant	Adaptation	Transport and storage	To improve road access for 800,000 members of rural communities in the Western Region of Nepal, thereby improving economic opportunities and increasing access to markets and social services throughout the year. The project will lift 20,000 people out of poverty through access to work, skill trainings, and will promote equal opportunities for women. The project aims to contribute towards sustainable poverty reduction through investments in high value crops and will lay the foundations for private sector led development in the poorest region in the country. At least £6 million will be accounted for as International Climate Fund (ICF) finance, and will focus on scaling up social protection for highly climate-affected people in the Karnali region.
Cooperation in International Waters in Africa	4.5	6.1	Provided	ODA	Grant	Adaptation	General environmental protection	To Strengthen cooperative management and development of international waters in Sub-Saharan Africa to facilitate sustainable, climate resillent growth.
Nepal Climate Change Support Programme	4.3	5.7	Provided	ODA	Grant	Adaptation	General environmental protection	To build capacity of the Government of Nepal to develop, cost, budget and implement adaptation measures at the local level aimed at mainstreaming climate change in key development sectors (agriculture, forestry, water and energy), including through public private partnerships.
Promoting Conservation Agriculture in Zambia	3.7	5.0	Provided	ODA	Grant	Adaptation	Agriculture	To raise agricultural productivity in Zambia, particularly small scale farmers, using climate smart agriculture techniques and facilitating commercial relationships with agriculture companies.
Burma Humanitarian Assistance and Resilience Programme	2.9	3.9	Provided	ODA	Grant	Adaptation	Water and sanitation	To save lives, reduce poverty and suffering of 400,000 crisis affected people in Burma and Burmese refugees in Thailand through providing humanitarian assistance, enhancing resilience and building local and international organisations' capacity to respond to future humanitarian need in Burma. Longer term work on resilience and vulnerability will assist people to cope with shocks and stresses that will include climate-related shocks.

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Southern Agriculture Growth Corridor Programme in Tanzania	2.8	3.8	Provided	ODA	Grant	Adaptation	Transport and storage	To raise rural incomes and increase food security by contributing to the improvements in the business environment for commercial agriculture in Tanzania (especially the southern corridor), as well as growth in number and scale of commercial agribusinesses and substantial improvement in the market operations of a number of agricultural commodity markets. This includes ensuring infrastructure is climate resilient, such as no weather-related road closures. The programme is expected to benefit 100,000 rural households by March 2015 and over 230,000 households by end of the Programme in 2017.
Water, Environmental Sanitation and Hygiene Programme	2.8	3.8	Provided	ODA	Grant	Adaptation	Water and sanitation	To provide sanitation and hygiene services in Freetown. Establishing and expanding sustainable waste management services in three large towns and improving water, sanitation and hygiene services in rural areas and in two small towns. Includes increasing water security and building resilience to future water scarcity as a result of climate change.
Social Protection Support to the Poorest in Rwanda	2.8	3.7	Provided	ODA	Grant	Adaptation	Health, general	To increase the coverage of social protection and to strengthen social protection systems for the poorest by providing financial aid to the Rwanda Local Development Support Fund (RLDSF) and technical assistance to RLDSF and the Ministry of Local Government. This will benefit an additional 55,000 poor households (approximately 217,680 individuals) each year with social cash transfers, helping them to meet their basic needs and to better manage risks such as natural disasters e.g. floods and landslides which will be exacerbated by climate change.
Post-Earthquake Reconstruction Programme in Nepal – Building Back better	2.7	3.6	Provided	ODA	Grant	Adaptation	Other social infrastructure and services	Establish partnerships with local & central government, communities and businesses to support the (i) districts effected by the Earthquake “build back better” including leading to more resilient (including climate resilient) infrastructure and institutions; (ii) the most vulnerable recover their livelihoods and assets; and (iii) the Government of Nepal to plan for and manage the response to the earthquake.

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Pacific Catastrophe Risk Assessment and Financing Initiative	2.5	3.4	Provided	ODA	Grant	Adaptation	Banking and financial services	To provide technical assistance and capital to provide insurance for the Pacific Islands so in future they can protect themselves against natural disasters such as cyclones and Tsunamis thereby reducing their reliance on humanitarian aid. The nations of Tonga, Marshall islands, Cook Islands, Vanuatu, and Samoa (625,000 people in total) will benefit from the insurance at the start of the programme.
Building adaptation to climate change in health through resilient water, sanitation & hygiene	2.3	3.1	Provided	ODA	Grant	Adaptation	Water and sanitation	To support the development of effective plans for climate change adaptation in the health sector in low and low-middle income countries. This project will involve both work at an international level to develop guidance with country level pilot projects focused on water, sanitation and hygiene to test and demonstrate practical examples of adaptation in the health sector.
Research Programme Consortium on Leveraging Agriculture for Nutrition in South Asia (LANSA)	1.9	2.5	Provided	ODA	Grant	Adaptation	Health, general	The purpose of this research programme is to answer the question “how can South Asian agriculture and related food security policies and interventions best be designed and implemented to increase their impacts on nutrition, especially the nutrition status of children and adolescent girls”? This programme will contribute to the acceleration in reductions in poverty and under nutrition of women and children by generating a body of high quality evidence in this area, working closely with policy makers and programme decision makers in the region to get this evidence into use in making agriculture pro poor and pro nutrition and supporting development of climate resilient agriculture. Work is undertaken in four countries with high levels of malnutrition: Afghanistan, Bangladesh, India and Pakistan.

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'Pakistan National Cash Transfers Programme'	1.9	2.5	Provided	ODA	Grant	Adaptation	General environmental protection	To reduce poverty and improve living standards and educational attainment in the poorest families by providing regular payments to the female head of household. This includes reducing vulnerability to shocks such as flooding due to climate change. 315,000 additional beneficiary families will benefit by 2020. This programme will contribute to 1.05 million primary school children being supported in school and directly contribute to Millennium Development Goals 1: Eradicating extreme poverty and hunger; and Millennium Development Goals 2: Achieve universal primary education.
Direct Response through Emergency Cash Transfers	1.4	1.9	Provided	ODA	Grant	Adaptation	Other social infrastructure and services	To provide financial grants to food insecure households with children under the age of two that are affected by effects of climate change so as to enable them access basic services (food, water, clothing) to cushion the impact until 2018.
Adapt Environmental and Climate Resilience in Sudan	1.4	1.9	Provided	ODA	Grant	Adaptation	General environmental protection	To increase understanding and integration of climate resilience and environmental management into delivery, plans and policy in Sudan.
African Risk Capacity (ARC)	1.4	1.9	Provided	ODA	Grant	Adaptation	Disaster prevention and preparedness	To support a parametric (index-based) weather risk insurance pool that will provide participating African countries with predictable, quick-disbursing funds with which to implement pre-defined contingency response plans in the case of a drought.

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African Agriculture Technology Foundation (AATF) Phase III (2015-2020)	1.4	1.8	Provided	ODA	Grant	Adaptation	General environmental protection	The expected impact of support to the proposed intervention is increased productivity of small-holder farmers in Sub-Saharan Africa, including scaling up of crops resilient to climate shocks such as drought. This impact will be achieved through two outcomes: a. Increased access/availability of appropriate agricultural technologies for small-holder farmers in targeted countries in Sub-Saharan Africa. b. A financially sustainable organisation/mechanism that is responsive to the needs of small-holder farmers in ensuring that market failures in the development and adoption of appropriate agricultural technologies continue to be addressed.
Building Urban Resilience to Climate Change in Tanzania	1.3	1.8	Provided	ODA	Grant	Adaptation	General environmental protection	To build urban resilience to current climate variability and future climate change in Tanzania's cities and towns through improved data and evidence, urban planning, and infrastructure provision for sustainable economic growth and development.
Building Disaster Resilience in Pakistan	1.3	1.7	Provided	ODA	Grant	Adaptation	General environmental protection	DFID support will strengthen community and household resilience to emergencies and disasters over six years. The programme will aim to build resilience in communities and households in Pakistan to manage the impact of disasters by maintaining or transforming living standards in the face of shocks and stresses without compromising their long-term prospects.
Care Adaptation Learning Programme	1.0	1.4	Provided	ODA	Grant	Adaptation	Agriculture	Community based adaptation approaches for vulnerable communities incorporated into development policies and programmes in Ghana, Kenya, Mozambique and Niger with plans to replicate across Africa. Including, specifically, to increase the capacity of vulnerable households in sub-Saharan Africa to adapt to climate variability and change.

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Transparency and Right to Information	0.7	0.9	Provided	ODA	Grant	Adaptation	General environmental protection	To increase transparency and accountability in Bangladesh by improving systems for management and proactive publication of official information that is relevant and accessible, timely and accurate, and by enabling state reformers, businesses and social activists to hold officials and decision makers answerable for their actions across a range of services including health, education, local government, climate finance and land administration.
Transboundary Water Management in Southern Africa	0.6	0.9	Provided	ODA	Grant	Adaptation	Water and sanitation	The project will support countries in Southern Africa to manage their shared water resources, thereby helping 2–3 million poor people better able to cope with the impacts of existing climate variability and climate change (especially floods and drought). It will do this by designing and building water infrastructure such as irrigation schemes, water supply systems and water storage schemes. This will help poor and vulnerable people gain access to clean and safe water, produce a predictable agricultural yield and store water for when it is needed during the dry months of the year. The programme will also help countries to communicate hydrological data between themselves – thus providing downstream countries with advance notice of floods and enabling countries to optimise how much water is stored in each country to ensure each has enough to meet their basic requirements.
Disaster Risk Insurance	0.5	0.7	Provided	ODA	Grant	Adaptation	Banking and financial services	To improve the resilience of the private sector in poor countries to natural disasters by improving access to insurance products. By supporting the development of a market for private sector disaster risk insurance in developing countries, the project will sustainably help strengthen resilience, mitigate the effects of climate change and supporting economic development through private sector growth.
Sustainable Crop Production Research for International Development (SCPRID)	0.3	0.3	Provided	ODA	Grant	Adaptation	Agriculture	The purpose of the project is to develop new science and technology to support the development of new crop varieties with more resistance and less vulnerability to biotic and abiotic shocks which will result from new and emerging crop pests and diseases, and climate change and water stress.

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UK Support to Access to Finance Rwanda (AFR) Phase II Operations (2016–2020)	0.3	0.3	Provided	ODA	Grant	Adaptation	Banking and financial services	To support a deeper and more inclusive financial sector that supports the livelihoods and well-being of low income people in Rwanda. This will be done by: (1) Supporting the capacity and systems development of financial service providers that serve the poor, with a specific focus on automating the operations of Rwanda's Umurenge Savings and Credit Cooperatives (SACCOs) and their connectivity to microfinancial institutions and commercial banks; (2) Supporting the flow of financial services to the agriculture sector; (3) Supporting the development of pensions for informal sector workers to promote long term savings; and (4) Supporting improved resilience to shocks whilst reducing the risks associated with productive investments through the utilisation of microinsurance. AFR targets to enhance livelihood opportunities for 1,670,000 poor women and men during the period 2016–2020.
UK Support to Increase Resilience to Natural Disasters in Nepal	0.2	0.3	Provided	ODA	Grant	Adaptation	Disaster prevention and preparedness	UK support will build resilience in Nepal by strengthening national systems for disaster risk management and response, increasing community-based earthquake readiness and improving preparedness for a national and international emergency response.

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Infrastructure for Climate Resilient Growth in India	0.2	0.3	Provided	ODA	Grant	Adaptation	General environmental protection	In line with the UK government's aid policy and revised development partnership with India, the Infrastructure for Climate Resilient Growth (ICRG) programme sees the UK provide world class expertise to improve the impact of the Indian Government's $5 billion per year National Rural Employment Guarantee Scheme. The scheme will help over 5 million people living in three of India's poorest states – Odisha, Chhattisgarh and Bihar – to increase their incomes and resilience to climate shocks. It guarantees 40 million households per year the opportunity to build small scale works (irrigation, flood defences, forest plantations etc.) to increase their incomes and protect themselves from extreme weather events. UK support will improve the design and quality of infrastructure built, increase the capacity of the government to deliver its own programmes and influence the policies of the largest programme of this type in the world.
Delivering climate resilient Water, Sanitation and Hygiene in Africa and Asia	0.1	0.2	Provided	ODA	Grant	Adaptation	Water and sanitation	The proposed programme will allow us to respond effectively to identified needs and to demonstrate to other funders the types of infrastructural and management interventions that build resilience.
Sustainable Inclusive Livelihoods through Tea Production in Rwanda	0.1	0.1	Provided	ODA	Grant	Adaptation	Trade policy and regulations and trade-related adjustment	The project purpose is to support job creation and increase incomes by working with smallholder farmers to develop greenfield tea. The Wood Foundation Africa (TWFA) will set up and run a Services Company supporting approximately 6,000 smallholder tea farmers over 3,400 hectares. These farmers will be supported to produce tea for the first time, employing best farming practices including understanding and managing climate risk and variability. The Services Company will be co-owned by the farmers. This will lead to improved incomes and livelihoods (in particular nutrition and education) for the farmers and their families. Unilever will build a factory and develop a core estate of approximately 817 hectares. The factory will be supplied by the core estate and the smallholder farmers supported by The Wood Foundation Africa.

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Managing Climate Risks for Urban Poor	0.1	0.1	Provided	ODA	Grant	Adaptation	Other multisector	This programme will help cities plan for and invest in reducing the impacts of weather-related changes and extreme events, through a partnership with the Rockefeller foundation and the Asian Development Bank, on 2 million urban poor and vulnerable people in 25 medium-sized cities in 6 Asian countries (initially Pakistan, Bangladesh, India, Vietnam, Indonesia) by improving planning processes so that they consider climate change risks, for developing and funding new investment and infrastructure opportunities, and for knowledge and lesson sharing by 2018.
Strengthening knowledge and tools for climate change adaptation	0.1	0.1	Provided	ODA	Grant	Adaptation	General environmental protection	To help people adapt to the impacts of climate by strengthening knowledge on what works best, and to use this knowledge to develop new adaptation programmes and maximise the effectiveness of the UK's International Climate Fund (ICF) and its investments to help over 25 million people in developing countries cope with the impacts of climate change.
Zambia Health Systems Strengthening Programme	0.1	0.1	Provided	ODA	Grant	Adaptation	Population policies/ programmes and reproductive health	To improve health of women and girls in Zambia across the continuum of care from adolescence, delivery, newborn and care of the under 5 child; this together with our other parallel interventions will by 2020 result in a drop in maternal mortality ratio, a drop in neonatal mortality and an increase in contraceptive prevalence in districts supported by DFID. This intervention will contribute to the achievement of MDGs 4 & 5 and will ensure that Zambia is able to prevent, detect, and raise a comprehensive response to disease outbreaks and the effects of climate change.
BRILHO – Energy Africa Mozambique	0.1	0.1	Provided	ODA	Grant	Adaptation	General environmental protection	To increase domestic and business energy access through private sector innovation and investment, and government support, through supply of dispersed off-grid energy solutions and improved cook stoves.
Strengthening International Waters Cooperation, Management and Development in sub-Saharan Africa	0.0	0.0	Provided	ODA	Grant	Adaptation	General environmental protection	To strengthen regional water security in Africa for sustainable and climate resilient development.

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Water Security For Growth	0.0	0.0	Provided	ODA	Grant	Adaptation	General environmental protection	To improve water security in Tanzania contributing to economic development, through better water resource management and climate-sensitive infrastructure investment.
CDC Programme of Support in Africa and South Asia (2015-2018)	75.8	102.3	Provided	ODA	Equity	Cross cutting	Banking and financial services	To enable CDC to scale up its activity of investing and lending to support the building of businesses in developing countries, to create jobs and make a lasting difference to people's lives in some of the world's poorest places. CDC is DFID's main vehicle for investing in private companies in Africa and South Asia. CDC encourages capital investments, including in climate change mitigation and adaptation measures, from other private investors by being a first mover, demonstrating to other investors that commercial returns are possible in these frontier markets, and by sharing risk and expertise. The additional equity from DFID will enable CDC to meet demand for capital in its target markets and allow CDC to sustain a higher volume of more developmental investments across priority regions and business sectors.
Forest Governance, Markets and Climate	30.1	40.6	Provided	ODA	Grant	Cross cutting	Forestry	A global programme supporting governance and market reforms aimed at reducing the illegal use of forest resources, benefitting poor forest-dependent people and promoting sustainable growth in developing countries.
UK Caribbean Infrastructure Fund	21.6	29.1	Provided	ODA	Grant	Cross cutting	Transport and storage	As announced by the UK government in September 2015, the UK Caribbean Infrastructure Fund will create critical economic infrastructure including: bridges; renewable energy; ports; water; and sea defences that will increase productivity and resilience to natural disasters and climate change. This fund aims to improve economic development in 8 ODA eligible and 1 ODA eligible Overseas Territory by helping to boost growth and creating jobs across the region.
Support to the Global Agriculture and Food Security Programme (GAFSP)	15.4	20.8	Provided	ODA	Grant	Cross cutting	Agriculture	To improve agricultural productivity in developing countries (including development of more sustainable and climate resilient agriculture) and to increase farmers' access to markets whilst increasing the economic resilience of poor people globally.

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Climate Smart Agriculture in Africa	10.0	13.5	Provided	ODA	Grant	Cross cutting	General environmental protection	Improved knowledge, policies and longer-term incentives to drive increased uptake of Climate Smart Agriculture (CSA) in Eastern and Southern Africa member states.
Investments in Forests and Sustainable Land Use	7.5	10.1	Provided	ODA	Grant	Cross cutting	Forestry	To support public-private partnerships that demonstrate how companies, communities, smallholders and governments can work collaboratively to reduce deforestation and benefit forest dependent communities.
Scaling up of the Energy and Environment Partnership with Southern and East Africa	7.5	10.1	Provided	ODA	Grant	Cross cutting	General environmental protection	Greater access to clean energy services achieved through fast tracking of renewable energy project demonstration and deployment, including through technology learning, donor coordination and private sector investment.
International Forestry Knowledge (KnowFor)	7.0	9.5	Provided	ODA	Grant	Cross cutting	Forestry	Uptake of international forestry knowledge, evidence and tools for international forestry policy and practice.
Sustainable Energy for Women and Girls (SEWG)	7.0	9.4	Provided	ODA	Grant	Cross cutting	General environmental protection	Programme aims to shift clean energy markets and delivery systems towards improving the health, safety and economic opportunities of low income girls and women in developing countries, principally in DFID and International Climate Fund (ICF) priority countries in Africa.
Climate and Development Knowledge Network	6.7	9.1	Provided	ODA	Grant	Cross cutting	General environmental protection	To improve access for developing countries to high quality research and information in designing climate change policies and programmes by 2015.
CDKN – Climate and Development Knowledge Network	6.6	8.9	Provided	ODA	Grant	Cross cutting	General environmental protection	The purpose is that developing countries have improved access to high quality research and information in designing climate change policies and programmes by 2015.

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Regional Transboundary Water Resources Programme – Phase 3	6.5	8.7	Provided	ODA	Grant	Cross cutting	General environmental protection	To improve governance of shared water resources in Southern Africa, by sustainably improving local water-management capability (helping to manage current and future climate risks of extreme flood and drought events) and supporting development of key water infrastructure. This will indirectly benefit populations in the 13 shared river basins of the SADC region, in which 95 million people reside, through more equitable sharing of water resources, reduced vulnerability to flooding, improved access to drinking water, as well as reducing risk of conflict and better food security. These outcomes will contribute to MDG 1 ("Eradicate Extreme Poverty and Hunger") and MDG7 ("Ensure Environmental Sustainability").
Kenya – Strengthening Regional Economic Integration	5.8	7.8	Provided	ODA	Grant	Cross cutting	Transport and storage	To improve the pace of infrastructure development and enhance regional trade competitiveness, by delivering improvement to the managerial capacity and physical layout for cargo handling at the Port of Mombasa, including climate resilient infrastructure and lower emission transport systems, and improved regulatory framework for trade. This will contribute to increased exports and regional trade in East Africa benefitting the regional population.
Strengthening Adaptation and Resilience to Climate Change in Kenya Plus (StARCK+)	5.4	7.3	Provided	ODA	Grant	Cross cutting	General environmental protection	To achieve transformational change by helping Kenya to scale up private sector innovation and investment in low carbon and adaptation products, services and assets (e.g. clean energy, sustainable agriculture, water management, weather forecasting). Enabling this change will require targeted support to critical aspects of climate change governance, and stimulation of civil society demand. This contributes to the UK Government's International Climate Fund (ICF) commitments and will benefit 828,000 people able to cope with the effects of climate change and 17,600 people with improved access to clean energy.

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Kenya Market Assistance Programme (MAP)	4.9	6.7	Provided	ODA	Grant	Cross cutting	Industry	To reduce poverty in Kenya by enabling poor people to benefit from better functioning markets, including through mainstreaming climate resilience into market interventions, and by building greater awareness among influential decision makers of how markets can work better for the poor. This will increase household incomes of 148,000 small scale farmers and entrepreneurs – of whom 33% are women – by an average of over 20% by 2018. 36,000 jobs for women and 73,000 for men and male youth will also be created.
WISER – Weather and climate Information and SERvices for Africa	4.4	5.9	Provided	ODA	Grant	Cross cutting	General environmental protection	WISER will help at least 24 million people across Africa (focusing initially on East Africa (Ethiopia, Kenya, Tanzania, Uganda, Rwanda and Burundi) to be more resilient to natural disasters and climate change by 2030 by improving early warning systems (giving more time to prepare for heavy rains for example) as well as helping them make better decisions by knowing what the weather and climate is likely to be (enabling them to make better crop choices or alter planting times in farming, for example). We estimate that this will save over £190 million in terms of avoided damage to health, homes, livelihoods and infrastructure between now and 2030. The WISER programme will initially benefit the East African fishing and farming communities, as well as a wide range of African people, including young, old, men and boys and women and girls.
Northern Uganda: Transforming the Economy through Climate Smart Agribusiness (NU-TEC)	4.2	5.7	Provided	ODA	Grant	Cross cutting	Agriculture	To increase the resilience to climate change of poor farmers in Northern Uganda, and to increase their incomes. This will be achieved by working with agricultural businesses to supply farmers with cheaper, better and more varied agricultural inputs and services, and to create stronger markets for farmer produce. This will benefit 250,000 households in Northern Uganda, who will adopt new practices, products and markets that will make them more resilient to climate change, while 150,000 households will see measurable increases to income. This will contribute to the MDGs (and their successor targets) by reducing poverty in Uganda.

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Green Mini-Grids Africa Regional Facility for Market Preparation, Evidence and Policy Development	3.8	5.2	Provided	ODA	Grant	Cross cutting	General environmental protection	The Green Mini-Grids regional facility will improve policy, evidence and market conditions to increase investment in green mini-grids across Africa.
Programme of Support to Agriculture in Rwanda	3.8	5.1	Provided	ODA	Grant	Cross cutting	Agriculture	To sustainably increase the agricultural productivity of poor farmers by transforming Rwandan agriculture from a subsistence-based to a more commercial-based sector that accelerates agricultural growth. This will help address challenges that may limit agriculture productivity, reduce the rate at which poverty is falling, increase inequality and hamper improvements in food security and malnutrition. The programme will build resilience to climate variability and improve sustainable management of agricultural land by increasing soil erosion control, small scale irrigation and strengthening sustainability and resilience strategies. The programme will result in increased agricultural productivity, food security and incomes of poor households and contributes towards the MDG's by helping to eradicate extreme poverty and hunger and; promoting gender equality and empowering women.
Strengthening Health Facilities in the Caribbean	3.7	5.0	Provided	ODA	Grant	Cross cutting	Health, general	To provide safer, greener health facilities in Belize, Dominica, Grenada, Guyana, Jamaica, St Lucia and Saint Vincent and the Grenadines to deliver care in disasters, generate operational savings and reduce disaster losses.
ESPA – Eco System Services for Poverty Alleviation	3.4	4.6	Provided	ODA	Grant	Cross cutting	General environmental protection	To understand why ecosystems are becoming degraded, including as a result of climate change, and how to reverse this and to ascertain what institutional changes need to be put in place for ecosysyem management to improve for the benefit of the poor.
Multi-Year Humanitarian Support to Afghanistan	2.9	4.0	Provided	ODA	Grant	Cross cutting	Disaster prevention and preparedness	To provide support to the most vulnerable groups in Afghanistan to have access to timely, appropriate and cost-effective humanitarian aid, have fewer life-critical needs, build the capacity of communities to mitigate the risk of natural disasters, including climate risk mitigation, and to better respond to these events when they occur.

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New Climate Economy Phase 2	2.6	3.6	Provided	ODA	Grant	Cross cutting	Government and civil society, general	Phase II of the New Climate Economy will build on the success of the report launched in September 2014 by focusing on engagement with key decision-makers in priority countries; catalysing action on a small number of targeted opportunities for change; and developing and communicating a new report that focuses on supporting global growth and poverty reduction while reducing carbon emissions through international collaboration.
CONGO – Improving Livelihoods and Land Use in Congo Basin Forests	2.5	3.3	Provided	ODA	Grant	Cross cutting	Forestry	To improve the the livelihoods of forest dependent communities and reduce deforestation in the Congo Basin by providing support to forest zoning, independent forest monitoring, civil society advocacy and the strengthening of legal frameworks for community forestry, as well as direct investments in community forest enterprises. The programme is expected to benefit 2.4million beneficiaries (direct and indirect). The programme will also have a demonstration effect, building a body of evidence on Community Forestry in the Congo Basin.
Enhancing Community Resilience Programme	2.2	3.0	Provided	ODA	Grant	Cross cutting	General environmental protection	To achieve sustainable disaster-resilient communities through community-based best practices, public awareness and policy change.
I2I – Innovative support for climate research – testing new, innovative approaches to address climate and environment development challenges	2.2	3.0	Provided	ODA	Grant	Cross cutting	General environmental protection	To develop and test new, innovative approaches to support research that addresses the needs of those without access to clean energy access, clean water and appropriate sanitation, or solutions to support adaptation to environmental changes. This includes testing the use of results-based financing, such as innovative prizes, and peer to peer financing, such as crowdfunding. The goal is to provide improved access to energy and water services for 12 million people through innovative, affordable technologies and business models for poor consumers by 2025.
Monitoring , Evaluation and Learning from the International Climate Fund	2.1	2.8	Provided	ODA	Grant	Cross cutting	General environmental protection	The purpose of the programme is to provide the evidence and learning to increase the effectiveness and measure the impact of the UK's international climate funding.

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Renewable Energy and Adaptation Climate Technologies (Africa Enterprise Challenge Fund)	2.0	2.7	Provided	ODA	Grant	Cross cutting	Heating, cooling and energy distribution	To stimulate private sector investment in developing low cost, clean energy and climate change technologies and services, such as solar power, biomass energy, irrigation and crop insurance products for small holder farmers. Every business supported by REACT must demonstrate a positive impact on the rural poor through increased incomes, employment and productivity or by reducing costs. By 2015 REACT will have provided an additional 200,000 people with access to cheaper, cleaner energy technologies.
East Africa Geothermal Energy (EA-Geo)	1.6	2.2	Provided	ODA	Grant	Cross cutting	Energy generation, distribution and efficiency – general	The project will increase investment in geothermal power in East Africa. It will reduce the risk of exploratory test drilling, leading to increased investor confidence in under exploited East Africa geothermal energy. It will also improve geothermal strategy, policy and regulations that facilitate investments.
Energy Security and Resource Efficiency in Somaliland	1.4	1.9	Provided	ODA	Grant	Cross cutting	General environmental protection	To support Somaliland in diversifying its energy mix, enhancing resilience and facilitating an enabling institutional and regulatory environment for the expansion of access to electricity.
Philippines Reconstruction Programme	1.4	1.9	Provided	ODA	Grant	Cross cutting	General environmental protection	Enhanced resilience of vulnerable people to respond to, and recover from, exisiting climate variability and the impacts of climate change.

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Kenya Devolution Support Programme	1.3	1.8	Provided	ODA	Grant	Cross cutting	General environmental protection	The Kenyan Constitution, adopted by referendum in 2010, introduced far reaching devolution to 47 newly-established counties. Hopes are high that devolution will improve accountability and service delivery and contribute to poverty reduction. The purpose of this programme is to build and improve public services for Kenyan citizens, particularly focusing at the county level where poverty exists and where public service delivery is poor. The programme will improve the ability of county governments to better plan, deliver and monitor the delivery of public services. This includes working with county governments to strengthen public financial management systems (e.g. improving accounting, audit and procurement systems) to ensure that public money is effectively spent and can be accounted for. It also includes a focus on critical services for example health and natural resource management (such as water scarcity due to climate change). The programme will help county governments to improve planning and allocation of budgets.
Assisting Public Institutions and Markets to Become Resilient to Effects of Climate Change in Tanzania (AIM for Resilience)	1.3	1.8	Provided	ODA	Grant	Cross cutting	General environmental protection	To enable the poorest and most vulnerable in Tanzanian society to become more resilient to climate change and to benefit from low carbon growth through the strengthening of the United Republic of Tanzania Public sector institutions to implement the national climate change strategy and adaptation plans. The programme will also support relevant sector Ministries to implement their sector resilience plans; support to building the capacity of the Tanzania Meteorological Agency to provide meteorological data management and providing efficient services to its customers; and seek to develop sustainable private sector markets. This programme is a central element of the UK International Climate Fund portfolio in Tanzania and will help maximise the return from the wider investments.

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Provision of finance to the Rwanda Fund for Climate Change and Environment	1.3	1.7	Provided	ODA	Grant	Cross cutting	Agriculture	To improve climate adaptation and low carbon development by providing finance to the Rwanda Fund for Climate Change and Environment from the UK International Climate Fund. This will benefit 15,000 people to cope better with climate change impacts, 2,000 people gain access to clean energy especially in rural areas, protect 1,200 hectares of land against soil erosion, create 2,000 green jobs as well as mobilise £8 million of additional finance from the private sector by July 2015. This contributes towards the MDG on environmental sustainability and ensuring an effective response to the impacts of climate change, thus securing current and future development gains as well as protection of the livelihoods of the poorest people.
Arid Lands Support Programme	1.1	1.5	Provided	ODA	Grant	Cross cutting	Agriculture	To improve the coping strategies for over 500,000 of the poorest people in Northern Kenya (Turkana, Wajir, Mandera and Marsabit counties) to help them to adapt to climate change and improve their livelihoods. The programme will also provide opportunities to support the poorest during drought, provide benefits for livestock insurance, increase average real value of assets owned by households, and will allow 64,000 beneficiaries to become less poor relative to non-beneficiaries in the four counties.
Private Enterprise Programme in Zambia	1.0	1.3	Provided	ODA	Grant	Cross cutting	Industry	To create jobs and investment in Zambia by building the capacity of micro, small and medium enterprises, including for example those which use climate resilient technology or promote soil conservation. The programme will help to create over 26,500 jobs by 2019.

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AGMIP – Agricultural Model Inter-Comparison and Improvement Project	0.9	1.2	Provided	ODA	Grant	Cross cutting	General environmental protection	To improve substantially the characterization of risk of hunger and world food security due to climate change and to enhance adaptive capacity in developing regions.DFID will fund the Sub-Saharan Africa and South Asia regional projects of a global initiative to improve crop and agricultural economic models to provide substantially improved assessments of climate impacts on the agricultural sector. The regional projects will improve the reliability and accessibility of assessments of impacts of climate change on agriculture in SUB-SAHARAN AFRICA and S.Asia and improved identification of potential adaptation strategies.
Dar Es Salaam Port Improvement Programme (preparatory Phase)	0.9	1.2	Provided	ODA	Grant	Cross cutting	Transport and storage	To increase Tanzania's trade competiveness by providing the Port of Dar es Salaam with essential infrastructure and efficiency enhancements including reducing greenhouse gases and other emissions. This will benefit Tanzania and neighbouring countries through improved market access. This will contribute towards our G8 commitment to cut bureaucracy at international borders by reducing port dwell time from 9 to 5 days by 2017.
Blue Forests	0.9	1.2	Provided	ODA	Grant	Cross cutting	Fishery Development	Currently focussed in Madagascar, expanding in later years to Indonesia and one SE Asia country (TBC).The project aims to design and introduce a model of sustainable development for mangrove habitats by selling credits for the carbon sequestered by the mangroves, fisheries management and improvement, mangrove livelihood diversification, community health and women's empowerment.
Punjab Education Support Programme II	0.9	1.2	Provided	ODA	Grant	Cross cutting	Basic education	To improve access, retention and the quality of education for all children in primary and secondary schools of Punjab Province in Pakistan. All government school children (6 million primary, 4 million secondary) and children attending school through the Punjab Education Foundation (around 2.2 million) will have benefited from UK support in Punjab by March 2019. Buildings will be sited and constructed in environmentally sound and climate resilient ways (such as to build resilient to floods), testing new approaches including using climate-friendly local materials.

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Khyber Pukhtunkhwa Education Sector Programme	0.7	1.0	Provided	ODA	Grant	Cross cutting	Secondary education	To improve primary and secondary education in Khyber Pakhtunkhwa by providing up to £283.2million in technical assistance, financial aid and infrastructure which aims to benefit all primary and lower secondary children in the province by 2020. Infrastucture will aim to have a lower carbon footprint and be sited away from flood prone areas. This programme targets primary enrolment specifically girl child enrolment and female literacy which contributes towards Millennium Development Goals 2 and 3.
Comprehensive Programme on Spatial Planning and Low Carbon Development in Papua	0.7	0.9	Provided	ODA	Grant	Cross cutting	Forestry	Strengthened spatial and development plans and government supported actions on low carbon investment which will contribute towards ensuring environmental sustainability (MDG 7) and improved awareness among civil society about LCD and spatial planning.
Multi-Stakeholder Forestry Programme – Nepal	0.6	0.9	Provided	ODA	Grant	Cross cutting	General environmental protection	Nepal's forestry sector contributing to inclusive economic growth, poverty reduction and tackling climate change.
Kenya Essential Education Programme	0.6	0.8	Provided	ODA	Grant	Cross cutting	General environmental protection	To increase access, retention and improve the quality of education of 300,000 children in primary schools. Contributing to 38,000 more children enrolled and staying in schools within the arid lands and urban slums, a 3% improvement in learning achievements in the early grades and a 10% reduction in teacher absenteeism by 2015. Activities will contribute to the MDGs of universal primary education and gender equity through improvements in the accessibility, affordability and quality of education for Kenyan children.To support 980,000 Kenyan children improve their reading and writing skills and 200,000 of the most marginalised children in Kenya to access better quality schools and to improve their ability to cope with the effects of climate change. Activities will contribute to the MDGs of universal primary education and gender equity through improvements in the accessibility, affordability and quality of education for Kenyan children.

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Kenya Health Programme	0.6	0.8	Provided	ODA	Grant	Cross cutting	General environmental protection	Support the Kenya Ministry of Health (MoH) and implementing partners to strengthen capacity for service delivery support systems and governance, providing clean energy solutions for clinics.
Climate Smart Development for Nepal	0.5	0.7	Provided	ODA	Grant	Cross cutting	General environmental protection	This will help Nepal to cope with impacts of climate change (CC) and promote clean development. It will provide strategic support to the Govt of Nepal to design and implement CC policies, to integrate resilience throughout government planning. This will:Improve resilience of 700,000 poor & vulnerable people (especially women) to floods, landslides, droughts in most remote districts;Improve resilience of businesses in 5 growing urban centres & 3 river basins through investments in urban planning, large scale irrigation systems & flood management;Facilitate connection of over 25,000 households to new micro-hydro power installations; connect over 70,000 homes to solar power & install RET in more than 200 schools/ health clinics;Develop industry standard for 'clean' brick production and enable over half of the brick kilns (at least 400) to adopt more efficient technologies;Improve design of future CC programming & beyond through generation of world class evidence.
Infrastructure and Cities for Economic Development (ICED)	0.5	0.6	Provided	ODA	Grant	Cross cutting	General environmental protection	To improve the enabling environment for sustainable, inclusive growth-enhancing infrastructure service delivery in DFID focus countries; and, Harness the benefits of cities for sustainable economic growth and poverty reduction in DFID focus countries. This includes focus on low carbon energy generation, energy efficiency and infrastructure resilient to climate impacts, particularly flooding and storms.

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Adaptation for Smallholder Agricultural Programme (ASAP)	0.4	0.5	Provided	ODA	Grant	Cross cutting	Agriculture	To provide knowledge and best practices to help over 6 million smallholder farmers in up to 43 countries adapt to climate change. Grants will be made to: build small scale water-harvesting, water storage and irrigation systems for farmers; provide farmers with improved seeds that are drought tolerant; help farmers access markets to sell their crops; to plant trees on farms and introduce soil and water conservation practices; and, enable farmers to access daily and seasonal weather forecasts (e.g. using text messages) so they know when best to plant and harvest crops.
Carbon Market Finance for Africa (CMF-Africa)	0.4	0.5	Provided	ODA	Grant	Cross cutting	Heating, cooling and energy distribution	The project will transform the use of Clean Development Mechanism and other carbon market finance in Africa, for increased access to small scale, low carbon energy applications in rural areas. This will be through demonstrating the practical use and financial viability of innovative “standardised baselines” and new approaches to bundle small scale CDM projects (programmatic approaches).
NIAF 2 – Nigeria Infrastructure Advisory Facility Phase 2	0.3	0.4	Provided	ODA	Grant	Cross cutting	Other multisector	To enhance the management of Nigeria’s infrastructure development towards power sector reform, capital spending, repair and maintenance of roads, climate change adaptation and mitigation. This is expected to result to increased economic growth, job creation and contribute towards the MDGs by significantly reducing poverty for the majority of the Nigeria populace by year 2020.
Support for priority actions to operationalise the “Implementation Plan for Development Resilient to Climate Change in the Caribbean”	0.3	0.3	Provided	ODA	Grant	Cross cutting	General environmental protection	To increase regional, national and local climate adaptation measures for the vulnerable poor in the Caribbean.
Reducing Maternal and Newborn Deaths in Kenya	0.2	0.3	Provided	ODA	Grant	Cross cutting	General environmental protection	To avert 4000 maternal deaths and 5500 neonatal deaths through nationwide life saving skills training for health professionals, and integrated health system strengthening in selected counties, 2013-2018, including water conservation and solar panels at health facilities.

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Strategic Climate Institutions Programme	0.2	0.3	Provided	ODA	Grant	Cross cutting	General environmental protection	To build organisational and institutional capacity within Ethiopian Government, civil society and the private sector to 1) increase resilience of vulnerable people to current climate variability, 2) adapt to future climate change and 3) benefit from the opportunities for low carbon growth. This helps Ethiopia to meet its MDGs in a sustainable way, developing a Climate Resilient Green Economy.
Support to Bangladesh's National Urban Poverty Reduction Programme (NUPRP)	0.2	0.3	Provided	ODA	Grant	Cross cutting	Other multisector	Improvement in the integration of poor communities into municipal planning, budgeting and management, with a particular focus on women and girls and climate resilience; piloting of options for scale up and lesson learning at national level to inform overall urban policy and poverty reduction.
Creation of the National Fund for Climate & Environment (FONERWA)	0.2	0.3	Provided	ODA	Grant	Cross cutting	General environmental protection	To help the Government of Rwanda achieve low carbon, climate resilient growth by providing technical assistance to help them manage FONERWA – a national fund for environment and climate change. This will help build national capacity for managing the fund by September 2015 and ensure that contributions to the fund are well-spent.
Achieving Water Security in the Southern Agricultural Growth Corridor	0.2	0.2	Provided	ODA	Grant	Cross cutting	General environmental protection	To ensure economic growth and poverty eradication resulting from investment in agriculture is sustainable in the context of climate change.
Energy Access Policy Fund	0.1	0.2	Provided	ODA	Grant	Cross cutting	Energy generation, non-renewable sources	To strengthen national and state level policies and practices that will enable India's poor gain access to energy, particularly achieving benefits for poor women and girls. The Fund will support development of policy products through the provision of technical assistance for enhancing access to power for cooking, lighting and productive activities . It will pilot projects for supply of electricity or renewable energy products in the poorest areas of Indian states such as Jharkhand, Orissa, Bihar etc.

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Strengthening Economic Systems in Bangladesh	0.1	0.2	Provided	ODA	Grant	Cross cutting	Government and civil society, general	To increase the dialogue on economic reforms, and support the Government of Bangladesh to make more pro-poor economic policies, including building evidence on the macro-economic impact of climate change and the econmoic impact of climate-induced migration.
South Sudan Humanitarian Programme (HARISS) 2014–2020	0.1	0.2	Provided	ODA	Grant	Cross cutting	Developmental food aid/ food security assistance	To help approximately three million South Sudanese by providing critical life-saving support and helping people to better cope with shocks from conflict, drought and flooding. This programme aims to save the lives of an estimated two million people who will receive at least one form of humanitarian assistance; and build the capacity of an estimated one million people to recover and cope better with shocks. Over five years this programme will provide food, shelter and access to water and health services to millions of vulnerable people, including women and children.
Accountability in Tanzania Programme (ACT)	0.1	0.2	Provided	ODA	Grant	Cross cutting	General environmental protection	To increase the accountability and responsiveness of government to its citizens through a strengthened civil society, supporting civil society to help them work in key policy areas such as: the development of a national climate change strategy; disaster risk reduction; and agriculture, forestry, energy, infrastructure, health and water sector strategies. The focus of the programme will be on increasing resilience and reduce the adverse impact on the environment.
Deepening Democracy Programme	0.1	0.1	Provided	ODA	Grant	Cross cutting	General environmental protection	To improve the Kenyan Government's accountability to its citizens by delivering peaceful, transparent, inclusive elections and providing support to non-governmental organisations, oversight bodies and independent commissions that can influence and deliver reforms thereby supporting the goal of making Kenya a more stable democracy. The project aims to improve county government planning, budgeting, human resource management, results, performance management and citizen engagement. In each of these areas, UK support will focus on governance, health, climate change and local economic development.

Recipient country/region/project/programme	*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, Water and sanitation, Cross-cutting, Other, Not applicable*	
	Domestic currency (£m)	*USD ($m)*						
Results Based Financing for Low Carbon Energy Access	0.1	0.1	Provided	ODA	Grant	Cross cutting	Heating, cooling and energy distribution	To increase access to clean energy through the creation of an expanding market of green mini-grid installations in Africa serving rural villages unconnected to the main grid. This is expected to benefit around 1.3 million people by 2018, while reducing carbon emissions by around 260,000 Tonnes of carbon dioxide, through supported private investment in the installation and operation of over 110 renewably-powered mini-grids (figures to be updated after Business Case completion). Electricity access for lighting, communications and productive uses creates jobs, enables studying at night and enhances public services (such as clinics) and public safety (eg through streetlighting). This project also addresses the post-2015 High Level Panel's recommendation on a development goal entitled Secure Sustainable Energy, which includes energy access and renewable energyThe Results-Based Financing for Low Carbon Energy Access Programme aims to accelerate access to sustainable energy services in developing countries. The funding generates and tests different forms of Results-Based Financing (RBF) mechanism, which aim to stimulate decentralised energy markets and to leverage private investment to increase access to clean energy products and services.
Increasing renewable energy and energy efficiency in the Eastern Caribbean	0.1	0.1	Provided	ODA	Grant	Cross cutting	General environmental protection	To increase the use of renewable energy and energy efficiency measures and to improve energy security in the Eastern Caribbean.
Tanzania Climate Change Institutional Strengthening Programme	0.0	0.0	Provided	ODA	Grant	Cross cutting	General environmental protection	To improve Tanzania's access to climate finance and use it effectively to support climate change resilience and low carbon sustainable growth by securing international climate change funds both from multilaterals and bilaterals and by assessing targets annually which have been set in the National Climate Change Strategy.

Recipient country/region/project/programme	*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, Water and sanitation, Cross-cutting, Other, Not applicable*	
	Domestic currency (£m)	*USD ($m)*						
Smart Urban Development in Indian States (SmUDI)	0.0	0.0	Provided	ODA	Grant	Cross cutting	Other multisector	Provide UK support on smart urban technology, planning and investment to deliver Govt of India's smart cities mission to develop 100 smart cities in poorest states e.gBihar,Odisha and Madhya Pradesh. City Parternships will bring best expertise from UK to help Indian cities invest create economically vibrant and safe cities by supporting smart city design,solutions for urban services,energy efficiency and protect cities from climate change.
Private Sector Energy Efficiency	0.0	0.0	Provided	ODA	Grant	Cross cutting	General environmental protection	To reduce energy consumption, avoid greenhouse gas emissions and increase investment in companies benefitting from the programme by providing remote advice and funding energy audits and strategies for South Africa businesses by 31 March 2015.
Transformative Carbon Asset Facility	60.0	81.0	Provided	ODA	Grant	Mitigation	Energy generation, renewable sources	A new multidonor initiative set up by the World Bank that will use a results-based payment mechanism to incentivise emission reductions in developing countries.
Renewable Energy Performance Platform (REPP)	42.4	57.2	Provided	ODA	Grant	Mitigation	Energy generation, renewable sources	Supporting private sector investment in small to medium scale renewable energy projects, primarily in Africa.
Sustainable Rural Development Phase II	30.0	40.5	Provided	ODA	Grant	Mitigation	Agricultural Development	Supporting farmers implement Brazil's Plano ABC programme (low carbon agriculture technologies and practices) by addressing the barriers farmers face accessing low carbon agriculture credit. It aims to achieve this by supporting low carbon agriculture technologies and practices such as, but not limited to, establishing integrated systems (crop-livestock-forestry) and reforestation (the full suite of technologies are set out in, as well as conservation of natural forests at risk of deforestation by small and medium-scale farmers.

Recipient country/region/project/programme	*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, Water and sanitation, Cross-cutting, Other, Not applicable*	
	Domestic currency (£m)	*USD ($m)*						
NAMA Facility	25.0	33.7	Provided	ODA	Grant	Mitigation	Energy generation, renewable sources	Multi-donor facility set up by UK and Germany, to support countries to implement ambitious mitigation projects, chosen through a competitive annual call for projects.
Solar Nigeria Programme	19.7	26.6	Provided	ODA	Grant	Mitigation	Energy generation, renewable sources	To improve the welfare outcomes of the currently underserved communities in Lagos state and Northern Nigeria by making a significant financial contribution towards the solar power electrification of public institutions, such as schools and hospitals. The intervention is expected to, by year 2020, ensure improved welfare outcomes for more than 2.8 million people using domestic solar photovoltaic (PV) systems, with 190,000 school pupils and 4.7 million clinic patients benefiting from public institutions with PV systems, create more than 3000 jobs and ensure greater effectiveness of DFID's other health and educational sector intervention in Nigeria.
Capacity Building for Transparency	11.0	14.8	Provided	ODA	Grant	Mitigation	Energy sector policy, planning and administration	Assisting developing countries to create and/or strengthen the domestic institutions and technical tools required to implement the transparency provisions of the Paris Agreement in relation both to estimating greenhouse gas emissions and removals and tracking progress towards targets.
Forestry, Land-use and Governance in Indonesia	7.1	9.6	Provided	ODA	Grant	Mitigation	General environmental protection	To reduce greenhouse gas emissions and deforestation in Indonesia as part of the UK's efforts to avoid catastrophic climate change that would hit the very poorest first and set back global efforts at poverty reduction.

Recipient country/region/project/programme	*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, Water and sanitation, Cross-cutting, Other, Not applicable*	
	Domestic currency (£m)	*USD ($m)*						
Stability and Growth Programme (IMF)	6.4	8.6	Provided	ODA	Grant	Mitigation	Other social infrastructure and services	To improve macro-economic stability and growth in Pakistan by providing the Government with financial aid and technical assistance in support of the International Monetary Fund Extended Financing Facility. Energy subsidy reforms under the EFF should contribute to increased investment in green energy and less waste and carbon emissions. This will benefit the people of Pakistan by establishing the conditions for faster and more equitable growth. This contributes towards our MDGs by enabling the Government of Pakistan to finance essential public expenditure and protect the poor from the adverse impact of structural reforms.
TEA – Transforming Energy Access	6.2	8.4	Provided	ODA	Grant	Mitigation	Energy generation, distribution and efficiency – general	The project is up to £65 million over five years, to support early stage testing and scale up of innovative technologies and business models that will accelerate access to affordable, clean energy services for poor households and enterprises, especially in Africa. The programme will include: i) partnership with Shell Foundation, enabling support to another 30+ early stage private sector innovations. ii) Innovate UK's Energy Catalyst to stimulate technology innovation by UK enterprises; iii) build other strategic clean energy innovation partnerships (e.g. testing a new 'P2P Solar' crowdfunding platform; and scoping a potential new partnership with Gates Foundation on Mission Innovation); iv) skills and expertise development. To support early stage testing and scale up of innovative technologies and business models that will accelerate access to affordable, clean energy services for poor households and enterprises, especially in Africa.
Development of Geothermal Energy in Montserrat	6.1	8.2	Provided	ODA	Grant	Mitigation	Energy generation, renewable sources	To support the development of geothermal energy in Montserrat, by undertaking the exploratory drilling and testing of 3 geothermal wells.
Strategic Technical Assistance – Asian Development Bank Clean Energy Fund	5.0	6.7	Provided	ODA	Grant	Mitigation	Energy generation, renewable sources	Supporting developing countries to build capacity for making large scale energy efficiency and renewables investments. Building the enabling conditions for scaled up investment in RE and EE through technical assistance projects.

Recipient country/region/project/programme	*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, Water and sanitation, Cross-cutting, Other, Not applicable*	
	Domestic currency (£m)	*USD ($m)*						
UK Climate Investments (UKCI)	4.3	5.8	Provided	ODA	Equity	Mitigation	Energy generation, renewable sources	Joint venture with the UK Green Investment Bank to make equity investments in private sector renewable and energy efficiency projects in developing countries.
Providing Clean Energy to the Rural Poor of Bangladesh	3.9	5.2	Provided	ODA	Grant	Mitigation	General environmental protection	Climate change mitigation and access to clean energy to improve the livelihoods of rural poor in off- grid areas in Bangladesh.
Climate Public Private Partnership Programme (CP3)	2.6	3.6	Provided	ODA	Grant	Mitigation	General environmental protection	CP3 aims to demonstrate that climate friendly investments in developing countries, including in renewable energy, water, energy efficiency and forestry are not only ethically right but also commercially viable. It aims to attract new forms of finance such as pension funds and sovereign wealth funds into these areas by creating two commercial private equity funds of funds which will invest in subfunds and projects in developing countries, creating track records of investment performance which should in turn encourage further investments and accelerate the growth of investment in climate.
Global Climate Partnership Fund (GCPF) Technical Assistance	2.0	2.7	Provided	ODA	Grant	Mitigation	Energy conservation and demand-side efficiency	An investment vehicle that invests through local banks in developing countries to make finance available to small and medium enterprises (SMEs) for energy efficiency improvements and renewable energy projects.

Recipient country/region/project/programme	*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, Water and sanitation, Cross-cutting, Other, Not applicable*	
	Domestic currency (£m)	*USD ($m)*						
Support for Protection and Assistance of Refugees in Kenya (SPARK)	1.6	2.1	Provided	ODA	Grant	Mitigation	General environmental protection	To improve the efficiency in delivery of basic services to refugees (including developing or rehabilitating climate-smart camp infrastructure) and to strengthen their resilience and that of the communities hosting them. This will be achieved through targeted assistance and greater use of cash-based assistance. This programme will assist adolescent girls and women of reproductive age and malnourished children under 5 years of age through nutritional interventions as well as ensuring that the survivors of sexual and gender based violence (SGBV) receive appropriate medical care in a timely manner. The project will also assist 8,000 refugees with livelihoods opportunities, including climate smart opportunities such as processing solid waste for onselling or producing energy-efficient stoves, and will support the voluntarily return of refugees to their countries of origin.
Accelerating Investment and Infrastructure in Nepal	1.3	1.8	Provided	ODA	Grant	Mitigation	Energy generation, renewable sources	To accelerate private investment and economic growth in Nepal by providing technical expertise to help Nepalese institutions develop major infrastructure (including renewable energy); improve the business climate for domestic and foreign investors; improve the implementation of economic policy and test new approaches for local economic development. This will result in at least £600 million of private investment into growth-boosting sectors and a reduction by at least 10% in time or cost for at least five regulatory processes perceived as burdensome by the private sector.
On Grid Small Scale Renewable Energy in Uganda	1.0	1.3	Provided	ODA	Grant	Mitigation	Energy generation, renewable sources	To improve the environment for private investment in Uganda's renewable energy sector by supporting the construction of at least 15 on-grid small scale power plants. This will increase Uganda's energy production by circa 20%, mobilise up to £240 million in private finance and stabilise Uganda's power sector finances by saving approximately $260m to 2.7bn during the period 2013–35, and lead to greenhouse gas emission savings of between 1 and 10 $MtCO_2e$.

Recipient country/region/project/programme	*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, Water and sanitation, Cross-cutting, Other, Not applicable*	
	Domestic currency (£m)	*USD ($m)*						
NDC Partnership	0.5	0.7	Provided	ODA	Grant	Mitigation	Energy sector policy, planning and administration	The NDC Partnership is a new international partnership aiming to help turn countries' climate targets under the Paris Agreement, known as Nationally Determined Contributions (NDCs), into specific strategies and measures.
Green Mini-Grids Kenya	0.5	0.6	Provided	ODA	Grant	Mitigation	Energy generation, renewable sources	Support for project preparation and leveraging of private investment in Green Mini-Grids (GMGs) in Kenya.
Humanitarian Innovation and Evidence Programme: greater use of evidence and innovation in humanitarian responses	0.5	0.6	Provided	ODA	Grant	Mitigation	Other multisector	This is business case 2/3 which implements the DFID Humanitarian Innovation and Evidence Strategy. This programme will develop and test innovative approaches to humanitarian practice; provide evidence of the cost effectiveness of investments in disaster risk reduction; provide new evidence on the scaling up of cash-based approaches; support better evidence on insurance as a risk management tool; and create new evidence on the best intervention to improve health and nutrition in emergencies.This is one of three business cases which implements the DFID Humanitarian Innovation and Evidence Strategy. Between 2000–2009, more than 2.2 billion people were affected by 4,484 natural disasters. Vulnerability to hazards is increasing as a result of demographic, political and environmental changes. Demand for humanitarian assistance is likely to rise while economic constraints are also increasing. In this context it is important to ensure that the most effective and cost efficient approch.
2050 Calculator	0.3	0.4	Provided	ODA	Grant	Mitigation	Energy research	Supporting 10 developing countries to develop their own 2050 Calculator energy models to support their low-carbon development plans, and creation of a global calculator.

Recipient country/region/project/programme	*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, Water and sanitation, Cross-cutting, Other, Not applicable*	
	Domestic currency (£m)	*USD ($m)*						
Decentralised Renewable Energy Access Markets (DREAM)	0.3	0.4	Provided	ODA	Grant	Mitigation	Energy generation, distribution and efficiency – general	DREAM will help three of the poorest States in India provide energy to around 1.8m people. It will use UK expertise to mobilise public and private investment in sustainable and affordable energy supplies delivered by private energy businesses – creating 2,000 jobs and supporting at least 200 women develop energy businesses.
Rural Electrification in Sierra Leone	0.3	0.4	Provided	ODA	Grant	Mitigation	Heating, cooling and energy distribution	To increase access to clean energy through the creation of environmentally and economically sustainable electric mini-grid systems for small remote rural communities in Sierra Leone by 2020. This is expected to directly benefit around 360,000 people in rural Sierra Leone, and indirectly help up to 1.8 million people access low carbon electricity. This will add more than 10 Mega Watts (MW) to the country's power generation capacity of an estimated average peak demand requirement of 300–500 MW. There will be a welfare increase in rural communities in terms of saved fuel costs, improved health and education outcomes, improved communications and access to information and health and safety. The project will also result in a significant reduction in Sierra Leone's future Green House Gas emissions through supported private investment in the installation and operation of renewably-powered mini-grids.
Climatescope – Clean Energy Investment Index	0.2	0.2	Provided	ODA	Grant	Mitigation	General environmental protection	To increase private investment in renewable energy projects in poorer countries by providing investors with concrete policy and financial information. Renewable energy is a cheaper solution than fossil fuels in many developing countries and by increasing the amount of renewable energy in developing countries this will encourage growth and allow businesses to prosper
Capital Markets Climate Initiative (CMCI) and Global Innovation Lab	0.1	0.1	Provided	ODA	Grant	Mitigation	Financial policy and administrative management	The Lab is an international partnership of senior public and private sector stakeholders designing instruments to mobilise private climate investment in developing countries.

Recipient country/region/project/programme	*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, Water and sanitation, Cross-cutting, Other, Not applicable*	
	Domestic currency (£m)	*USD ($m)*						
India: Affordable Housing in Poor States	0.1	0.1	Provided	ODA	Grant	Mitigation	Other multisector	The project in partnership with National Housing Bank will enable first-time home ownership for the poor bankable families in Low Income States of India and stimulate the growth of the affordable housing market, by providing loans to build 17,000 housing units and 10,000 home loans for first-time home owners. This will result in 27,000 construction jobs for the poorest people in low income states in India by 2020. Appropriate choice of location will enhance resilience to climate shocks (flood, cyclone etc.) and disasters. Effective site planning and building envelope design, use of efficient building materials and construction practices, maximising the reuse and recycling of materials, and use of renewable resources can all help in reducing GHG emissions and environmental degradation.
Supporting Structural Reform in the Indian Power Sector	0.0	0.1	Provided	ODA	Grant	Mitigation	Energy generation, renewable sources	In line with the UK government's aid policy and new development partnership with India, the 'Supporting Structural Reform in the Indian Power Sector' programme will improve the efficiency, reliability and sustainability of electricity supply in India through technical expertise, not through traditional grant support. It will provide world class expertise to support the market reforms and scale up of renewable energy supply that the Indian power sector needs to support growth and create jobs. It will work at the Central level and in upto three States which may include DFID focus states such as Odisha, Andhra Pradesh and Madhya Pradesh.

Recipient country/region/project/programme	*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, Water and sanitation, Cross-cutting, Other, Not applicable*	
	Domestic currency (£m)	*USD ($m)*						
Green Economic Growth for Papua	0.0	0.0	Provided	ODA	Grant	Mitigation	Forestry	The programme aims to promote green growth in Papua. It will contribute to the government of Papua's vision and spatial plan that intends to preserve 90 per cent forest cover in the province. In doing so the programme will support the provinces transition away from a high carbon business as usual growth trajectory onto a low carbon development pathway. The programme is designed to address the key barriers to private sector development in Papua that will enable firms to pursue low carbon business opportunities. It will work directly with firms, the financial sector, and the public sector to improve the commercial and environmental sustainability of small and medium sized enterprises. In addition, the programme will generate knowledge on how green growth can be implemented in Indonesia and globally.
Negative ODA flow	-0.0	-0.0	Provided	ODA	Returned money	Cross cutting	Forestry	A number of projects have returned ODA, until this money is respent is counts as negative ODA which we have recorded against the appropriate themes.
Negative ODA flow	-0.0	-0.0	Provided	ODA	Returned money	Mitigation	Government and civil society, general	
Negative ODA flow	-14.1	-19.1	Provided	ODA	Returned money	Cross cutting	General environmental protection	
Total contributions through bilateral, regional and other channels	**781.7**	**1,054.9**						

Note
Monetary figures are rounded to the nearest (£/$)100,000.

Table 8
Provision of technology development and transfer support

	Targeted area	*Measures and activities related to technology transfer*	*Sector*	*Source of the funding for the technology transfer*	*Activities undertaken by*	*Status*	*Additional Information*
Recipient country and/ or region	*Mitigation Adaptation Mitigationand adaptation*		*Energy Transport Industry Agriculture Water and sanitation Other*	*Private Public Private and public*	*Private Public Private and public*	*Implemented Planned*	
Global	Mitigation	The Clean Technology Fund is supporting several examples of low carbon technology. These include supporting the first utility scale CSP plant to be built in a developing country now providing power to 80,000 people in South Africa. Helping to kickstart the market in onshore wind in Mexico, which is now commercially viable, and growing without climate finance support.	Energy	Private and public	Private and public	Implemented	
Southern/East Africa	Mitigation	Scaling up of the Energy and Environment Partnership with Southern and East Africa. Greater access to clean energy services achieved through fast tracking of renewable energy project demonstration and deployment, including through technology learning, donor coordination and private sector investment.	Energy	Private and public	Private and public	Implemented	

	Targeted area	*Measures and activities related to technology transfer*	*Sector*	*Source of the funding for the technology transfer*	*Activities undertaken by*	*Status*	*Additional Information*
Recipient country and/ or region	*Mitigation Adaptation Mitigationand adaptation*		*Energy Transport Industry Agriculture Water and sanitation Other*	*Private Public Private and public*	*Private Public Private and public*	*Implemented Planned*	
Africa	Mitigation	Renewable Energy and Adapting to Climat Renewable Energy and Adaptation Climate Technologies (Africa Climate Change Challenge Fund). To stimulate private sector investment in developing low cost, clean energy and climate change technologies and services, such as solar power, biomass energy, irrigation and crop insurance products for small holder farmers. Every business supported by REACT must demonstrate a positive impact on the rural poor through increased incomes, employment and productivity or by reducing costs. By 2015 REACT will have provided an additional 200,000 people with access to cheaper, cleaner energy technologies.	Energy	Private and public	Private and public	Implemented	

	Targeted area	*Measures and activities related to technology transfer*	*Sector*	*Source of the funding for the technology transfer*	*Activities undertaken by*	*Status*	*Additional Information*
Recipient country and/ or region	*Mitigation Adaptation Mitigationand adaptation*		*Energy Transport Industry Agriculture Water and sanitation Other*	*Private Public Private and public*	*Private Public Private and public*	*Implemented Planned*	
Africa	Adaptation	African Agriculture Technology (AATF) Phase III (2015-2020). The expected impact of support to the proposed intervention is increased productivity of small-holder farmers in Sub-Saharan Africa. This impact will be achieved through two outcomes a. Increased access/availability of appropriate agricultural technologies for small-holder farmers in targeted countries in Sub-Saharan Africa. b. A financially sustainable organisation/ mechanism that is responsive to the needs of small-holder farmers in ensuring that market failures in the development and adoption of appropriate agricultural technologies continue to be addressed.	Private and public	Implemented	Public	Implemented	

Notes:
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 included above.

Table 9
Provision of Capacity-building support

	Targetted area		
Recipient country/region	Mitigation, Adaptation, Technology development and transfer, Multiple areas	Programme or project title	Description of programme or project
Global	Multiple areas	Climate Development Knowledge Network (CDKN)	The Climate and Development Knowledge Network (CDKN) was established in 2010 as a UK flagship initiative aimed at providing developing country policy- and decision-makers with access to high-quality research and policy-relevant advice on climate change and development. CDKN delivers its work through a portfolio of country technical assistance, research, and knowledge management. Through these combined actions CDKN aims to better equip developing countries with capacity, resources and tools to address their national priorities on poverty and growth in the context of a changing climate.
Kenya	Adaptation	Strengthening Emergency Preparedness and Response in Kenya (2014-2018)	To enhance Kenya Red Cross' capacity to prepare and respond to disaster's, through providing a timely and effective response to small and medium disasters; ensuring overall response effectiveness is improved; maintaining the dignity of people affected by disasters in Kenya by providing direct support to over 3,400 men, women and children per year.
Tanzania	Adaptation	Assisting Public Institutions and Markets to Become Resilient to Effects of Climate Change in Tanzania (AIM for Resilience)	To enable the poorest and most vulnerable in Tanzanian society to become more resilient to climate change and to benefit from low carbon growth through the strengthening of the United Republic of Tanzania Public sector institutions to implement the national climate change strategy and adaptation plans. The programme will also support relevant sector Ministries to implement their sector resilience plans; support to building the capacity of the Tanzania Meteorological Agency to provide meteorological data management and providing efficient services to its customers; and seek to develop sustainable private sector markets.
Asia	Mitigation	Strategic Technical Assistance - Asian Development Bank Clean Energy Fund	Supporting developing countries to build capacity for making large scale energy efficiency and renewables investments.
Asia	Multiple areas	Climate Proofing Growth and Development in South Asia	Integrate climate change into development planning, budgeting and delivery in national and sub-national governments in Afghanistan, Bangladesh, India, Nepal and Pakistan, by strengthening planning, budgeting and delivery mechanisms, building awareness and capacity of stakeholders, providing technical and some implementation support, helping leverage domestic finance and actively sharing knowledge by 201.8
Ethiopia	Multiple areas	Strategic Climate Institutions Programme	To build organisational and institutional capacity within Ethiopian Government, civil society and the private sector to 1) increase resilience of vulnerable people to current climate variability, 2) adapt to future climate change and 3) benefit from the opportunities for low carbon growth. This helps Ethiopia to meet its MDGs in a sustainable way, developing a Climate Resilient Green Economy
Global	Mitigation	Capacity Building for Transparency	Assisting developing countries to create and/or strengthen the domestic institutions and technical tools required to implement the transparency provisions of the Paris Agreement in relation both to estimating greenhouse gas emissions and removals and tracking progress towards targets.
Nepal	Adaptation	Nepal Climate Change Support Programme	To build capacity of the Government of Nepal to develop, cost, budget and implement adaptation measures at the local level aimed at mainstreaming climate change in key development sectors (agriculture, forestry, water and energy), including through public private partnerships.
Pacific Islands	Adaptation	Pacific Catastrophe Risk Assessment and Financing Initiative	To provide technical assistance and capital to provide insurance for the Pacific Islands so in future they can protect themselves against natural disasters such as cyclones and Tsunamis thereby reducing their reliance on humanitarian aid. The nations of Tonga, Marshall islands, Cook Islands, Vanuatu, and Samoa (625,000 people in total) will benefit from the insurance at the start of the programme.
Global	Mitigation	Global Climate Partnership Fund (GCPF) Technical Assistance	An investment vehicle that invests through local banks in developing countries to make finance available to small and medium enterprises (SMEs) for energy efficiency improvements and renewable energy projects.
Global	Mitigation	NDC Partnership	The NDC Partnership is a new international partnership aiming to help turn countries' climate targets under the Paris Agreement, known as Nationally Determined Contributions (NDCs), into specific strategies and measures.

Notes:
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 included above.

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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Edited by:
Weimu Xu
Science and Innovation for Climate and Energy Directorate
Department for Business, Energy and Industrial Strategy
1 Victoria Street
London
SW1H 0ET
United Kingdom

Simon Gilbert
Met Office
FitzRoy Road
Exeter
Devon
EX1 3PB
United Kingdom

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Natural Resources Wales (formally Countryside Commission for Wales)
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Annex 3: Contents

Annex 3: GCOS Implementation plan

1. Introduction

This report provides an assessment of UK contributions towards the realisation of the Global Climate Observing System (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 report includes systematic observing systems operated by or on behalf of UK public sector organisations that are relevant to the GCOS Implementation Plan. Similar to the sixth National Communication, 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
- Oceanic Essential Climate Variables
- Terrestrial Essential Climate Variables
- Additional information

[1] Subsidiary Body for Scientific and Technological Advice, Twenty-seventh session, Bali, 3–11 December 2007, FCCC/SBSTA/2007/L.14/Add.1

2. Common issues

2.1 Planning

2.1.1 Overview

Systematic observations in the UK and its overseas territories are made by a number of national agencies and organisations. Climate research and procurement of climate-related observations are sponsored by various public sector organisations in support of a range of responsibilities and policy requirements. In addition, 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 have set national plans for climate research and observations as such, it regularly reviews such activities through coordination functions. This coordination is facilitated through the Research and Innovation for our Dynamic Environment (RIDE) forum (see section 2.1.3 for more information). The UK Environmental Observations Framework (UKEOF) is a second way in which climate observation is coordinated (see section 2.3.1 for more information).

2.1.2 Responsible departments

Two central government departments share the majority of the responsibility for climate research and observations in the UK.

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, Energy and Industrial Strategy (BEIS) has responsibility for reporting to the UNFCCC, leads on climate change policy and provides funds for climate research and observations to advise the UK's policy and its impacts and response strategies.

BEIS is also the main or single source of funding for many of the other public sector organisations that undertake climate research and observations. These include:

- The Research Councils. These Councils are responsible for maintaining the science base by providing funding for university research. Whilst funded by central government, they operate at arms length. 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. NERC research centres include the British Antarctic Survey (BAS); the British Geological Survey (BGS); the Centre for Ecology and Hydrology (CEH); the National Centre for Atmospheric Science (NCAS); the National Centre for Earth Observation (NCEO); and the National Oceanography Centre (NOC).
- The climate change programme at the Met Office, the UK's national meteorological agency. This research happens primarily through the Met Office Hadley Centre. The Met Office is the lead agency for making and collecting meteorological and atmospheric observations.

Other national capability Delivery Partners include: Plymouth Marine Laboratory; the Scottish Association for Marine Science; and the Sea Mammal Research Unit

2.1.3 Coordination processes

This section provides information on three of the main processes for coordinating UK environmental research and observations activities.

Research and Innovation for our Dynamic Environment (RIDE) Forum

The RIDE Forum has evolved from the Living With Environmental Change (LWEC) partnership. It is a forum of 19 public sector member organisations holding a stake in environmental change research, innovation, training and capabilities. It supports coordination across different organisations working on climate research and observations including funders, providers of research and users of research.

The RIDE Forum's unique contribution lies in its breadth. It brings together the complementary resources of the many different disciplines and publically-funded sector stakeholders needed to increase our understanding of the natural, social, economic and technological systems interacting with environmental change, and the translation of that knowledge into policy and practice. It focuses on the UK perspective and challenges, whilst necessarily placing that in the international context.

The RIDE Forum enhances the impact of the UK's publicly-funded environmental change research, evidence and innovation by enabling members to coordinate strategic activities. By adding value, leveraging resources and avoiding duplication, members can be more efficient in their use of public funds to give decision-makers the knowledge they need to respond to the challenges and opportunities presented by environmental change.

Marine Science Co-ordination Committee (MSCC)

The MSCC is a partnership of government departments, devolved administrations of Scotland, Northern Ireland and Wales, environment agencies and research bodies involved in funding and providing marine science in the UK.

The MSCC has two main responsibilities: to drive forward the implementation of the UK Marine Science Strategy; and to identify opportunities for improved UK marine science collaboration and co-ordination. The MSCC published the first UK Marine Science Strategy[2] 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.

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 MSCC published the Strategic implementation plan 2015 to 2025[3] in 2016. A collaborative approach by stakeholders across the delivery areas forms the basis of the implementation of the Strategy. It outlines the key topics for policy decision-making and implementation of the strategy which is reviewed annually.

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[2] http://www.defra.gov.uk/mscc/files/uk-marine-science-strategy-.pdf

[3] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/528400/mscc-strategic-implementation-plan.pdf

National Centre for Earth Observation (NCEO)

The NCEO is a NERC research centre, based around five core scientific units and expert staff located at leading universities and research organisations, two scientific facilities concerned with near real-time scientific services and field instrumentation, and the Centre for Environmental Data Analysis (CEDA) hosted at the Science and Technology and Facilities Council Rutherford Appleton Laboratory (STFC-RAL). The University of Leicester hosts the NCEO Director, central hub and one core science unit. Other core units are based at the Universities of Reading, Edinburgh, London (King's and University College London), Imperial College London and STFC-RAL/Oxford.

NCEO provides research capability in Earth Observation (EO) data sets, associated merging (assimilation) techniques and model evaluation to underpin Earth System research. It aims to improve climate observations of current and the recent past as well as predictions of the future by exploiting EO data alongside models to examine the interactions between the atmosphere, biosphere and hydrosphere. NERC research through NCEO is building on the success of UK climate-orientated satellite instruments, the ATSRs and GERBs, to derive climate data sets for temperature, radiative fluxes, aerosols and clouds. NCEO also provides key climate measures such as greenhouses gases, ocean biological parameters, fire radiative power, vegetation and biomass.

2.1.4 International involvement

The UK participates in a number of international observations programmes and in particular activities at European level. Such activities include the following:

- **ESA**: The UK contributes to a number of ESA programmes and is currently the joint-lead funder in the Earth Observation Envelope Programme (EOEP) and the lead funder of the Climate Change Initiative (CCI+). In the past the UK has contributed to the European Remote Sensing and Envisat satellite programmes, and continuity from these is provided by the joint European Commission-ESA Copernicus Programme Sentinel Missions. The UK is a leading contributor to the ESA Earth Explorer Programme, which is developing a regular drumbeat of missions providing new forms of observation of value to climate studies such as:
    - **Cryosat**: This mission is dedicated to measuring the thickness of polar sea ice and monitoring changes in the ice sheets that blanket Greenland and Antarctica. The UK has provided scientific leadership of Cryosat, which has generated high quality science of major public interest (with 25% of publications citing a UK author) and is providing observations which complement those undertaken by the substantial UK investment in polar research vessels.
    - **EarthCare**: This mission will advance our understanding of the role that the interaction between clouds and aerosols play in climate regulation. The UK is developing and supplying the multi-spectral imager (MSI) instrument, the BroadBand Radiometer (BBR) instrument, the battery and the Instrument Control Units (ICUs) for EarthCare.
    - **Aeolus**: It is the first space mission to acquire profiles of the wind on a global scale. These near-real-time observations will improve the accuracy of numerical weather and climate prediction and advance our understanding of tropical dynamics and processes relevant to climate variability. The UK led the assembly of the Aeolus satellite. After launch, wind profile retrieval will be carried out by the European Centre for Medium-Range Weather Forecasts (ECMWF) from Reading, UK

- **Biomass**: It will provide global maps of the amount of carbon stored in the world's forests and how this changes over time, mainly through absorbing carbon dioxide, which is released from burning fossil fuels. Biomass will provide essential support to UN treaties on the reduction of emissions from deforestation and forest degradation. The UK is priming Biomass and will lead the assembly of the satellite.

The UK is the largest contributor to the ESA Climate Change Initiative programme (CCI+) and leads Essential Climate Variables (ECV) production activities in sea surface temperature, Antarctic Ice Sheets, land surface temperature and ocean colour, with substantial contributions to aerosols, clouds, ozone, greenhouse gases and cryosphere ECV data. UK has also contributed to Fire, Glaciers, Greenland Ice Sheets, Sea Level and some evaluation of land cover through the Met Office. Through NERC funding the UK has funded the lake Surface temperature component to the ECV work. The UK also led the ESA CCI Climate Modelling User Group (CMUG) CCI+ is run from the UK in the ESA Climate Office in Harwell. 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 Meteosat series (MSG, MTG). The Met Office is a member of 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 ESA to which the UK contributes. The fleet of Sentinel satellites is the world's leading Earth observation constellation. Recent UK involvement includes:
  - manufacture of the Sentinel-5 Precursor satellite, launched in October 2017, bridging the data gap between Envisat and Sentinel-5 providing measurements of greenhouse gas concentration in the atmosphere;
  - Instrument contributions including: CCD detectors; radar electronics; cryo-coolers; instrument calibration expertise and facilities;
  - Platform equipment including: batteries; propulsion systems and communications equipment;
  - UK scientists are leading the specification of the anticipated Sentinel-8 high spatial resolution land surface temperature instrument;
  - The UK has a scientist on the CO_2 monitoring task force.
- In addition to the Sentinel satellite activity, Copernicus also involves in-situ measurements and the provision of services. The European Centre for Medium Range Weather Forecasting (ECMWF) manages the Copernicus Climate Change and Atmosphere Services from the UK. The Climate Change Service combines observations of the climate system with the latest science to develop authoritative,

quality-assured information about the past, current and future states of the climate in Europe and worldwide. 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, which is based in the UK (see section 2.5.9 for more information on this Centre). 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 Group on Earth Observations (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. ILTER is represented at the European scale by the LTER-Europe community who have been developing the case for a European long-term ecosystem research infrastructure (the eLTER RI). The ambition for the eLTER RI, is that coordinated and co-located measurements of biological, hydrological, geochemical and climate measurements are undertaken across Europe, and that data and models are made available through linked systems in order to contribute to global scale assessments of the effects of climate change impacts on ecosystems and ecosystem services. The UK's formal contribution to both ILTER and LTER-Europe is the Environmental Change Network (ECN), managed by the NERC Centre for Ecology and Hydrology (CEH). The ECN has been gathering information about the pressures on, and responses to, environmental change in physical, chemical and biological systems across a wide range of UK habitats over the past 25 years. CEH are currently partners in a proposal to the EU for eLTER RI to be formally recognised as an 'emerging infrastructure' on the EU's European Strategy Forum on Research Infrastructures (ESFRI) programme. ILTER is also a key partner in GEO, which, through its Biodiversity Observation Network (GEO

BON), is developing a set of Essential Biodiversity Variables to complement the ECVs that have already been developed for GCOS.

- **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 vapour, 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 National Oceanography Centre (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 metres. 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 EU 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, and coordinates a network of globally sustained hydrographic sections as part of the global ocean / climate observing system. GO-SHIP Reference Sections are repeat hydrographic sections that are in general coast-to-coast or coast-to-ice. The UK has contributed through surveys using the ships RRS Discovery, RRS James Cook and BAS's RRS James Clark Ross.
- **RAPID-26N**: RAPID-26N is collaboration between the UK (funded by NERC) and the USA (funded by NSF and NOAA) that has been measuring the Atlantic Meridional Overturning Circulation (AMOC) since 2004. These observations have supported a number of research programs that aim 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. Significant co-funding has also been obtained from related EU Framework Programme. In collaboration with US, Canadian and

European partners the UK is also participating in the international OSNAP program to monitor the AMOC in the sub-polar North Atlantic.

- **ARGO**: The international Argo project to establish a global network of profiling floats was initiated in 2000. The UK's contribution to Argo is undertaken by a partnership between the Met Office, the National Oceanography Centre (NOC) Southampton, the British Oceanographic Data Centre (BODC) and Plymouth Marine Laboratory (PML). The Met Office are responsible for programme management and coordination, organizing float deployments, preparation of floats for deployment, telecommunications (costs) and international contributions. NOC and BODC have responsibility for Argo science and data management respectively. PML play a leading role in the recent expansion of the UK programme into biogeochemical floats (BGC-Argo). The UK presently has around 173 active floats contributing to the Argo float array which consists of 3,839 floats in total (JCOMMOps website, 14 Nov 2017). The UK is a full and founder member of the Euro-Argo ERIC (European Research Infrastructure Consortium) which was established in 2014[4] The consortium 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. In addition, the Euro-Argo ERIC is preparing for the evolution of Argo to address new scientific and operational challenges and in particular to engage in the new phases of Argo (biogeochemistry, deep ocean, Arctic). Euro-Argo has recently procured 150 floats under the MOCCA (Monitoring the Oceans and Climate Change with Argo) project, and has deployed 72 of these (correct at 28 Sep 2017).
- **ISTI**: The International Surface Temperature Initiative[5] (ISTI) was formally launched in 2010. 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 continued the responsibility for providing the role of a full-time GCOS Network Manager, through funding from a contract with GCOS and its own internal public-weather service resources. The role of an international network manager, considers all aspects of the in-situ 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.

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4 http://www.euro-argo.eu/

5 http://www.surfacetemperatures.org/

NERC 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.

The National Centre for Earth Observation (NCEO) of NERC has supported the GCOS Implementation Plan in a number of ways: inputs to and review of the GCOS requirements and implementation plans, working on definitions of new Essential Climate Variables (ECV) and support for long-term data sets. Technical quality and traceability of the climate data is clearly a pre-requisite for usability and NCEO is working in the UK and in European fora to underpin work on appropriate algorithms, their expressions of uncertainty in the data and in testing of the output datasets.

Establishment of land surface temperature as a new ECV and expansion of the lake ECV to include surface temperature and ocean colour has been supported by NCEO through leading international teams for these important metrics. International reporting of climate data has been a priority for key climate parameters, for example, new works on trends in water vapour and tropospheric ozone. NCEO, NERC and the European Space Agency have enabled projects undertaking the first steps towards climate data records for land surface temperature, using the UK Along-Track Scanning Radiometers, and above-ground biomass. NCEO has supported state-of-the-art, long-term satellite data sets for carbon dioxide and methane, and worked extensively on inverse modelling to regional land fluxes. The UK Geostationary Earth Radiation Budget experiment data is being provided in Obs4MIPS format for the international community.

2.3 Quality control

2.3.1 Efforts to ensure ECV-observing activities adhere to the GCOS climate monitoring principles

UKEOF *Coordinating Climate Observations Group:*

UKEOF is a partnership of public sector organisations with an interest in using and providing evidence from environmental observations. It aims:

- To achieve effective partnership working in environmental observations; and
- To maximise the benefits of observations to the UK including for science, policy and economic growth.

The UKEOF Coordinating Climate Observations Group ran from 2012-2014. The aim of the group was to oversee coordination of UK climate observing activities, advise on UK user priorities, and encourage implementation of common observing standards and methods. The group produced a report and a guidance note in 2013. Activities were then taken on by the UKEOF Management Group and Secretariat. The UKEOF holds a catalogue of UK monitoring and observation activities[6], which was updated in 2016 so records can now be searched in terms of Global Climate Observing System (GCOS) Essential Climate Variables (ECVs).

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6 https://catalogue.ukeof.org.uk

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 employs dedicated teams to inspect land and marine observing sites to ensure consistency of exposure according to WMO No. 8 guidelines and assess exposure using the CIMO siting classification for land observing sites. Details of local conditions, instruments and exposure (Metadata) are recorded using in-house developed software and archived.

In 2016, the Met Office undertook an exercise to introduce a new model of radiosonde across the observing network. As part of the project an extensive programme of intercomparison flights were conducted at stations across the network (including the BAS radiosonde station at Halley). The purpose of these intercomparison flights was to ensure the relative performance of the old and new radiosondes is well understood and documented for future reference.

British Rainfall Standard:

The national standard for the Acquisition and Management of Meteorological Precipitation Data from a Raingauge Network - BS 7843 (2012) was reported on previously and is still being used to minimise measurement uncertainty such as implementing change, collection of metadata, quality control and the operation of long-term monitoring sites.

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

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). These sites receive additional attention to prioritise mitigation of any potential issues at those sites that may compromise climate monitoring.

Automation of ordinary climate stations:

The Met Office continues to automate important manual climate stations at risk of closure to ensure the continuation of the climate record across the United Kingdom. The Automatic Weather Station network has exceeded 99% data completeness and 97.5% quality targets for 2017. Current challenges relate to new communication solutions and the introduction of SurfaceNet to replace the MMS system.

Voluntary climate observing stations:

The Met Office supports a supplementary network of approximately 160 manual stations to support national climate monitoring activities for the UK. Recent development includes the installation of new thermometry to remove mercury-in-glass thermometry from the UK observing network by October 2017.

Hydrological networks:

The Met Office work closely with a number of other partner agencies in the maintenance of supplementary rain gauge networks for hydrological applications. This results in a UK network of daily and monthly rain gauges currently in excess of 2,500. An important network for capturing detailed spatial information of rainfall, particularly extreme events.

Corrections to the global record of sea-surface temperature and humidity:

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[7]. Uncertainties in these corrections are also quantified and made available together with uncertainties relating to under-sampling. A prototype revision of the global surface marine humidity record has been produced in HadISDH, requiring careful quality control and correction of ship data to remove the impact of changes in measurement height through time.

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 provide reports on data quality and reporting issues from the global CLIMAT network to GCOS.

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 and has created 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[8] (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[9] has news of developments on INSPIRE and an archive of EC INSPIRE documents.

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7 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.

8 http://ceda.ac.uk

9 http://inspire.jrc.ec.europa.eu/index.cfm

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. However, the Met Office continues to provide a significant portion of both real time and historical data from its network of observing stations and weather forecasts under an open licence agreement.

NERC's Data Policy details its commitment to support the long-term management of environmental data by requiring that NERC-funded scientists must make their data openly available within two years of collection and deposit it in a NERC Data Centre for long term preservation. In this way all NERC-funded data are managed and made available for the long-term for anybody to use without any restrictions.

2.5 Data centres

The section describes UK efforts to ensure that international data centres are established and strengthened for all the Essential Climate Variables.

2.5.1 Met Office Hadley Centre

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. The below sets out the datasets available from the Met Office Hadley Centre.

Datasets available:

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 and 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.

More detailed 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 will soon extend series back to 1884 for temperature and 1862 for precipitation. Recently all UK climate observations and NCIC products have been made openly available for any purpose, both research and commercial.

An annual assessment of the State of the UK Climate has been published for the past three years, which puts the year just past into its historical context.

Global monitoring

The Met Office Hadley Centre routinely publishes, on the Met Office website, assessments of the global surface temperature on land and over the sea, global precipitation and Arctic and Antarctic sea ice extent. In addition, annual international assessments are significantly contributed to including the State of the Climate report published in the Bulletin of the American Meteorological Society and the WMO Statement on Climate.

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); night marine air temperature (HadNMAT – developed in collaboration with the National Oceanography Centre, Southampton); and sea level pressure (HadSLP); sub-daily station measurements of various meteorological variables (HadISD); global, gridded indices of extreme indices (HadEX, developed in collaboration with the University of New South Wales; and, with NOAA (USA), worldwide gridded land daily temperatures (HadGHCND). Recently, a prototype global (land and ocean) surface humidity data set has been developed (HadISDH). Many of these data sets and analyses are provided with quantified uncertainties. These and other data holdings are fully described on the Met Office Hadley Centre Observations website[10]. Some of these data have also been made available through the Centre for Environmental Data Analysis (CEDA).

The Met Office Hadley Centre is also contributing to the development of the Copernicus Climate Change Service (C3S) global surface data base service with provision of expertise on quality control and data integration.

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 simulations; comparison with other SST data sets and analyses; and the amalgamation and reporting of feedback from trial users.

As part of the EUMETSAT Climate Monitoring Satellite Application Facility, the Met Office Hadley Centre develops a Climate Data Record of Upper Tropospheric Humidity.

Co-ordination of international research on surface temperature

The Met Office Hadley Centre coordinates the EU Horizon2020 project EUSTACE (EU Surface Temperature for All Corners of Earth) This aims to produce a daily, globally-complete analysis of surface air temperature bringing together measurement made in situ with estimates from satellite data.

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 OPACE2 Expert Team on National Climate Monitoring Products

The Met Office Hadley Centre co-chairs the WMO OPACE2 Expert Team on National Climate Monitoring Products which has developed a common set of climate monitoring products (and code and guidance to calculate these) that all nations around the world could produce in order to facilitate their participation in global climate monitoring activities.

Reanalysis work:

The below sections highlight where the Met Office is involved in reanalysis of data.

EU-funded ERA-CLIM2 project developing next generation reanalysis at ECMWF

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[10] http://www.metoffice.gov.uk/hadobs/

The Met Office Hadley Centre has developed data sets and analyses for boundary forcing of and assimilation into ERA-CLIM2 reanalyses. These include: an ensemble of driving global SST and sea ice analyses (HadISST2); an integrated data base of surface and sub-surface ocean temperature and salinity; an extension of the sub-daily station data set (HadISD); advice on and facilitation of the use of early satellite data 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. 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

The Met Office plans to contribute in-situ surface data to the European 20th Century Reanalysis ERA-20C.

UERRA

The Met Office is also a major participant in the EU Framework 7 project Uncertainties in Ensembles of Regional Re-Analyses (UERRA). We have produced 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 data:

Met Office Hadley Centre model data are distributed through the MOHC Data Pipeline with the end point hosted by the Centre for Environmental Data Analysis which is part of the Science and Technology Facility Council (STFC). This activity provides climate simulations from the Met Office Hadley Centre to the UK and international academic community and beyond.

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[11] 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 of responsibility.

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[11] http://www.metoffice.gov.uk/weather/marine/observations/gathering_data/gcc.html

2.5.3 Permanent Service for Mean Sea Level (PSMSL)

The Permanent Service for Mean Sea Level (PSMSL) is the internationally recognised global sea level data bank for long-term sea level change information from tide gauges and bottom pressure recorders. The below sets out the background of the PSMSL.

Established in 1933, the PSMSL is responsible for the collection, publication, analysis and interpretation of sea level data from the global network of tide gauges and also provides a wider service to the sea level community. The PSMSL is embedded within the National Oceanography Centre (NOC) at Liverpool, and is funded by NERC/NOC. The PSMSL also reports to the International Association of Geodesy (IAG). PSMSL also has a key role in the Intergovernmental Oceanographic Commission's (IOC's) Global Sea Level Observing System (GLOSS) and contributes to the IAG Global Geodetic Observing System (GGOS). Towards the end of 2015, the PSMSL was accepted as a regular member of the International Council for Science – World Data System (ICSU-WDS).

Datasets available:

The primary aim of the PSMSL the provision of the global data bank for long-term sea level information from tide gauges. There are 65000 station-years from over 2200 stations in PSMSL (2016). The data set and ancillary information are provided free of charge and are made available to the international scientific community through the PSMSL website[12]. In addition, the PSMSL, together with the British Oceanographic Data Centre (BODC), is responsible for the archive of delayed-mode higher-frequency sea level data (e.g. hourly or higher frequency values) from the IOC's GLOSS Core Network.

Other activities carried out by PSMSL:

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 data sets have contributed to and acknowledged in all five Assessment Reports of the Intergovernmental Panel on Climate Change (IPCC). Dr Svetlana Jevrejeva was a lead author for Working Group I.

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.

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 two sites, the NOC Liverpool and the NOC Southampton. Data holdings include biological, chemical, physical and geophysical oceanographic data, including measurements of nearly 22,000 different variables.

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[12] https://www.psmsl.org

Datasets available:

Data can be retrieved directly from the BODC website[13]. Data currently available include:

- All data (including CTD profiles, current meter and wave data) held in the National Oceanographic Database
- Argo floats
- 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)
- Numerical model data — access to BODC's numerical model data holdings
- Historical bottom pressure recorder data

Services:

- NERC Vocabulary Server (NVS) web service - providing access to controlled vocabularies
- Sensor Web Enablement (SWE) - developing interoperable standards to publish sensors and their data on the web
- Published Data Library (PDL) - assigning Digital Object Identifiers (DOIs) in collaboration with the British Library
- Managing real time data from platforms such as Argo floats, gliders and seal tags for operational use in the Global Telemetry System and Global Data Assembly Centres

2.5.5 Centre for Environmental Data Analysis (CEDA)

The Centre for Environmental Data Analysis (CEDA)[14] is one of NERC's Environmental Data Centres, operating jointly for the National Centre for Atmospheric Sciences and the National Centre for Earth Observation. CEDA provides data and information services for environmental science, for the atmospheric science and Earth observation research communities. The role of the CEDA is to assist UK researchers to locate, access, analyse and interpret data.

Datasets available:

The data held at the CEDA are of two types:

- Datasets produced by NERC-funded projects: these datasets are of high priority since the CEDA 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. UK Met Office, ECMWF, ESA and WCRP datasets).

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[13] https://www.bodc.ac.uk/data/online_delivery/

[14] https://www.ceda.ac.uk

Some datasets of particular relevance to the UNFCCC:

- Couple Model Intercomparison Project Phase 5 (CMIP5): CEDA holds a 1Pb copy of the core of the CMIP5 archive, including the projections which underpin the IPCC 5th Assessment Report;
- ESA Climate Change Initiative: CEDA hosts data from 14 ESA CCI projects: cloud, aerosol, ocean colour, glaciers, sea level, fire, soil moisture, ozone, greenhouse gases, sea ice, Greenland ice sheet, land cover, Antarctic ice sheet, and sea surface temperature.

2.5.6 The IPCC Data Distribution Centre (DDC)

The UK component of IPCC Distribution Centre is run by CEDA (see above) on behalf of the IPCC, funded by the Department for Business, Energy and Industrial Strategy. The DDC is overseen by the IPCC Task Group on Data and Scenario Support for Impact and Climate Analysis (TGICA)[15] and jointly managed by the Centre for Environmental Data Analysis (CEDA) in the United Kingdom, the ICSU World Data Centre Climate (WDCC)[16] in Germany, and the Centre for International Earth Science Information Network (CIESIN)[17] at Columbia University, New York, USA. The data are provided by co-operating modelling and analysis centres.

The UK component of the DDC hosts the main web pages[18], guidance documents on the use and interpretation of climate data and a variety of data resources. The main web pages link through to additional resources provided by the US and German partners.

The data resources include climatologies of observational data and simulations.

2.5.7 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.

2.5.8 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 and 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.

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15 http://www.ipcc.ch/activities/tgica.shtml

16 http://www.wdc-climate.de/

17 http://www.ciesin.columbia.edu/

18 www.ipcc-data.org

Datasets available:

The NRFA is the UK's focal point for hydrometric data, providing stewardship of, and access to, over 61,000 years' of daily river flow data from 1465 gauging stations. The NRFA also holds two further types of data – annual maxima (AMAX) and peaks over threshold (POT) for approximately 1,000 stations which forms the basis for flood risk estimation and underpin flood research in the UK. Across the UK, 1174 gauging stations are currently operational and providing data to the national archive (November 2017). 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.

Improvement of Datasets:

Efforts are made to improve data quality through rigorous quality assurance and control 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, and a marked increase in these areas has been witnessed since its implementation. 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. For AMAX and POT data, and the accompanying metadata, a programme of period of record validation exists at the NRFA, whereby a proportion of the dataset is reviewed each year, which identifies any inconsistencies in the historical record with a systematic review process.

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. The original Benchmark Network (UKBN) was designated in 2003, and has since been systematically reviewed resulting in its second iteration, UKBN2. Each of the 146 Benchmark catchments has been assigned a score base on their benchmark suitability at low, medium and high flows, recognising all stations cannot be benchmark across the full flow regime. 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.

Data sharing:

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 225 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.

2.5.9 European Centre for Medium-Range Weather Forecasts (ECMWF)

The European Centre for Medium-Range Weather Forecasts (ECMWF) is 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 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. ECMWF is currently developing a new global atmospheric reanalysis, ERA5, which will replace ERA-Interim when production is complete in 2018. ERA5 uses a recent (2016) version of the ECMWF Integrated Forecast System and will provide data at a global resolution of 31 km.

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.

Finally, ECMWF has been entrusted by the European Commission with the implementation of two environmental information services within the EU Copernicus Earth Observation Programme: the Copernicus Climate Change Service (C3S) and the Copernicus Atmospheric Composition Service (CAMS). The implementation of both services relies on contributions from many European institutions, including national meteorological services, satellite agencies and

private companies. The services also make use of ECMWF's modelling and data assimilation systems for generation of global datasets in support of environmental monitoring and prediction.

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:

The below sections highlight where the ECMWF is involved in reanalysis of data.

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 was 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 have been available to users since mid-2014. The follow-up ERA-CLIM2 project (2014-2017) extends these activities to the production of climate reanalyses based on a coupled atmosphere-ocean model. A substantial work package, led by the Met Office, is dedicated to research and development in coupled data assimilation.

2.6 Capacity building

The sections below describe activities for capacity-building in least developed countries, small island developing States and countries with economies in transition related to the collection, exchange and use of observations.

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 MetService.

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 the Secretariat of the Pacific Regional Environment Programme (SPREP) and New Zealand's MetService) at Funafuti in Tuvalu and Tarawa in Kiribati. 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.

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), has a major WMO GAW station on Sao Vicente, Cape Verde since 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

The sections below provide an overview of UK activities in setting current climatic changes within a historical context using palaeoclimate data.

Palaeoclimate data relating to a range of climate variables are being acquired and synthesised by a number of groups in the UK. The UK has several world-leading laboratories for palaeoclimate research, with specialties including novel proxies for past climate conditions, model-data integration, and creation of high-resolution records. In addition, much of this

research into climate of the past is only possibly due to the UK's leading role in ocean and continental drilling programmes[19&20]

- National Oceanography Centre & University of Southampton: Current research topics within the Palaeoceanography and Palaeoclimate and Geochemistry Research Groups include:
  - Climate sensitivity in the past
  - Past ocean circulation, temperature, climate and continental ice volume (sea level).
  - The history of biogeochemical cycling and global biodiversity.
  - High frequency climate change on seasonal through centennial time scales.
  - Past changes in regional and global carbon cycling, including ocean acidity and atmospheric CO_2 levels. Long-term impacts of climate dynamics on past human societies (PLUS – geography)
- University of Aberdeen:
  - Research into the influence of past climates on the behaviour of ice sheets and glaciers, using landforms and landscapes.
- 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:
  - Multi-proxy research on ocean-ice-climate interaction in the North East Atlantic to investigate ocean circulation, climate and ice sheet behaviour during the last 60,000 years.
- University of Cambridge:
  - Department of Earth Sciences – current research includes:
    - Understanding astronomical forcing of climate change records as recorded in oceanic sediments.
    - Multi-proxy studies of abrupt climate change in the oceans, and its impacts recorded in ice.
    - Sedimentological and geochemical tracers of past deep-sea circulation vigour and its role for changing atmospheric CO2:
    - Use of foraminiferal metal chemistry and the stable isotopic composition of biogenic sediments in palaeochemical studies of ocean temperature and nutrient variations.
    - The stability of the Greenland and West Antarctic ice sheets, particularly during past warm periods

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19 https://www.iodp.org/

20 https://www.bgs.ac.uk/icdp/

  - ‘Cambridge Quaternary’ (comprised of staff and students from Archaeology, Earth Sciences, Geography, Plant Sciences and Zoology departments): research centres on glacial cycles over the past 2.6 million years, causing significant fluctuations in sea level, major geographical changes and major plant and animal population migrations. Sedimentary sequences record these changes in great detail and are central to unravelling past events.

- Cardiff University:
  - Current research projects cover a wide variety of timescales, ranging from the causes and consequences of rapid climate change since the last ice age; to the reasons for the long-term global cooling since the age of the dinosaurs. Archives such as deep-sea cores contain evidence of sudden and gradual change in factors like seawater temperatures, ice cover, ocean currents, and CO2 levels that tell us how the climate system works. Recent focus on historic climate change.
- 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 St Andrews:
  - Research on global change covers environments from forests and tropical coral reefs, to the polar ice caps and deep ocean, investigating change in climate and marine chemistry on timescales ranging from millions of years to months, and seeking to understand controls on environmental change in Earth’s past, present and future.
- 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.

- Durham University:
  - Palaeoclimate research group uses geochemical, biological, and geological proxies to reconstruct climate change throughout geological time. All temporal scales are represented, from ultra-high resolution records of tropical cyclone activity over the last two thousand years to records of the timing and extent of global glaciations more than one billion years in the past. The group's vision is to clarify how the climate system responded to external and internal forcings in the past, and then use this information to predict how climate may respond in the future.
- University of Birmingham: palaeoclimate research integrates sedimentologists, palaeontologists, geochemists and climate modellers to produce an integrated view of ancient palaeoenvironmental change. Current projects include:
  - Palaeoclimate Records from Ocean Drilling
  - Origins and Global Impacts of Antarctic Glaciation
  - Palaeoclimate Proxy data assimilation into Climate Models
  - Novel climate proxies from coccolith calcite
  - Atmospheric Forcing of Sulphate in Speleothems
  - Early Cenozoic climates of Extreme Warmth
- University of Exeter (Camborne School of Mines)
  - The Deep Time Global Change group seeks to understand the geological history and governing processes behind some of the major environmental changes that have affected the Earth through deep time. Using samples from cores and outcrops, work spans from lithosphere to atmosphere, and an age range from the Precambrian to the Quaternary.
- University of Bristol: Research at the Cabot Institute includes:
  - Determining the drivers of environmental and climate change in the distant past and linking it to the future.
  - Heavy focus on climate modelling
  - Understanding past changes in ice sheet extent in response to past climate
  - Proxies for palaeoclimate reconstruction
- University of Oxford; Department of Earth Sciences in oceanography, climate and Palaeoenvironment research group
  - Assessment of how the climate system operates in the past using cave deposits
  - Investigations into sealevel variation and ice volume change
  - Using the geological records from the Mesozoic to understand how the climate system operates when warmer than today.
  - Ocean anoxia in the Mesozoic.

- University of Plymouth (Centre for Research in the Earth Sciences)
  - Understanding response of the climate system to large perturbations of the Earth system
  - Ocean anoxia in the Mesozoic, mass extinctions and climate change.
- University of Nottingham (School of Geography: Geosciences Research Theme)
  - Reconstructing the past environment on a variety of scales.
  - Human impacts and their intersection with climate change
  - Calibration of novel proxies.
- Northumbria University (Geography and Environmental Sciences, cold and Palaeo-environmental Group)
  - Understand the interplay between the ancient biosphere, atmosphere and cryrosphere to improve the understanding of the Earth System
- Imperial College London (Earth Sciences and Engineering, within MAGIC research group)
  - Long-term ocean circulation patterns & climate change
  - Monsoon dynamics in Central Asia during the Holocene
  - Stability and dynamics of the Antarctic Ice Sheet
  - Global atmospheric dust cycle - Geochemistry and Modelling
- The Open University (Environment, Earth and Ecosystem Sciences)
  - Rapid global warming events
  - Sea-level change, stratigraphy and sedimentology
  - Palaeoceanography and oceanography
  - Palaeobiology and ecosystem dynamics
- University of Leeds (School of Earth and Environment; Institute for climate and atmospheric science)
  - Use computer simulation and proxy data to understand the evolution of the climate system

2.8 Guideline issues

Steps being taken to improve the availability of information:

As detailed in section 2.3.1, the UKEOF set up a coordinating Climate Observations Group which ran from 2012-2014. The aim of the group was to oversee coordination of UK climate observing activities, advise on UK user priorities, and encourage implementation of common observing standards and methods. The group produced a report and a guidance note in 2013. Activities were then taken on by the UKEOF Management Group and Secretariat. The UKEOF holds a catalogue of UK monitoring and observation activities which was updated in 2016 so records can now be searched in terms of Global Climate Observing System (GCOS) Essential Climate Variables (ECVs).

3. Atmospheric Essential Climate Variables (ECVs)

The below sections describe the UK's national contributions of atmospheric ECV observations to the international community, with a focus on the requirements outlined in the GCOS implementation plan.

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), supported by the UK through VCP. 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 jointly by SAWS and the UK (through VCP); Bermuda is run by serco for the Bermudan Government; and Pitcairn is serviced by MetService New Zealand (supported through funding from VCP).

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 two 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 four 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 drifting buoys per year in the North Atlantic, Nordic Seas and Mediterranean. At end of October 2017, 67 drifters were operating in the frame of E-SURFMAR. This includes 60 E-SURFMAR funded Iridium SVP-Bs (including nine in the Arctic and one HRSST-2 drifters with more accurate SST sensors), the remaining buoys were one ICEB buoy in the Arctic and six Iridium drifters owned by NOAA upgraded with barometers by E-SURFMAR.

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 ten drifters each year, with 15 drifters active at end October 2017.

The Met Office currently manages around 241 Voluntary Observing Ships (VOS) making manual observations, of which around 224 meet climate (VOSClim) standards. Over the last six years the Met Office has developed an Autonomous Marine Observing System (AMOS),

which has now been installed on 60 ships, initially only operating around the British Isles, but now also further afield on vessels sailing in the Far East and South Atlantic. All VOS data are exchanged on the Global Telecommunication System (GTS) and available to the International Comprehensive Ocean-Atmosphere Data Set (ICOADS)[21]. This includes the contribution from two 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 151 synoptic stations. There are an additional 2700 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.

[21] 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 two sites in the UK are Lerwick (03005) and Camborne (03808). There are 2 GUAN stations overseas: St Helena (61901) and Mt. Pleasant (88889), and two GUAN stations in UK overseas territories: Gough Island (jointly supported by SAWS and the Met Office through VCP) (68906) and Bermuda (78016).

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 Met Office is a contributing member of the EUMETNET E-ASAP programme, which manages the ship-bourne radiosonde network on behalf of members.

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 also processes GPS water vapour data on behalf of a number of other National Meteorological Services and provides the data processing services on behalf of EUMETNET under the E-GVAP programme.

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 EUMETNET wind profiler network (E-PROFILE).

The Met Office manages 1500+ AMDAR (Aircraft Meteorological Data Relay) reporting aircraft within the E-AMDAR Programme that generates 60,000+ high quality upper air observations of temperature, wind speed and wind direction from commercial aircraft on a daily basis. A small number (9) aircraft in Europe also report humidity observations from water vapour sensor installed as part of an E-AMDAR Extended Humidity Trial project. E-AMDAR is a major contributor to the World Weather Watch (WWW) of WMO, forming a regional component of the WMO AMDAR global Programme.

British Antarctic survey:

The British Antarctic Survey acquires measures of air temperature, air pressure, wind speed and direction and water vapour at Rothera and Halley stations. The upper air programme at the Halley (89022) station is fully GCOS compliant and forms part of GUAN network. For the Antarctic winters of 2017 and 2018 Halley has been closed between the start of March and the start of November due to safety concerns caused by a large crack that has formed in the ice shelf that it is built on. During these time is it not possible to carry out radiosonde ascents. Rothera upper air programme is GCOS compliant in all respects except that it has flights on only 5 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 Long-term observatories:

The Chilbolton Facility for Atmospheric and Radio Research (CFARR) in southern England is operated by the Rutherford Appleton Laboratory. The main activity of the station is the remote sensing of clouds and aerosols using cloud radars and lidar. Co-located surface meteorological measurements including solar irradiance (relevant to the surface radiation budget) are also taken. Continuous monitoring of cloud profiles has allowed evaluation of biases/errors in model cloud parameterisations. 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. Chilbolton has played a leading role in international collaborations on remote sensing of clouds such as CLOUDNET, and now ACTRIS.

The Mesosphere-Stratosphere-Troposphere Radar Facility at Aberystwyth is operated by the Rutherford Appleton Laboratory. The primary role of the facility is to measure upper air wind speed and direction profiles with high vertical and time resolution. Continuous measurements started in 1997. Supporting measurements of cloud base and surface meteorological parameters are also made, and the station hosts a UV-visible zenith sky spectrometer which contributes stratospheric ozone and NO_2 column totals to NDACC.

The Weybourne Atmospheric Observatory on the north Norfolk coast has since 2012 been measuring greenhouse gas concentrations (CO_2, CH_4, N_2O, SF_6, and CO) on a continuous basis. Ozone, oxygen, hydrogen and basic meteorological parameters are also measured.

3.3 Contributions to the Global Atmospheric Watch

Cape Verde Atmospheric Observatory:

The Cape Verde Atmospheric Observatory[22] 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 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 six long-term observatories that are part of NCAS's Atmospheric Measurement Facility (AMF) 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. The gases measured are O_3, CO, NO, NO_2, NO_y, VOCs, halocarbons, and mercury. Data is archived at both the World Data Centre for Greenhouse Gases (WDCGG) and the World Data Centre for Reactive Gases (WDCRG). The Observatory has been audited by WMO GAW for ozone, carbon monoxide, greenhouse gases and VOCs and was featured in the 2017 WMO/GAW Reactive Gases bulletin[23].

Long-Term Atmospheric Trace Gas Monitoring at Mace Head, Ireland:

Atmospheric composition monitoring began at Mace Head in 1987 with measurements of ozone, and a range of gases as part of GAGE (CH_4, N_2O and the CFCs) and now cover a wide range of parameters relevant to all of the atmospheric ECVs including measurements of ozone, CO, H_2, CO_2, CH_4 and other GHGs (including N_2O, SF_6, NF_3, HFCs, PFCs, halocarbons and a range of ozone depleting substances) and aerosol optical depth. Mace Head has the dual status of a WMO GAW global station and is an EMEP supersite. Mace Head is also part of AGAGE[24] and the "UK DECC (Deriving Emissions linked to Climate Change) Network[25]". 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. Mace Head also contributes to the NOAA collaborative sampling network, filling weekly flasks that are returned to NOAA/ESRL's Global Monitoring Division.

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, with measurements dating back to the 1950s. The Reading site uses a Brewer spectrophotometer with measurements dating back to the 1990s. 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 by the University of Manchester.

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22 http://www.ncas.ac.uk/index.php/en/cvao-home

23 https://library.wmo.int/opac/doc_num.php?explnum_id=3554

24 http://agage.mit.edu/

25 https://www.metoffice.gov.uk/research/monitoring/atmospheric-trends

Sun photometers:

Sun photometer measurements of the direct (collimated) solar radiation provide information to calculate the columnar aerosol optical depth (AOD). There are currently 18 sun photometer stations in the UK which are collecting data for the assessment of aerosol optical depth as part of the NASA AERONET project. These are listed below and they operate a CIMEL sun photometric system. Additionally there is a PREDE POM sun photometer which is operated by the Plymouth Marine Laboratory which is not part of the AERONET network.

Bayfordbury (51N,0W)
Blyth_NOAH (55N,1W)
Camborne_MO (50N,5W)
Chilbolton (51N,1W)
EastMalling_MO (51N,0E)
Edinburgh (55N,3W)
Exeter_MO (50N,3W)
Glasgow_MO (55N,4W)
Leicester (52N,1W)
Loftus_MO (54N,0W)
Oxford (51N,1W)
Portglenone_MO (54N,6W)
Rame_Head (50N,4W)
Rhyl_MO (53N,3W)
Stornoway_MO (58N,6W)
Thornton_C-power (51N,2E)
Watnall_MO (53N,1W)
Weybourne (52N,1E)

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. As stated earlier, Halley has been closed during the Antarctic winter of 2017 and will not operate in the Antarctic winter of 2018. NOAA samples will be collected weekly when the station is operating during the Antarctic summer.

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 CO2 & 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.

UK DECC (Deriving Emissions linked to Climate Change) Network:

The UK DECC Network[26] is a network of tall tower measurement sites set up to complement the measurements that take place at Mace Head, Ireland. This is described in detail in section 2.11 of Chapter 2.

Defra funded networks monitoring air pollution: United Kingdom Eutrophying & Acidifying Network (UKEAP):

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[27] is operated by CEH and supports atmospheric chemistry, climate and ecosystem measurements by Defra/EA, research organisations and SMEs. Within EMEP the site aims to contribute as a Level II/ III site. Auchencorth Moss has been contributing since 2006, and gained regional status in WMO-GAW in 2014. It became an ICOS site in 2017. 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 including radiation measurements, surface wetness, soil surface and below surface temperature, water vapour fluxes. The datset is archived on the NERC/STFC CEDA catalogue[28]. 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

[26] https://www.metoffice.gov.uk/research/monitoring/atmospheric-trends

[27] http://www.auchencorth.ceh.ac.uk/

[28] http://catalogue.ceda.ac.uk/uuid/8e6cbb111cfd41a19c92aadcb2d040fd

stream that flows out of the site including flow, composition and GHG gas exchange information (held internally at CEH). The site has facility for short term intensive atmospheric measurements and for testing of prototype technologies.

4. Oceanic Essential Climate Variables (ECV)

The below sections describe the UK's national contributions of oceanic ECV observations to the international community, with a focus on the requirements outlined in the GCOS implementation plan. Collection of oceanographic (and marine) observations is widely distributed throughout the UK, with many government departments and laboratories, universities and commercial companies involved.

4.1 Measurements of surface oceanic ECVs

Met Office:

The Met Office routinely produce (and periodically enhance) many global ocean products (including SST, see section 2.5).

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.

National Oceanography Centre:

Global Sea Level Observing System:

The Global Sea Level Observing System (GLOSS) tide gauge network, which is coordinated by IOC with assistance from NOC, Liverpool, provides sea level and supporting measures of air pressure to the GLOSS Core Sea-Level Network. The UK contributes 3 tide gauges 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. PSMSL is providing assistance for data management for some stations situated in Africa and the Caribbean. The 3 UK stations are part of the UK Tide Gauge Network (see below).

UK National 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 UK Environment Agency is now responsible for the operation of the 44 permanent tide gauge sites around the UK itself. However, the NTSLF is 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/NOC)	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.

UK Argo Programme:

The UK Argo Programme that contributes to the international Argo array of profiling floats measures temperature and salinity in the water column. The UK presently has 173 active floats contributing to the Argo float array. The UK Argo programme is managed by the Met Office and operated in partnership with NOC, BODC and PML.

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. There are currently 40 deep floats deployed in the oceans, which are capable of measuring to a maximum depth of 3,500 to 6,000 metres, depending on float model. Deep ocean currents are derived from positions of floats as they surface, usually every 10 days. At present, 288 floats are measuring biogeochemical parameters[29] in addition to temperature and salinity. Of these, 279 floats are measuring dissolved oxygen. All float numbers are from JCOMMOps website, as at 14 November 2017.

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

[29] A float must measure between one and six of these six essential variables to be considered a biogeochemical Argo float: dissolved oxygen, nitrate, pH, chlorophyll-a, backscattering, irradiance

the GDACs. At September 2017, about 54% of eligible delayed-mode 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)[30] — VOS-based upper ocean CO_2 parameters, funded by the Swire Group Trust and China Navigation.
2. Carbon-OPS project[31] — 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)[32] — biogeochemical surveys of N and S Atlantic. The programme is now entering its fifth phase with funding from NERC's LTSS National Capability to the Plymouth Marine Laboratory (PML).

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	~173	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[33] 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 - BAS also conducts quasi-annual autonomous underwater vehicle (ocean glider) deployments from Rothera, to extend the spatial scale of the monitoring across Marguerite Trough and the Antarctic Peninsula shelf, with measurements including ocean temperature, salinity, fluorescence and mixing.. BAS holds other CTD datasets

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30 http://www.snoms.info/

31 www.bodc.ac.uk/carbon-ops

32 http://www.amt-uk.org/default.aspx

33 https://www.bas.ac.uk/project/rats/

collected in consistent sampling areas over time, e.g. Drake Passage and Western Core Box, in addition to those collected at the Antarctic Peninsula.

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 RAPID-26N array is funded by NERC and run by NOC and became operational in April 2004. It comprises a monitoring array of 25 moorings and landers and contributes measurements of sub-surface temperature, salinity, oxygen, currents and bottom pressure. Currently a trial for gathering further biogeochemical data is underway.

Plymouth Marine Laboratory:

The Atlantic Meridional Transect (AMT) provides an array of measurements of relevance to surface and sub-surface ECVs over 100° of latitude in the Atlantic Ocean. These include: ocean acidification, phytoplankton, ocean colour, partial pressure CO_2, carbon, nutrients, oxygen, greenhouse gases, temperature and salinity. AMT has provided over two decades; sustained observations of biogeochemical variables including named ECVs, an annual research cruise with opportunities to collaborate for the international community, access to the remote North and South Atlantic gyres, opportunities for technological development. The Western Channel Observatory is a NERC funded (LTSS – National Capability) 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 extended Ellet line oceanographic section (from Scotland to Iceland) provides a comprehensive range of measurements of relevance to many of the oceanic surface and subsurface ECVs. This includes measurements of nutrients, carbon, oxygen, salinity and temperature of the column and subsurface currents. This line has been extended in 2014 to Canada via Greenland completing a transatlantic section. The transatlantic section will be repeated in 2022. This section contributes to The Global Ocean Ship-Based Hydrographic Investigations Program (GO-SHIP). Measurement standards are maintained through long-established 'best practice' and follow protocols outlined by GO-SHIP. Data and meta data are reported and logged through the BODC. SAMS also maintains a winter occupation of the extended Ellett line using Seagliders. These autonomous vehicles glide from the surface to 1 km depth, from Scotland to Iceland to Scotland collection temperature and salinity profiles and depth-averaged currents.

The UK maintains two mooring arrays contributing to international transatlantic transport monitoring programmes: OSNAP array (since 2014) in the subpolar gyre (SAMS & NOC supporting 9 mooring sites) and; RAPID-MOCHA-WBTS array (since 2004) in the subtropical gyre (NOC supporting 32 mooring sites). SAMS also has a continuous Seaglider presence from

Scotland to the Iceland Basin as part of OSNAP. These transport monitoring arrays and glider missions are funded as part of research programmes rather than via sustained observation budgets.

Marine Scotland Science:

Marine Scotland Science (MSS) coordinates environmental monitoring programmes covering coastal locations around Scotland and key hydrographic sections in the Northern North Sea and Faroe-Shetland Channel. Branded under the Scottish Coastal Observatory (SCObs), temperature, salinity, nutrients, chlorophyll, phytoplankton, zooplankton and ocean acidification are monitored around the Scottish coast and have been since 1997. SCObs sites provide data to fulfil the monitoring requirements of the Water Framework Directive and Marine Strategy Framework Directives, as well as generating the time series of data to describe variability in coastal waters and investigate the impacts of environmental change. MSS also support ship-based hydrographic surveys in the Faroe-Shetland Channel and Northern North Sea, collecting temperature, salinity, nutrients, chlorophyll and oxygen measurements. An array of moorings has also been maintained in the Faroe-Shetland Channel since the early 1990s. Combining these current observations and satellite sea surface height measurements (altimetry) provide a gap-less time series of the transport of Atlantic Water. These are critical measurements of the warm-water–path of the North Atlantic Current as it enters the Nordic Sea. Changes in temperature and transport there would be strongly indicative of changing ocean circulation in response to climate change. Measurement standards are maintained through long-established 'best practice'. Data and meta-data are reported and logged internally, as well as through the BODC and ICES data centres. MSS monitoring programmes are funded through Scottish Government funding budgets, supplemented with European research programme funding.

Water Framework Directive Monitoring:

The Water Framework Directive monitoring network includes measurements in coastal areas, covering Transitional (estuaries) and Coastal Waters. In England and Wales monitoring takes place up to one 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 (hazardous substances, nutrients, dissolved oxygen, salinity, temperature, phytoplankton, benthic invertebrates, macroalgae, seagrass, saltmarsh and estuary fish).

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 approximately 13 shipping companies, it obtains samples at monthly intervals on about 22 routes across the oceans. The Foundation has been collecting plankton with the resulting data providing information on biogeography and ecology of the planktonic community. The results of the Survey are used by marine biologists, scientific institutes, governmental bodies and in environmental change studies across the world.

5. Terrestrial Essential Climate Variables (ECVs)

The below sections describe the UK's national contributions of terrestrial ECV observations to the international community, with a focus on the requirements outlined in the GCOS implementation plan.

Terrestrial observations are made or coordinated by the Natural Environment Research Council (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.

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, 67 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	67	67	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

The information below provides additional information on the UK's national climate programmes that contribute observations of the ECVs not reported elsewhere in these reports.

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 the 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 Meteosat series (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.

The UK has also provided instruments to international programmes. DECC (now BEIS; 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. Additional funding has supported the reprocessing of the ATSR-1 and ATSR-2 datasets into the format used by AATSR in order to create a consistent, long-term sea surface temperature archive. The availability of the long-term archive has led to a wealth of scientific exploitation of the ATSR data. This includes the development of several surface temperature datasets, the latest of which is the ATSR Arctic Surface Temperature (AAST) dataset. In order to ensure that the ATSR geophysical data products are reliable, they must be validated by comparing them with *in situ* measurements. Measurements from the long-term *in situ* deployment of the Infrared sea surface temperature Autonomous Radiometer (ISAR), and also from the Scanning Infrared Sea surface Temperature Radiometer (SISTeR), have confirmed the consistency of the sea surface temperature data products. Following a break in the series with the failure of ENVISAT, similar future European capabilities have resumed with the launch of the Sea and Land Surface Temperature Radiometer (SLSTR) instrument on the Copernicus Sentinel 3A platform in 2016, to be followed by Sentinel 3B, C, and D in future years.

More recently, UK involvement in the Sentinel programme has included provision of the satellite platform for the Sentinel-5 Precursor mission, which was successfully launched in October 2017.

Through a bilateral Implementation Arrangement with CNES in France the UK is also contributing to:

- **SWOT**: the NASA led Surface Water and Ocean Topography (SWOT) mission. This mission will provide vital oceanographic data to help understand climate change. The UK has designed and built the Duplexer to this mission.
- **IASI NG**: This mission will determine temperature and water vapour profiles in the atmosphere, record ocean surface and land temperatures and monitor a vast range of chemical compounds and other key variables for climate research, including greenhouse gases, desert dust and cloud cover. UK is supplying the detectors for the IASI-NG instruments flying aboard the MetOp-SG satellites, providing atmospheric temperature and composition information contributing to NWP and ECVs;
- **MicroCarb**: The UKSA is a mission partner with CNES on the MicroCarb mission. MicroCarb is a small satellite mission monitoring CO_2 sources and sinks over the whole Earth, and on a regional scale to inform climate change decision making. It is the first European mission dedicated to Carbon. The UK Space Agency has agreed to fund and manage the Assembly, Integration and Test (AIT) of the satellite. The UK has also committed to providing key elements of the mission preparation activities, contributing UK scientists to the Mission Advisory group, calibration and validation activity- including UK contributions to the OGSE and development of the Payload Data Ground Segment and a pointing and calibration sub-system as well as other platform and instrument sub-system development. MicroCarb is set to launch in 2020.

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 at least 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 largest contributor to the second phase of CCI known as CCI+ 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 LeicesterMet Office, Space Connexions
User group	Met Office (lead)

ESA sponsors other relevant research, e.g. through its DUE (Data User Element) programme[34] and the STSE (Support to Science Element) programme[35] 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[36/37].

Other ESA sponsored projects relevant to ECV production with 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 CO2 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
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

UK is participating in a range of EU Framework 7 projects aimed at developing climate services incorporating the use of satellite data.

Internationally, the UK is a member of the Committee on Earth Observation Satellites (CEOS) and is a participating member of its Working Group on Climate (WGClimate). This is a joint group including CEOS Agencies and the Coordination Group for Meteorological Satellites (CGMS), with a remit to coordinate and encourage collaborative activities between the world's major space agencies in the area of climate monitoring with the overarching goal of improving the systematic availability of Climate Data Records through the coordinated implementation and further development of a global architecture for climate monitoring from space.

WGClimate facilitates the implementation and exploitation of ECV time-series through coordination of the existing and substantial activities undertaken by CEOS Agencies and via strong collaboration with other CEOS Working Groups and Virtual Constellations. The UK has provided input to the CEOS Agency response to the GCOS Implementation Plan and the ECV Inventory and Gap Analysis to the UNFCCC.

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34 http://due.esrin.esa.int/

35 http://due.esrin.esa.int/stse/

36 http://due.esrin.esa.int/duedirectory2010.pdf provides a complete list of all DUE projects

37 http://due.esrin.esa.int/stse/files/document/STSE_report_121016.pdf provides a complete list of all STSE projects

The UK also participates in Global Earth Observation/Global Earth Observation System of Systems (GEO/GEOSS)[38] and leads the coordination of Group for High Resolution Sea Surface Temperature (GHRSST; with UK funding from NERC)[39]. NCEO hosts the UK GEO/CEOS office and the GHRSST Project Office.

National activities also include:

- Development and use of ECVs within NERC's National Centre for Earth Observation[40], including activities which span most of the satellite related ECVs. There is close collaboration with the ESA CCI programme and the European Commission's Copernicus Climate Change Service (C3S).
- 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)[41]
- Funding for national infrastructure to develop and archive ECVs through NERC's Centre for Environmental Data Analysis (CEDA) and JASMIN facility located at Rutherford Appleton Laboratory (RAL) and closely associated with the Satellite Applications Catapult. The capacity to develop and archive ECVs at the RAL facilities through NCEO has been augmented by funding from UK Space Agency to create a "Climate data from Space Zone".
- Establishment of the Space4Climate (formerly CDSSG)[42] initiative to coordinate the flow of data for climate. This is chaired by government but part funded by academia and industry, the group brings together all elements and people involved and aims to create a seamless supply chain of space climate data to users and customers who are non-experts in space data. There is a dedicated data processing zone and various activities of the group to respond to the challenges such a big ambition creates.

In addition, as stated in the 6th National Communication, 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"[43]. 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.

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38 https://www.earthobservations.org/geoss.php

39 https://www.ghrsst.org/contact/ghrsst-project-office-contacts/

40 http://www.nceo.ac.uk/

41 http://www.ceh.ac.uk/staffwebpages/drfrancegerard.html

42 http://www.the-iea.org/space4climate/

43 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	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			(kt CO_2 equivalent)			(kt)					
Total national emissions and removals	598,519.96	5,413.90	172.24	14,391.43	1,651.53	NO,NE	0.06	0.00	2,929.37	7,424.52	2,951.37	3,695.51
1. Energy	567,583.58	1,492.22	16.25						2,877.07	6,488.24	1,867.99	3,619.24
A. Fuel combustion (Sectoral approach)	560,107.09	125.35	16.11						2,863.20	6,428.01	1,078.71	3,590.78
1. Energy industries	235,822.84	8.12	4.66						863.88	136.49	9.10	2,887.48
2. Manufacturing industries and construction	95,418.76	4.52	3.64						413.08	395.32	31.16	404.25
3. Transport	114,252.40	50.14	4.65						1,320.73	4,803.70	945.78	90.68
4. Other sectors	109,328.27	62.42	3.00						226.56	1,079.14	90.45	202.20
5. Other	5,284.82	0.15	0.16						38.96	13.37	2.21	6.17
B. Fugitive emissions from fuels	7,476.49	1,366.87	0.14						13.87	60.23	789.29	28.46
1. Solid fuels	1,698.56	873.07	0.00						0.53	38.74	223.64	20.68
2. Oil and natural gas and other emissions from energy production	5,777.92	493.80	0.14						13.34	21.49	565.65	7.78
C. CO_2 Transport and storage	NO											

Greenhouse Gas Source and Sink Categories	Net CO_2 emissions/ removals	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			(kt CO_2 equivalent)			(kt)					
2. Industrial processes and product use	24,525.61	11.27	81.91	14,391.43	1,651.53	NO,NE	0.06	0.00	37.31	609.12	934.76	68.78
A. Mineral industry	9,803.78								NO	5.30	4.65	4.27
B. Chemical industry	6,764.97	8.55	79.86	14,387.09	17.55	NO	NO	NO	18.03	94.97	172.08	39.52
C. Metal industry	7,403.74	1.48	0.06	NO	1,553.11		0.02		19.28	508.85	2.38	23.13
D. Non-energy products from fuels and solvent use	553.12	NO,IE	NO,NE,IE						NO,IE	NO,IE	678.41	1.87
E. Electronic industry				4.34	NO,NE,IE	NO,NE	NO,NE,IE	0.00				
F. Product uses as substitutes for ODS				NO,NA,IE	NO							
G. Other product manufacture and use	NO	NO	1.99		80.87		0.04		NO	NO	NO	NO
H. Other	IE,NE,NO	1.24	NO						NO	IE,NO	77.24	IE,NO
3. Agriculture	1,831.42	1,317.85	63.08						7.61	279.91	131.91	NO
A. Enteric fermentation		1,120.78										
B. Manure management		177.79	5.94								105.84	
C. Rice cultivation		NO									NO	
D. Agricultural soils		NE	56.48						NE	NE	NE	
E. Prescribed burning of savannas		NO	NO						NO	NO	NO	
F. Field burning of agricultural residues		8.21	0.21						7.61	279.91	26.06	
G. Liming	1,576.48											
H. Urea application	252.19											
I. Other carbon-contining fertilizers	NO											
J. Other	2.75	11.07	0.45						NE,NO	NE,NO	NE,NO	NO

Greenhouse Gas Source and Sink Categories	Net CO_2 emissions/ removals	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			(kt CO_2 equivalent)					(kt)			
4. Land use, land-use change and forestry	3,222.58	0.66	8.26						0.79	17.05	NO,NA	NA
A. Forest land	-10,540.57	0.13	1.35						0.08	2.95	NO	
B. Cropland	15,122.71	0.00	3.42						0.00	0.09	NO	
C. Grassland	-7,750.95	0.40	0.03						0.62	10.93	NO	
D. Wetlands	486.95	NO,NE,NA	0.01						NO	NO	NO	
E. Settlements	6,913.52	0.14	1.96						0.09	3.08	NO	
F. Other land	NO	NO	NO						NO	NO	NO	
G. Harvested wood products	-1,009.08											
H. Other	NA	NA	NA						NA	NA	NA	NA
5. Waste	1,356.77	2,591.90	2.74						6.60	30.20	16.71	7.48
A. Solid waste disposal	NO,NE	2,417.36							NO,NE	NO,NE	9.52	
B. Biological treatment of solid waste		0.22	0.01						NE	NE	NE	
C. Incineration and open burning of waste	1,356.77	5.49	0.10						6.60	30.20	7.19	7.48
D. Wastewater treatment and discharge		168.83	2.63						NO,NE	NO,NE	NO,NE	
E. Other	NO	NO	NO						NO	NO	NO	NO
International bunkers	24,035.53	0.42	0.71						262.06	40.90	11.25	101.35
Aviation	15,272.37	0.28	0.48						69.46	20.54	4.86	2.92
Navigation	8,763.16	0.14	0.22						192.60	20.36	6.39	98.43

Summary Table for National Greenhouse Gas Inventories – 2015
(Summary1.As1 to Summary1.As3 from CRF tables)

Greenhouse Gas Source and Sink Categories	Net CO_2 emissions/ removals	CH_4	N_2O	HFCs[1]	PFCs[1]	Unspecified mix of HFCs and PFCs[1]	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			(kt CO_2 equivalent)			(kt)					
Total national emissions and removals	406,808.20	2,104.67	77.93	15,963.56	327.23	NO	0.02	0.00	921.98	1,669.55	837.20	236.89
1. Energy	398,328.62	317.64	11.85						907.63	1,355.03	258.32	219.47
A. Fuel combustion (Sectoral approach)	393,768.62	59.96	11.73						905.47	1,333.55	113.26	203.87
1. Energy industries	132,959.65	12.07	3.21						265.88	93.21	4.37	127.50
2. Manufacturing industries and construction	53,164.65	3.97	2.48						141.64	336.34	19.27	42.18
3. Transport	117,362.94	4.70	3.77						397.03	385.87	37.01	2.93
4. Other sectors	88,296.70	39.17	2.21						84.89	513.12	51.63	30.19
5. Other	1,984.68	0.06	0.06						16.02	5.01	0.98	1.07
B. Fugitive emissions from fuels	4,560.00	257.68	0.12						2.16	21.49	145.06	15.60
1. Solid fuels	434.28	55.38	0.00						0.26	11.99	10.21	15.22
2. Oil and natural gas and other emissions from energy production	4,125.72	202.29	0.12						1.90	9.49	134.85	0.38
C. CO_2 Transport and storage	NO											
2. Industrial processes and product use	15,918.36	3.32	2.84	15,963.56	327.23	NO	0.02	0.00	12.18	269.07	470.73	16.65
A. Mineral industry	6,638.00								NO	1.22	0.85	4.03
B. Chemical industry	4,582.71	2.45	0.15	10.60	161.27	NO	NO	NO	4.50	16.67	14.17	1.73
C. Metal industry	4,392.39	0.66	0.03	2.28	11.27		0.00		7.69	251.18	1.65	10.07
D. Non-energy products from fuels and solvent use	305.26	NO,IE	NO,NE,IE						NO,IE	NO,IE	357.79	0.83
E. Electronic industry				17.50	NO,IE	NO	NO,IE	0.00				
F. Product uses as substitutes for ODS				15,933.17	NO							
G. Other product manufacture and use	NO	NO	2.65		154.69		0.02		NO	NO	NO	NO
H. Other[3]	NO,NE,IE	0.20	NO						NO	NO,IE	96.26	NO,IE

Greenhouse Gas Source and Sink Categories	Net CO_2 emissions/ removals	CH_4	N_2O	HFCs[1]	PFCs[1]	Unspecified mix of HFCs and PFCs[1]	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			(kt CO_2 equivalent)			(kt)					
3. Agriculture	1,192.67	1,111.38	53.44						NO,NE	NO,NE	102.57	NO
A. Enteric fermentation		962.91										
B. Manure management		140.68	4.93								102.57	
C. Rice cultivation		NO									NO	
D. Agricultural soils		NE	48.21						NE	NE	NE	
E. Prescribed burning of savannas		NO	NO						NO	NO	NO	
F. Field burning of agricultural residues		NO	NO						NO	NO	NO	
G. Liming	769.30											
H. Urea application	420.90											
I. Other carbon-contining fertilizers	NO											
J. Other	2.46	7.79	0.30						NO,NE	NO,NE	NO,NE	NO
4. Land use, land-use change and forestry	-8,913.30	1.06	5.09						0.74	24.43	NO,NA	NA
A. Forest land	-15,980.26	NO,NE,IE,NA	0.73						NO,IE	NO,IE	NO	
B. Cropland	11,782.74	0.00	1.64						0.00	0.06	NO	
C. Grassland	-9,143.69	0.87	0.12						0.62	20.26	NO	
D. Wetlands	268.69	NO,NE,NA	0.00						NO	NO	NO	
E. Settlements	6,081.26	0.18	1.72						0.12	4.11	NO	
F. Other land	NO	NO	NO						NO	NO	NO	
G. Harvested wood products	-1,922.04											
H. Other	NA	NA	NA						NA	NA	NA	NA

Greenhouse Gas Source and Sink Categories	Net CO_2 emissions/ removals	CH_4	N_2O	HFCs[1]	PFCs[1]	Unspecified mix of HFCs and PFCs[1]	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			(kt CO_2 equivalent)					(kt)			
5. Waste	281.85	671.27	4.71						1.43	21.02	5.58	0.77
A. Solid waste disposal	NO,NE	491.97							NO,NE	NO,NE	1.29	
B. Biological treatment of solid waste		42.02	2.19						NE	NE	NE	
C. Incineration and open burning of waste	281.85	0.36	0.17						1.43	21.02	4.30	0.77
D. Wastewater treatment and discharge		136.92	2.35						NO,NE	NO,NE	NO,NE	
E. Other	NO	NO	NO						NO	NO	NO	NO
International bunkers	40,737.65	0.21	1.24						350.41	37.09	9.01	44.00
Aviation	33,040.68	0.09	1.05						176.93	19.30	2.24	16.74
Navigation	7,696.98	0.12	0.19						173.48	17.79	6.78	27.26

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	SF6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)	598,519.96	135,347.45	51,326.06	14,391.43	1,651.53	1,279.06	NO,NE	0.42	802,515.91
1. Energy	567,583.58	37,305.49	4,842.85						609,731.92
A. Fuel combustion (sectoral approach)	560,107.09	3,133.68	4,802.00						568,042.77
1. Energy industries	235,822.84	203.12	1,387.99						237,413.96
2. Manufacturing industries and construction	95,418.76	112.88	1,086.11						96,617.75
3. Transport	114,252.40	1,253.45	1,385.45						116,891.29
4. Other sectors	109,328.27	1,560.49	895.21						111,783.97
5. Other	5,284.82	3.73	47.24						5,335.79
B. Fugitive emissions from fuels	7,476.49	34,171.81	40.84						41,689.15
1. Solid fuels	1,698.56	21,826.86	0.09						23,525.51
2. Oil and natural gas	5,777.92	12,344.96	40.75						18,163.64
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	24,525.61	281.70	24,408.34	14,391.43	1,651.53	1,279.06	NO,NE	0.42	66,538.07
A. Mineral industry	9,803.78								9,803.78
B. Chemical industry	6,764.97	213.70	23,797.23	14,387.09	17.55	NO	NO	NO	45,180.53
C. Metal industry	7,403.74	36.89	17.70	NO	1,553.11	387.17			9,398.62
D. Non-energy products from fuels and solvent use	553.12	NO,IE	NO,NE,IE						553.12
E. Electronic Industry				4.34	NO,NE,IE	NO,NE,IE	NO,NE	0.42	4.75
F. Product uses as ODS substitutes				NO,NA,IE	NO				NO,NA,IE
G. Other product manufacture and use	NO	NO	593.41		80.87	891.89			1,566.16
H. Other	IE,NE,NO	31.10	NO						31.10

Greenhouse Gas Source and Sink Categories	CO_2	CH_4	N_2O	HFCs	PFCs	SF6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
3. Agriculture	1,831.42	32,946.25	18,796.51						53,574.19
A. Enteric fermentation		28,019.46							28,019.46
B. Manure management		4,444.68	1,769.05						6,213.73
C. Rice cultivation		NO							NO
D. Agricultural soils		NE	16,830.49						16,830.49
E. Prescribed burning of savannas		NO	NO						NO
F. Field burning of agricultural residues		205.37	63.47						268.83
G. Liming	1,576.48								1,576.48
H. Urea application	252.19								252.19
I. Other carbon-containing fertilizers	NO								NO
J. Other	2.75	276.73	133.51						412.99
4. Land use, land-use change and forestry	3,222.58	16.62	2,460.91						5,700.11
A. Forest land	-10,540.57	3.24	402.43						-10,134.90
B. Cropland	15,122.71	0.09	1,019.85						16,142.64
C. Grassland	-7,750.95	9.91	10.28						-7,730.75
D. Wetlands	486.95	NO,NE,NA	4.13						491.09
E. Settlements	6,913.52	3.38	583.99						7,500.89
F. Other land	NO	NO	NO						NO
G. Harvested wood products	-1,009.08								-1,009.08
H. Other	NA	NA	NA						NA

Greenhouse Gas Source and Sink Categories	CO_2	CH_4	N_2O	HFCs	PFCs	SF6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
5. Waste	1,356.77	64,797.40	817.45						66,971.62
A. Solid waste disposal	NO,NE	60,433.95							60,433.95
B. Biological treatment of solid waste		5.59	3.92						9.51
C. Incineration and open burning of waste	1,356.77	137.22	29.85						1,523.84
D. Waste water treatment and discharge		4,220.63	783.69						5,004.32
E. Other	NO	NO	NO						NO
International bunkers	24,035.53	10.46	210.10						24,256.09
Aviation	15,272.37	7.02	144.50						15,423.88
Navigation	8,763.16	3.44	65.61						8,832.21

Summary Report for CO_2 equivalent – 2015 (Summary2 from CRF tables)

Greenhouse Gas Source and Sink Categories	CO_2	CH_4	N_2O	HFCs	PFCs	SF6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)	406,808.20	52,616.66	23,223.15	15,963.56	327.23	457.48	NO	0.44	499,396.72
1. Energy	398,328.62	7,940.92	3,529.84						409,799.39
A. Fuel combustion (sectoral approach)	393,768.62	1,499.04	3,494.60						398,762.26
1. Energy industries	132,959.65	301.84	956.92						134,218.42
2. Manufacturing industries and construction	53,164.65	99.26	737.60						54,001.51
3. Transport	117,362.94	117.38	1,124.57						118,604.89
4. Other sectors	88,296.70	979.17	657.84						89,933.72
5. Other	1,984.68	1.39	17.66						2,003.73
B. Fugitive emissions from fuels	4,560.00	6,441.89	35.24						11,037.13
1. Solid fuels	434.28	1,384.52	0.07						1,818.88
2. Oil and natural gas	4,125.72	5,057.36	35.17						9,218.25
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	15,918.36	83.01	845.43	15,963.56	327.23	457.48	NO	0.44	33,595.50
A. Mineral industry	6,638.00								6,638.00
B. Chemical industry	4,582.71	61.32	45.48	10.60	161.27	NO	NO	NO	4,861.38
C. Metal industry	4,392.39	16.60	9.93	2.28	11.27	79.43			4,511.90
D. Non-energy products from fuels and solvent use	305.26	NO,IE	NO,NE,IE						305.26
E. Electronic Industry				17.50	NO,IE	NO,IE	NO	0.44	17.94
F. Product uses as ODS substitutes				15,933.17	NO				15,933.17
G. Other product manufacture and use	NO	NO	790.01		154.69	378.05			1,322.75
H. Other	NO,NE,IE	5.09	NO						5.09

Greenhouse Gas Source and Sink Categories	CO_2	CH_4	N_2O	HFCs	PFCs	SF6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
3. Agriculture	1,192.67	27,784.61	15,925.71						44,902.99
A. Enteric fermentation		24,072.79							24,072.79
B. Manure management		3,516.99	1,469.21						4,986.20
C. Rice cultivation		NO							NO
D. Agricultural soils		NE	14,366.16						14,366.16
E. Prescribed burning of savannas		NO	NO						NO
F. Field burning of agricultural residues		NO	NO						NO
G. Liming	769.30								769.30
H. Urea application	420.90								420.90
I. Other carbon-containing fertilizers	NO								NO
J. Other	2.46	194.84	90.34						287.64
4. Land use, land-use change and forestry	-8,913.30	26.43	1,518.20						-7,368.66
A. Forest land	-15,980.26	NO,NE,IE,NA	216.07						-15,764.19
B. Cropland	11,782.74	0.04	489.38						12,272.16
C. Grassland	-9,143.69	21.87	36.30						-9,085.51
D. Wetlands	268.69	NO,NE,NA	0.30						268.99
E. Settlements	6,081.26	4.51	512.27						6,598.05
F. Other land	NO	NO	NO						NO
G. Harvested wood products	-1,922.04								-1,922.04
H. Other	NA	NA	NA						NA

Greenhouse Gas Source and Sink Categories	CO_2	CH_4	N_2O	HFCs	PFCs	SF6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
5. Waste	281.85	16,781.69	1,403.96						18,467.49
A. Solid waste disposal	NO,NE	12,299.24							12,299.24
B. Biological treatment of solid waste		1,050.46	654.09						1,704.56
C. Incineration and open burning of waste	281.85	9.06	49.95						340.85
D. Waste water treatment and discharge		3,422.93	699.92						4,122.85
E. Other	NO	NO	NO						NO
International bunkers	40,737.65	5.17	369.92						41,112.74
Aviation	33,040.68	2.16	312.61						33,355.45
Navigation	7,696.98	3.00	57.31						7,757.29

Emissions trends by gas
(Table 10s6 from CRF tables)

Greenhouse Gas Emissions without LULUCF	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
CO_2 emissions without net CO_2 from LULUCF	595,297.38	603,513.43	588,190.30	573,587.60	568,639.37	559,783.11	581,701.35	556,475.79	560,479.67	553,175.90	560,581.68	569,954.50	553,849.20	565,146.38	566,740.01	563,637.43	561,885.71	553,544.55	539,840.65	488,856.02	507,469.96	464,758.59	484,226.39	473,699.57	433,370.55	415,721.50
CH_4 emissions without CH_4 from LULUCF	135,330.83	136,118.24	135,749.43	134,106.29	127,260.34	128,817.93	128,049.03	125,550.81	122,062.63	116,494.46	111,019.80	106,059.75	103,596.93	98,461.93	94,124.79	89,347.49	86,253.02	83,019.77	77,270.39	72,370.18	68,225.88	65,336.28	62,398.42	57,191.79	54,357.60	52,590.23
N_2O emissions without N_2O from LULUCF	48,865.15	49,068.43	44,634.42	40,550.27	40,838.94	39,494.99	39,225.19	39,381.82	39,404.37	29,478.45	29,191.38	27,640.54	25,840.86	25,638.54	26,345.50	25,364.40	24,505.61	24,314.43	23,770.04	22,093.91	22,493.48	21,437.32	21,301.62	21,263.69	21,905.12	21,704.94
HFCs	14,391.43	14,991.05	15,597.63	16,505.66	17,593.37	19,095.98	20,249.18	23,104.50	20,074.40	11,465.64	9,882.92	10,890.79	11,387.39	12,829.42	11,919.34	13,151.49	14,074.84	14,532.71	15,029.24	15,649.90	16,511.59	14,947.17	15,472.66	15,796.32	15,981.74	15,963.56
PFCs	1,651.53	1,385.14	690.35	602.73	611.40	596.94	596.36	503.12	493.73	473.96	596.79	485.59	408.23	356.61	433.85	385.15	387.67	287.84	266.25	197.33	287.71	416.94	255.06	318.74	278.31	327.23
SF_6	1,279.06	1,318.54	1,358.25	1,182.90	1,223.44	1,264.37	1,305.70	1,280.08	1,328.72	1,497.70	1,817.67	1,454.10	1,495.23	1,320.77	1,116.78	1,056.02	882.91	835.78	682.84	592.61	686.49	607.31	588.61	493.30	476.54	457.48
NF_3	0.42	0.48	0.55	0.63	0.73	0.83	0.96	1.10	1.27	1.46	1.69	1.03	1.03	0.95	0.59	0.29	0.29	0.28	0.27	0.26	0.27	0.30	0.33	0.36	0.40	0.44
Total (without LULUCF)	**796,815.80**	**806,395.30**	**786,220.93**	**766,536.08**	**756,167.59**	**749,054.14**	**771,127.77**	**746,297.22**	**743,844.79**	**712,587.57**	**713,091.94**	**716,486.30**	**696,578.86**	**703,754.61**	**700,680.85**	**692,942.28**	**687,990.04**	**676,535.37**	**656,859.68**	**599,760.21**	**615,675.37**	**567,503.92**	**584,243.08**	**568,763.78**	**526,370.27**	**506,765.38**

Greenhouse Gas Emissions with LULUCF	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
CO_2 emissions with net CO_2 from LULUCF	598,519.96	605,632.93	589,328.53	574,416.10	569,187.46	560,403.11	581,381.90	555,755.91	558,922.05	552,154.78	558,789.77	567,257.30	550,061.01	561,173.03	562,057.80	558,438.66	555,876.92	547,022.39	532,459.32	481,466.10	499,940.19	457,094.21	477,299.55	465,540.03	424,352.78	406,808.20
CH_4 emissions with CH_4 from LULUCF	135,347.45	136,137.10	135,764.04	134,122.07	127,275.81	128,847.75	128,071.44	125,577.15	122,083.56	116,511.03	111,051.97	106,091.62	103,629.16	98,522.12	94,158.08	89,388.50	86,289.33	83,065.69	77,305.28	72,413.28	68,266.12	65,372.03	62,461.56	57,223.69	54,390.09	52,616.66
N2O emissions with N_2O from LULUCF	51,326.06	51,506.85	47,047.47	42,951.26	43,226.26	41,877.78	41,585.70	41,728.29	41,732.06	31,791.11	31,441.89	29,815.38	27,946.95	27,707.15	28,326.08	27,290.58	26,373.09	26,133.14	25,520.13	23,796.94	24,161.71	23,084.43	22,942.03	22,849.15	23,464.24	23,223.15
HFCs	14,391.43	14,991.05	15,597.63	16,505.66	17,593.37	19,095.98	20,249.18	23,104.50	20,074.40	11,465.64	9,882.92	10,890.79	11,387.39	12,829.42	11,919.34	13,151.49	14,074.84	14,532.71	15,029.24	15,649.90	16,511.59	14,947.17	15,472.66	15,796.32	15,981.74	15,963.56
PFCs	1,651.53	1,385.14	690.35	602.73	611.40	596.94	596.36	503.12	493.73	473.96	596.79	485.59	408.23	356.61	433.85	385.15	387.67	287.84	266.25	197.33	287.71	416.94	255.06	318.74	278.31	327.23
SF_6	1,279.06	1,318.54	1,358.25	1,182.90	1,223.44	1,264.37	1,305.70	1,280.08	1,328.72	1,497.70	1,817.67	1,454.10	1,495.23	1,320.77	1,116.78	1,056.02	882.91	835.78	682.84	592.61	686.49	607.31	588.61	493.30	476.54	457.48
NF_3	0.42	0.48	0.55	0.63	0.73	0.83	0.96	1.10	1.27	1.46	1.69	1.03	1.03	0.95	0.59	0.29	0.29	0.28	0.27	0.26	0.27	0.30	0.33	0.36	0.40	0.44
Total (with LULUCF)	**802,515.91**	**810,972.08**	**789,786.82**	**769,781.36**	**759,118.47**	**752,086.76**	**773,191.25**	**747,950.16**	**744,635.77**	**713,895.68**	**713,582.71**	**715,995.81**	**694,928.99**	**701,910.06**	**698,012.51**	**689,710.70**	**683,885.05**	**671,877.84**	**651,263.33**	**594,116.41**	**609,854.08**	**561,522.38**	**579,019.79**	**562,221.61**	**518,944.11**	**499,396.72**

Emissions trends by gas
(Table 10s6 from CRF tables)

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	2012	2013	2014	2015
1. Energy	609,731.92	620,375.02	604,570.10	588,950.18	574,630.56	565,994.13	585,262.38	560,126.12	562,617.11	552,690.88	559,526.35	569,198.81	552,826.65	560,942.52	560,909.59	557,351.83	555,732.18	544,925.89	532,759.19	486,744.01	503,708.14	461,515.90	481,262.47	467,555.28	427,390.54	409,799.39
2. Industrial processes and product use	66,538.07	64,758.87	60,350.33	56,974.00	60,285.38	60,825.90	62,921.71	64,129.84	60,734.70	42,719.52	40,584.46	38,804.99	36,693.89	39,354.68	40,502.43	39,715.39	38,905.16	41,263.77	39,396.93	32,789.69	35,547.03	32,010.19	32,326.58	34,392.92	34,137.89	33,595.50
3. Agriculture	53,574.19	53,619.34	53,533.61	52,422.34	52,823.34	52,875.75	53,286.30	52,825.26	52,279.57	51,712.32	49,949.48	47,363.76	47,091.08	47,230.05	47,214.91	46,405.39	45,982.00	45,282.40	44,362.37	44,156.64	44,426.10	44,323.16	43,825.66	44,088.11	44,991.00	44,902.99
4. Land use, land-use change and forestry[5]	5,700.11	4,576.79	3,565.89	3,245.27	2,950.88	3,032.62	2,063.48	1,652.94	790.99	1,308.11	490.77	-490.48	-1,649.87	-1,844.54	-2,668.34	-3,231.58	-4,104.99	-4,657.53	-5,596.35	-5,643.80	-5,821.29	-5,981.53	-5,223.29	-6,542.18	-7,426.16	-7,368.66
5. Waste	66,971.62	67,642.06	67,766.88	68,189.56	68,428.30	69,358.37	69,657.38	69,215.99	68,213.41	65,464.86	63,031.65	61,118.74	59,967.24	56,227.35	52,053.92	49,469.67	47,370.70	45,063.31	40,341.19	36,069.87	31,994.11	29,654.66	26,828.37	22,727.47	19,850.84	18,467.49
6. Other																										
Total (including LULUCF)[6]	**802,515.91**	**810,972.08**	**789,786.82**	**769,781.36**	**759,118.47**	**752,086.76**	**773,191.25**	**747,950.16**	**744,635.77**	**713,895.68**	**713,582.71**	**715,995.81**	**694,928.99**	**701,910.06**	**698,012.51**	**689,710.70**	**683,885.05**	**671,877.84**	**651,263.33**	**594,116.41**	**609,854.08**	**561,522.38**	**579,019.79**	**562,221.61**	**518,944.11**	**499,396.72**

Annex 5: Mapping between IPCC and National Communications sectors and other breakdowns used in this report

IPCC (Inventory)				National Communications	Carbon Dioxide	Methane	Nitrous Oxide	F-Gases
1. Energy	A. Fuel Combustion Activities	1. Energy Industries		Energy Supply	Fuel combustion	Fuel combustion	Fuel combustion	Not Used
		2. Manufacturing Industries and Construction		Business				
		3. Transport		Transport				
		4. Other sectors	a. Commercial/ Institutional Combustion	Business				
				Public				
				Transport				
			b. Residential	Residential				
			c. Agriculture/Forestry/ Fishing	Agriculture				
				Transport				
		5. Other (not elsewhere specified)	b. Other, Mobile (including military)	Transport				
	B. Fugitive Emissions from Fuels	1. Fugitive Emissions from Solid Fuels	a. Coal Mining and Handling	Energy Supply	Not Used	Coal mining	Not Used	
			b. Solid fuel transformation		Iron and steel – flaring, solid smokeless fuel production	Charcoal, coke and solid smokeless fuel production, and Iron and steel – flaring.	Iron and steel – flaring	
		2. Oil and natural gas	a. Oil		Upstream oil production	Upstream oil production	Upstream oil production	
			b. Natural gas		Upstream gas production, Natural gas distribution	Upstream gas production, Natural gas distribution	Upstream Gas Production	
			c. Venting and flaring		Venting and flaring	Venting and flaring	Flaring only	
2. Industrial Processes and Product Use	A. Mineral Products	1. Cement Production		Industrial Process	Cement – decarbonising	Not Used	Not Used	
		2. Lime Production			Lime production – decarbonising			
		3. Glass Production			Glass – general			
		4. Other Process uses of Carbonates	a. Ceramics		Brick manufacture	Brick manufacture		
			d. Other	Energy Supply	Power stations – Flue-gas desulphurisation	Not Used		

	B. Chemical Industry	1. Ammonia Production		Business	Ammonia production – combustion	Ammonia production – combustion	Ammonia production – combustion	
				Industrial Process	Ammonia production – feedstock use of gas	Not Used	Not Used	
		2. Nitric Acid Production			Not Used		Nitric acid production	
		3. Adipic Acid Production					Adipic acid production	
		6. Titanium Dioxide Production			Chemical industry – titanium dioxide		Not Used	
		7. Soda Ash Production			Chemical industry – soda ash			
		8. Petrochemical and Carbon Black Production	a. Methanol		Not Used	Chemical industry – methanol		
				Business	Methanol production combustion	Not Used	Methanol production combustion	
			b. Ethylene	Industrial Process	Not Used	Chemical industry – ethylene	Not Used	
			c. Ethylene Dichloride and Vinyl Chloride Monomer		Chemical Industry – ethylene dichloride	Not Used		
			d. Ethylene Oxide		Chemical industry – ethylene oxide	Chemical industry – ethylene oxide		
			e. Acrylonitrile		Not Used	Chemical industry – acrylonitrile		
			f. Carbon Black		Chemical industry – carbon black	Chemical industry – carbon black		
			g. Other	Business	Chemicals (combustion)	Chemicals (combustion)	Chemicals (combustion)	
		9. Fluorochemical Production	a. By-product	Industrial Process	Not Used	Not Used	Not Used	Halocarbons production – by-product
			b. Fugitive					Halocarbons production – fugitive
		10. Other				Chemical industry – general		Not Used

	C. Metal Production	1. Iron and Steel production			Process related emissions	Process related emissions	Process related emissions	
		3. Aluminium Production	a. CO_2		Primary aluminium production – general	Not Used	Not Used	
			b. By-product		Not Used			Primary aluminium production – PFC emissions
		4. Magnesium Production						Magnesium cover gas
		6. Zinc Production			Non-ferrous metal processes			Not Used
	D. Non-energy Products from Fuels and Solvent Use	1. Lubricant Use		Business	Industrial engines			
				Transport	Road vehicle engines, Marine engines			
				Agriculture	Agricultural engines			
		2. Paraffin Wax Use		Residential	Non-aerosol products – household products			
		3. Other		Business	Non Energy Use: petroleum coke			
				Transport	Road transport – urea			
	E. Electronics Industry	1. Integrated circuit or semiconductor		Business	Not Used			Electronics
	F. Product Uses as Substitutes for ODS	1. Refrigeration and Air Conditioning Equipment						Refrigeration – all
		2. Foam Blowing Agents						Foams – all
		3. Fire Extinguishers						Firefighting
		4. Aerosols	a. Metered Dose Inhalers	Residential				Metered dose inhalers
			b. Other					Aerosols – halocarbons
		5. Solvents		Business				Precision cleaning – HFC
		6. Other	b. Contained					Refrigerant containers

	G. Other Product Manufacture and Use	1. Electrical Equipment						Electrical insulation
		2. SF_6 and PFCs from Other Product Use	a. Military Applications					Military applications
			b. Accelerators					Particle accelerators
			e. Other					High voltage swuitchgear, sporting goods and SF6 used as a tracer gas
		3. N_2O from Product Uses	a. Medical Applications				N_2O use as an anaesthetic	Not Used
			b. Other	Industrial Process			Other food – cream consumption	
		4. Other					Chemical Industry other process sources	
3. Agriculture	A. Enteric Fermentation			Agriculture		Enteric fermentation – all	Not Used	
	B. Manure Management					Manure management – all	Manure management – all	
	D. Agricultural Soils					Not Used	Agricultural soils – all	
	F. Field Burning of Agricultural Wastes					Field burning	Field burning	
	G. Liming				Liming	Not Used	Not Used	
	H. Urea Application				Agriculture – application of urea			
4. Land use, land use change and forestry	A. Forest Land			Land Use Change	Forest land – all	Forest land – all	Forest land – all	
	B. Cropland				Cropland – all	Cropland – all	Cropland – all	
	C. Grassland				Grassland – all	Grassland – all	Grassland – all	
	D. Wetlands				Wetlands – all	Wetlands – all	Wetlands – all	
	E. Settlements				Settlements – all	Settlements – all	Settlements – all	
	G. Harvested Wood Products				Harvested wood products	Harvested wood products	Harvested wood products	
5. Waste	A. Solid Waste Disposal	1. Managed Disposal sites	a. Anaerobic	Waste Management	Not Used	Landfill	Not Used	
	B. Biological Treatment of Solid Waste	1. Composting	a. Municipal Solid Waste			Composting and Mechanical Biological Treatment	Composting and Mechanical Biological Treatment	
				Residential		Composting (household)	Composting (household)	
	B. Biological Treatment of Solid Waste	2. Anaerobic Digestion at Biogas Facilities	a. Municipal Solid Waste	Waste Management		Mechanical Biological Treatment – Anaerobic Digestion, Other anaerobic digestion	Not Used	

	C. Incineration and Open Burning of Waste	1. Waste Incineration	1. Biogenic			Incineration – sewage sludge	Incineration – sewage sludge	
			2. Non-biogenic		Incineration – all	Incineration – all	Incineration – all	
		2. Open Burning of Waste	2. Non-biogenic	Residential	Small-scale waste burning	Accidental fires – vehicles	Not Used	
				Business	Not Used	Accidental fires – other buildings		
				Residential		Accidental fires – dwellings		
	D. Wastewater Treatment and Discharge	1. Domestic Wastewater		Waste Management		Sewage sludge decomposition, including in private systems	Sewage sludge decomposition	
		2. Industrial Wastewater				Industrial Waste Water Treatment	Not Used	

Annex 6:
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	7NC Chapter 2 Section 1.2 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	7NC Chapter 2 Section 1.2 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	7NC Chapter 2 Section 1.2 and NIR
(d) A description of the process and the results of key source identification and, where relevant, archiving of test data	7NC Chapter 2 Section 1.2 and NIR
(e) A description of the process for the recalculation of previously submitted inventory data	7NC Chapter 2 Section 1.2 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	7NC Chapter 2 Section 1.6 and NIR
(g) A description of the procedures for the official consideration and approval of the inventory.	7NC Chapter 2 Section 1,2 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.	7NC Chapter 2 Section 1.2 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	7NC Chapter 2 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	7NC Chapter 2 and SIAR
(c) A description of the database structure and capacity of the national registry	7NC Chapter 2 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)	7NC Chapter 2 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	7NC Chapter 2 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	7NC Chapter 2 and SIAR
(g) A list of the information publicly accessible by means of the user interface to the national registry	7NC Chapter 2 and SIAR
(h) The Internet address of the interface to its national registry	7NC Chapter 2 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.	7NC Chapter 2 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.	7NC Chapter 2 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.	7NC 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).	7NC 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.	7NC 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.	7NC 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.	7NC 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.	7NC 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	7NC 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.	7NC 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.	7NC 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.	7NC 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.	7NC 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.	7NC 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.	7NC 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.	7NC Chapter 5