Reducing UK emissions

2019 Progress Report to Parliament

Committee on Climate Change
July 2019

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Presented to Parliament pursuant to Section 36(1) of the Climate Change Act 2008.

This report is published in two volumes; Volume 1 (Reducing UK emissions – 2019 Progress Report to Parliament) and Volume 2 (Progress in preparing for climate change – 2019 Report to Parliament). Both volumes were laid before Parliament on 10 July 2019 and are available online at: www.theccc.org.uk/publications

Book 1 of 2

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Acknowledgements

The Committee would like to thank:

The team that prepared this report and its analysis. This was led by Chris Stark and Mike Thompson and included Tom Andrew, Owen Bellamy, Cloe Cole, James Darke, Ellie Davies, Adrian Gault, Aaron Goater, Rachel Hay, Mike Hemsley, Jenny Hill, David Joffe, Ewa Kmietowicz, Sarah Livermore, Richard Millar, Chloe Nemo, Alexandra Scudo, Indra Thillainathan, and Emma Vause.

Other members of the Secretariat who contributed to this report: Victoria Abrams, Jo Barrett, Tom Dooks, James Lees, Bianca de Farias Letti, Andrew Russell, Penny Seera, David Style, and Sean Taylor.

A number of organisations and stakeholders for their input and support, including the Department for Business, Energy and Industrial Strategy, the Department for Environment, Food, and Rural Affairs, the Department for Transport, Anne Owen and John Barrett (University of Leeds), and the Society of Motor Manufacturers and Traders.

A wide range of stakeholders who engaged with us or met with the Committee bilaterally.

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The Committee

The Rt. Hon John Gummer, Lord Deben, Chairman
Lord Deben was the UK's longest-serving Secretary of State for the Environment (1993 to 1997). He has held several other high-level ministerial posts, including Secretary of State for Agriculture, Fisheries and Food (1989 to 1993). He has consistently championed the strong links between environmental concerns and business interests. Lord Deben also runs Sancroft, a corporate responsibility consultancy working with blue-chip companies around the world on environmental, social and ethical issues. He is Chairman of Valpak Limited and the Personal Investment Management and Financial Advice Association.

Baroness Brown of Cambridge FRS
Baroness Brown of Cambridge DBE FREng FRS (Julia King) is an engineer, with a career spanning senior engineering and leadership roles in industry and academia. She currently serves as Chair of the CCC's Adaptation Committee; non-executive director of the Offshore Renewable Energy Catapult; and Chair of the Carbon Trust. She was non-executive director of the Green Investment Bank, she led the King Review on decarbonising transport (2008). She is a Fellow of the Royal Academy of Engineering and of the Royal Society, and was awarded DBE for services to higher education and technology. She is a crossbench Peer and a member of the House of Lords European Union Select Committee.

Professor Keith Bell
Keith Bell is a co-Director of the UK Energy Research Centre (UKERC) and a Chartered Engineer. In addition to teaching and being involved with energy system research in collaboration with academic and industrial partners, he has a number of additional roles including with the Offshore Renewable Energy Catapult, The IET Power Academy, the Conseil International des Grands Réseaux Electriques (CIGRE), the European Energy Research Alliance and as Scottish Power Chair in Smart Grids at the University of Strathclyde. Keith has also advised the Scottish Government, Ofgem, BEIS and the Government of Ireland on electricity system issues.

Professor Nick Chater
Nick Chater is Professor of Behavioural Science at Warwick Business School. He has particular interests in the cognitive and social foundations of rationality, and applying behavioural insights to public policy and business. Nick is Co-founder and Director of Decision Technology Ltd, a research consultancy. He has previously held the posts of Professor of Psychology at both Warwick University and University College London (UCL), and Associate Editor for the journals Cognitive Science, Psychological Review, Psychological Science and Management Science.

Professor Piers Forster
Professor Forster is Director of the Priestley International Centre for Climate and Professor of Physical Climate Change at the University of Leeds. He has played a significant role authoring Intergovernmental Panel on Climate Change (IPCC) reports, and is a coordinating lead author role for the IPCC's sixth assessment report. Professor Forster established the forest protection and research charity, the United Bank of Carbon, and has a number of roles advising industry, including membership of the Rolls Royce Environment Advisory Board.

Dr Rebecca Heaton
Rebecca Heaton is Head of Sustainability and Policy at Drax Group. She is responsible for the sustainability of the global forest supply chains used to produce biomass for its power station, and for research and policy work. She has extensive experience working for a number of energy businesses on a range of topics, including: biofuels, land-use and forestry and climate change adaptation.

Paul Johnson
Paul Johnson is Director of the Institute for Fiscal Studies and a visiting professor at University College London (UCL). He is widely published on the economics of public policy and is a columnist for The Times. He was previously director of public spending at HM Treasury and Chief Economist at the Department for Education. He was awarded a CBE for services to economics and social science in 2018.

Professor Corinne Le Quéré FRS
Corinne Le Quéré is a Royal Society Research Professor at the University of East Anglia (UEA), specialising in the interactions between climate change and the carbon cycle. She was lead author of several assessment reports for the UN's Intergovernmental Panel on Climate Change (IPCC), Director of the Tyndall Centre for Climate Change Research, and Director of the annual update of the global carbon budget by the Global Carbon Project (GCP). She currently Chairs the French Haut Conseil pour le Climat.

Foreword

It has been a remarkable 12 months. Globally, the impacts of the changing climate have become increasingly visible. Public protests have led to widespread awareness of the risks of further climate change - and the remedies. And we have seen a renewed desire from governments around the world to step up their response.

Here in the UK, there are grounds for optimism. In May, the Committee's Net Zero report offered compelling analysis of the need to reduce greenhouse gas emissions in the UK effectively to zero by 2050 – and provided evidence that we could meet this new goal at a cost already agreed by Parliament. The net-zero target meets the UK's obligations under the Paris Agreement and responds to the urgent need for action highlighted by the IPCC in last year's landmark Special Report on 1.5°C of global warming.

We welcome strongly the UK Parliament's decision to make net zero law – and the corresponding decisions of the Welsh Assembly and the Scottish Parliament. These are positive steps which are of fundamental consequence for the future path of our economy, our society and the climate. Carbon neutrality has now become a mainstream goal.

But tougher targets do not themselves reduce emissions. New plans must be drawn up to deliver them. And even if net zero is achieved globally, our climate will continue to warm in the short-term, and sea level will continue to rise for centuries. We must plan for this reality. Climate change adaptation is a defining challenge for every government, yet there is only limited evidence of the present UK Government taking it sufficiently seriously.

It is time to act. Next year may see the UK host the most important global climate summit since Paris in 2015. Our credibility in the COP26 Presidency rests on real action at home.

The Adaptation and Mitigation Committees have reviewed the UK Government's approach to climate change adaptation and emissions reduction. Our reports are published in parallel, as required under the Climate Change Act. We find a substantial gap between current plans and future requirements and an even greater shortfall in action.

Planning for climate change adaptation is a statutory obligation but the National Adaptation Programme (NAP) is incomplete. Of the 56 risks and opportunities identified in the UK's Climate Change Risk Assessment, 21 have no formal actions in the NAP. Furthermore, we have been unable to give high scores for managing risk to any of the sectors we have assessed in this report. We are now seeing the substantial impacts of a global temperature rise of just 1°C. The Paris Agreement targets a threshold of well below 2°C, ideally 1.5°C, but current global plans give only a 50% chance of meeting 3°C.

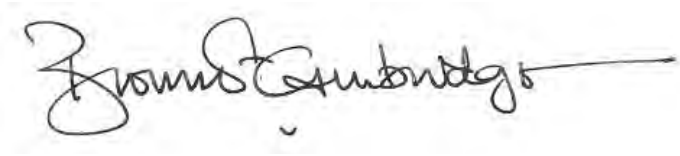
In these circumstances, although the UK is committed to working for global action to parallel our own adoption of a net-zero statutory target, it is prudent to plan adaptation strategies for a scenario of 4°C, but there is little evidence of adaptation planning for even 2°C. Government cannot hide from these risks.

The Clean Growth Strategy, the UK's plan for emissions reduction, provides a solid foundation for the action needed to meet a net-zero GHG target but policy ambition and implementation now fall well short of what is required. Last June, we advised that 25 headline policy actions were needed for the year ahead. Twelve months later, only one has been delivered by Government in full. Ten of the actions have not shown even partial progress. Government continues to be off track for the fourth and fifth carbon budgets – on their own appraisal – and the policy gap has widened further this year as an increase in the projection of future emissions has outweighed the impact of new policies.

The central premise of the Climate Change Act is that the Government of the day holds the responsibility to act to protect future generations. This principle is at risk if the priority given to climate policy is not substantially increased over the next year and the next G overnment spending review.

The need for action has rarely been clearer. Our message to government is simple: Now, do it.

Lord Deben
Chairman, Committee on Climate Change



Baroness Brown of Cambridge
Chair, Adaptation Committee of the Committee on Climate Change

Executive Summary

The UK Government and Parliament have adopted the Committee's recommendation to target net-zero emissions of greenhouse gases in the UK by 2050 (i.e. at least a 100% reduction in emissions from 1990). In the *Net Zero* report, the Committee made clear that meeting this target is contingent on early and decisive action to strengthen policy. Now the Government must act.

During the last year, the Government has introduced some new policies to reduce emissions, but their impact will be only incremental. Overall, actions to date have fallen short of what is needed for the previous targets and well short of those required for the net-zero target:

- **Policy implementation in the last year.** Last year, the Committee set out 25 headline policy actions for the year ahead. Twelve months later, only one has been delivered in full. Ten of the required actions have not shown even partial progress.
- **Underlying progress.** The Committee also monitor indicators of underlying progress such as improvements to insulation of buildings and the market share of electric vehicles. Only seven out of 24 of these were on track in 2018. Outside the power and industry sectors, only two indicators were on track. This is a continuation of recent experience - over the course of the second carbon budget (2013-2017), only six of 21 indicators were on track.
- **Projected progress.** The Government's own projections demonstrate that its policies and plans are insufficient to meet the fourth or fifth carbon budgets (covering 2023-2027 and 2028-2032). This policy gap has widened in the last year as an increase in the projection of future emissions outweighed the impact of new policies.

Too often efforts have been isolated to single departments or have progressed too slowly. The foundations in the Clean Growth Strategy have not been developed into a coordinated approach that will deliver even the existing carbon budgets:

- In the 2019 Spring Statement, the Treasury (**HMT**) showed leadership in announcing an end to gas heating in new homes, but now must engage more with the delivery challenge for reducing emissions across the economy. The strategic levers at HMT's disposal, including public spending and taxation, will be fundamental in driving the transition to net-zero emissions. The planned review of the distribution of costs for reaching net-zero emissions is an opportunity to ensure that incentives support low-carbon choices and that funding is aligned with the required pace of change.
- Despite good overall progress in the power sector to date, the business department (**BEIS**) has been too slow in developing plans for carbon capture and storage and has held back deployment of onshore wind that would cut energy bills and emissions. No large-scale trials have yet begun for heat pumps or low-carbon hydrogen. Development of these markets and of a skilled workforce needs to go hand-in-hand but there have been no serious steps towards their development, in buildings, industry or (for hydrogen) transport.
- The departments for transport (**DfT**) and for housing (**MHCLG**) are now on the frontline of efforts to meet the net-zero target. They must do more to prioritise emissions reduction, working with BEIS and HMT to drive down emissions in these areas.
  - The 'Road to Zero' ambition for a phase-out of petrol and diesel cars by 2040 is too late and plans to deliver it are too vague. A date closer to 2030 would save motorists money, cut air and noise pollution and align to the net-zero challenge.

- Policies are not in place to deliver the Government's ambitions on energy efficiency (i.e. to improve all homes to at least 'EPC band C'). Building standards are not sufficiently enforced across the building stock and will need to be strengthened to make UK homes fit for the future. Regulations for the private rented sector prioritise costs for landlords over running costs for renters. MHCLG must play its part, including minimum standards for social housing.

- The environment department (**Defra**) has made it a principle of future reforms that public money should pay for public goods. It is critical that this extends to addressing climate change. Not enough has been done on agriculture, land use or waste. The Committee recommended stronger policies than the current voluntary approach to agriculture emissions three years ago, but no changes have been made and emissions continue to rise. Tree planting rates in England have been below 5,000 hectares in every year since that was adopted as an aspiration in 2013. The Resources and Waste Strategy aims to end the landfilling of biodegradable waste 10 years later than the Committee have recommended (by 2035 instead of by 2025).

Important lessons can be drawn from areas of better progress, where well-designed and well-resourced policies have provided clear market signals that have driven rapid progress:

- Coal-fired generation has fallen from around a 40% share of electricity in 2012 to a 5% share in 2018 and offshore wind is now able to provide power at a comparable price to fossil fuels. Product standards drove electricity demand down by improving efficiency; long-term contracts with the necessary funding drove roll-out of renewables; and carbon pricing ensured that coal plants ran less as a result.
- Regulations and obligations have worked in the past, for example in driving the roll-out of more efficient boilers and, prior to policy changes in 2012, supporting installation rates for insulation over 15 times higher than now. Incentives have also played a role, for example the landfill tax drove a major reduction in landfill, although behaviours only changed after tax rates were raised considerably from initial levels.
- The Scottish Government is demonstrating how an effective policy package for energy efficiency improvements in buildings might be delivered - setting out a comprehensive framework of standards with clear trajectories for improvement, underpinned by definite steps for implementation including legislative instruments.

There have also been further positive developments that only in part reflect UK policy:

- Electric cars are being released with longer ranges (200+ miles) and are on track to be cheaper to buy as well as to run than conventional vehicles during the 2020s.
- Emissions across the economy (including international aviation and shipping) fell 40% from 1990 to 2018. Over the same period, the UK economy grew by 75%. In 2018 emissions fell 2% and the economy grew by 1%. This record of growing the economy and cutting emissions provides a powerful international example that can help encourage others to increase their own ambition.

Taken together, these steps provide a solid foundation from which to pursue the net-zero target. However, reaching net-zero emissions requires an annual rate of emissions reduction (15 $MtCO_2e$ per year, 3% of 2018 emissions) that is 50% higher than under the UK's previous 2050 target and 30% higher than achieved on average since 1990. This is an indication of how substantial the step up in action must be to cut emissions in every sector.

It is especially acute for those sectors such as transport, buildings and agriculture where emissions have not fallen significantly over recent years.

Analysis from our recent *Net Zero* report points to several priorities for the Government in stepping up their delivery approach:

- **Embed net-zero policy across all levels and departments of government, with strong leadership and coordination at the centre.** This is likely to require changes to the Government's overall approach to driving down emissions. For example, the Prime Minister could chair regular meetings of a Climate Cabinet that includes the Chancellor and relevant Secretaries of State, with transparent public reporting of progress and plans.
- **Make policy business-friendly.** It will be businesses that primarily deliver the net-zero target and provide the vast majority of the required investment. UK business groups have strongly welcomed the setting of the net-zero target and are already acting to reduce emissions. Policy should provide a clear and stable direction and a simple investable set of rules and incentives that leave room for businesses to innovate and find the most effective means of switching to low-carbon solutions.
- **Put people at the heart of policy design.** Over half of the emissions cuts to reach net-zero emissions require people to do things differently. The public must be engaged in the challenge and both policy and low-carbon products should be designed to reflect this. We welcome the programme of Citizens' Assemblies being convened by a group of Parliamentary Select Committees to discuss the pathways to net-zero emissions and the involvement of the Youth Steering Group announced alongside the net-zero target.
- **Support international increases in ambition and celebrate the UK ambition.** Global carbon-intensity of energy has improved every year since 2011 but total emissions still grew in 2018 to record levels, over 55 $GtCO_2e$. Many countries are currently considering revised pledges of effort ahead of the UN climate summit in late-2020 (COP26), which the UK expects to co-host with Italy. The UK should use its new net-zero target and potential position as host of COP26 to help encourage increased effort elsewhere, including adoption of similar targets by other developed countries in the EU and beyond.

To be an effective host of the UN talks, and an influential climate leader the UK Government must now back its net-zero emissions target with a coherent national policy package to deliver it. The key elements of that package should be developed over the next 12-18 months, ahead of the UN talks. We summarise required actions for the next year and the longer term across the emitting sectors of the economy in Table 1; fuller descriptions are set out in Chapter 3.

This report identifies a strong message that, despite some important foundations, progress is insufficient even for previous targets, and a major ramp-up is now needed for the net-zero target.

The report is set out in four chapters:

1. Progress in reducing emissions
2. Developments in international and European circumstances
3. Underlying progress in the UK towards deep emissions reduction
4. UK performance in reducing emissions over the second carbon budget period

Table 1. Priorities and milestones to prepare for a net-zero target		
Sector	**Priorities for the coming year**	**Longer-term milestones**
Surface Transport (115 $MtCO_2e$)	Sales ban on conventional vehicles moved to 2030-2035 Clearer approach to EU vehicle standards and testing Stronger incentives to purchase cleaner vehicles Plans for roll-out of zero emission HGVs and stretching targets for CO_2 reductions Schemes to support walking, cycling, public transport	Continued development of charging infrastructure Decision on future for HGVs in the 2020s 98% reduction in emissions by 2050
Aviation & Shipping (50 $MtCO_2e$)	Formal inclusion in Climate Change Act targets	Strategies for aviation and shipping that reflect the net-zero target
Industry (104 $MtCO_2$)	Detailed policy for +20% energy efficiency by 2030 Funded mechanism for fuel switching and CCS Award of capital support for industry decarbonisation Policy to reduce methane leakage and venting and decarbonise off-road mobile machinery Plans for resource efficiency to help reduce demand for carbon-intensive products	Industrial H_2 and CCS clusters operational from mid-2020s Demonstration of hydrogen and electrification technologies in early 2020s 90% reduction in emissions by 2050
CCS (carbon capture and storage)	Preferred mechanism for CO_2 infrastructure Plan for operational CCS by mid-2020s	Large-scale emissions removal (e.g. biomass with CCS) from the 2030s
Hydrogen (H_2)	Strategy for developing low-carbon hydrogen use, production and infrastructure Large-scale hydrogen trials to begin	270 TWh low-carbon hydrogen production by 2050

Table 1. Priorities and milestones to prepare for a net-zero target		
Sector	**Priorities for the coming year**	**Longer-term milestones**
Buildings (88 $MtCO_2e$)	Low-carbon heat strategy and plans to phase out fossil fuels in the 2020s from buildings not connected to the gas grid Policies to improve energy efficiency for all buildings New build standards to ensure all new homes are ultra-efficient and use low-carbon heating from 2025 Closure of the performance and compliance gaps	Decision on the future of the gas grid in the mid-2020s All new heating systems to be low-carbon from 2035
Power (65 $MtCO_2e$)	Completion of 2019 offshore wind auction Route to market for onshore wind and solar Contingency plans for delayed or cancelled low-carbon generation projects Plans for networks to be capable of meeting higher demand for electrical energy	320 TWh of low-carbon generation by 2030 99-100% low-carbon generation by 2050
Agriculture & land use (46, -10 $MtCO_2e$)*	Firm policies to reduce GHG emissions Development of an effective post-CAP framework Strategies across UK for 30,000+ ha/year afforestation Publication of England's Peatland Strategy	20% cut in consumption of beef, lamb & dairy 30,000-50,000 hectares afforestation every year to 2050
Waste (20 $MtCO_2e$)*	Commitment to ban landfill of bio-degradable waste by 2025	Limit emissions from non-bio wastes (e.g. with CCS)
F-gases (15 $MtCO_2e$)*	Plan to restrict the use of F-gases to the very limited uses where there are currently no viable alternatives	Phase out F-gases
Public Engagement	Strategy informed by Citizens' Assemblies and Youth Climate Steering Group	Ensure costs fairly distributed and a just transition

Notes: *2017 emissions figures. Longer-term milestones are indicative based on CCC's Net Zero scenarios. These priorities and milestones are at the UK level. In some cases (e.g. peatland) the UK Government only has powers covering England. The Committee provide separate reports for Scotland, Wales and Northern Ireland.

Chapter 1: Progress in reducing emissions

In this chapter we review performance in reducing emissions across the economy as a whole, focusing on changes in annual greenhouse gas emissions since 1990, in the last five years and from 2017 to 2018. We set out the latest trends in emissions in the following five sections:

1. Introduction to reporting progress towards carbon budgets
2. Economy-wide emissions trends for the UK
3. Sector-by-sector emissions trends for the UK
4. Consumption-based accounting - the UK's carbon footprint
5. Emissions trends for Scotland, Wales and Northern Ireland

1. Introduction to reporting progress towards carbon budgets

In May 2019, in response to a request by the UK, Scottish and Welsh Governments, the Committee advised that now is the right time to set a net-zero target for the UK, going beyond the existing 2050 target for at least an 80% reduction required by the Climate Change Act (2008):

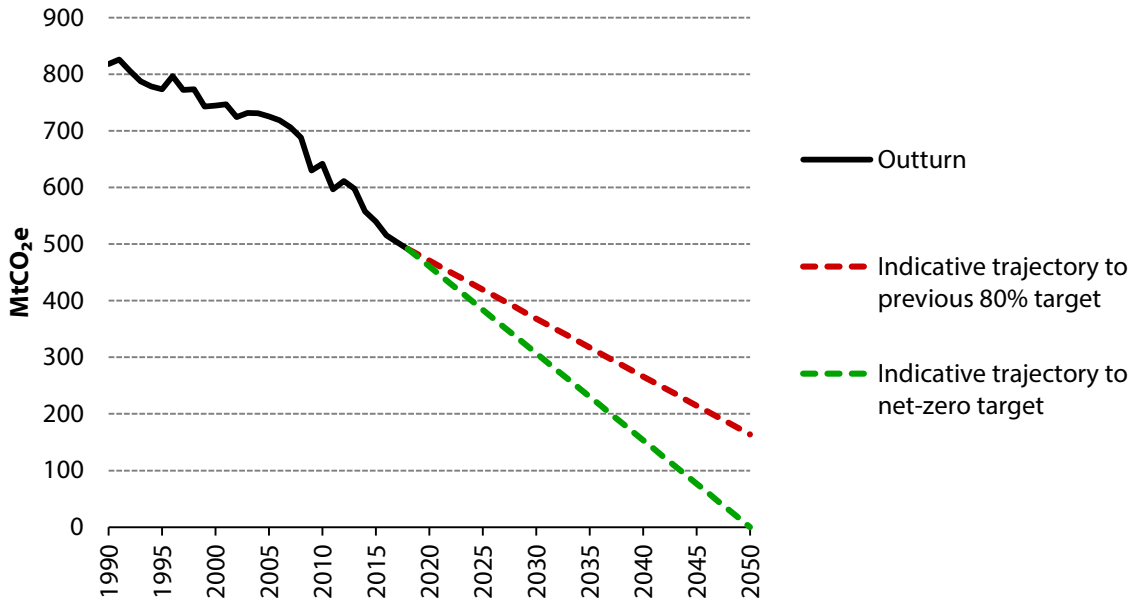
- The Committee recommended that the UK should set and vigorously pursue an ambitious target to reduce greenhouse gas emissions (GHGs) to 'net-zero' (i.e. at least a 100% reduction) by 2050. Reflecting their respective circumstances, Scotland should set a net-zero GHG target for 2045 and Wales should target a 95% reduction by 2050 relative to 1990.
- In June 2019, the UK Government accepted the Committee's advice and amended the 2050 target under the Climate Change Act to require net-zero greenhouse gas emissions by that date. The Government stated that emissions should reach net-zero across the whole economy (i.e. including international aviation and shipping) and that the aim would be to reach net-zero emissions without recourse to international credits (or 'offsets'), consistent with the Committee's advice.[1]
- Earlier, the Scottish Government announced that the recommended net-zero target for 2045 would be placed in legislation under the Climate Change (Emissions Reduction Targets) (Scotland) Bill that is currently passing through the Scottish Parliament. The Bill is currently at Stage 2 of the Scottish parliamentary process.
- The Welsh Government accepted the Committee's advice to legislate for a reduction in greenhouse gas emissions of 95% by 2050, but stated an ambition to reach net-zero emissions by this date. We will work further with the Welsh Government to understand how net-zero emissions could be achieved in Wales.

The path to achieving net-zero emissions by 2050 will necessarily entail a steeper reduction in emissions over the intervening three decades (Figure 1.1). On average, emissions will need to fall by 15 $MtCO_2e$ every year, equivalent to 3% of emissions in 2018.

As the existing carbon budgets were set on a cost-effective path to achieving an 80% reduction in UK greenhouse gas emissions by 2050, a more ambitious long-term target is likely to require outperformance of the carbon budgets legislated to date. The Committee will revise its assessment of the appropriate path for emissions over the period to 2050 as part of its advice next year on the sixth carbon budget (covering 2033-2037).

[1] House of Commons Hansard (12 June 2019) *Net Zero Emissions Target, Volume 661, Columns 673 and 682.*

Figure 1.1. Indicative rates of decarbonisation required to achieve 80% and 100% reductions by 2050



Source: BEIS (2019) *2018 UK Greenhouse Gas Emissions, Provisional Figures*; BEIS (2019) *2017 UK Greenhouse Gas Emissions, Final Figures*; CCC calculations.
Notes: Includes emissions from international aviation and shipping. Outturn data are based on the current emissions inventory and therefore do not reflect forthcoming revisions to peatland emissions or global warming potentials (Box 1.1).

The Committee's monitoring of progress on meeting carbon budgets and towards meeting the 2050 target is based on a detailed hierarchy of indicators. These will also need to be updated once the Committee has undertaken the full analysis on the pathway to net-zero emissions in 2050, as part of our advice on the sixth carbon budget. In this report we assess progress against the existing indicators to give an indication of whether the UK is on track even to meet the existing carbon budgets.

We set out in last year's progress report significant risks to meeting carbon budgets, and a set of actions needed from Government in the subsequent 12 months leading up to this year's progress report. This report assesses how far those actions have been delivered and identifies a provisional list of priorities that should be delivered over the next 12-18 months. These would mean that by the time of the key UN talks at COP26 the UK would have a world-leading net-zero target, credible scenarios for meeting it and a set of core policies and proposals consistent with its delivery.

In line with the requirements of the Climate Change Act we also include, in Chapter 4, a backward look at how the second carbon budget (2013-2017) was met.

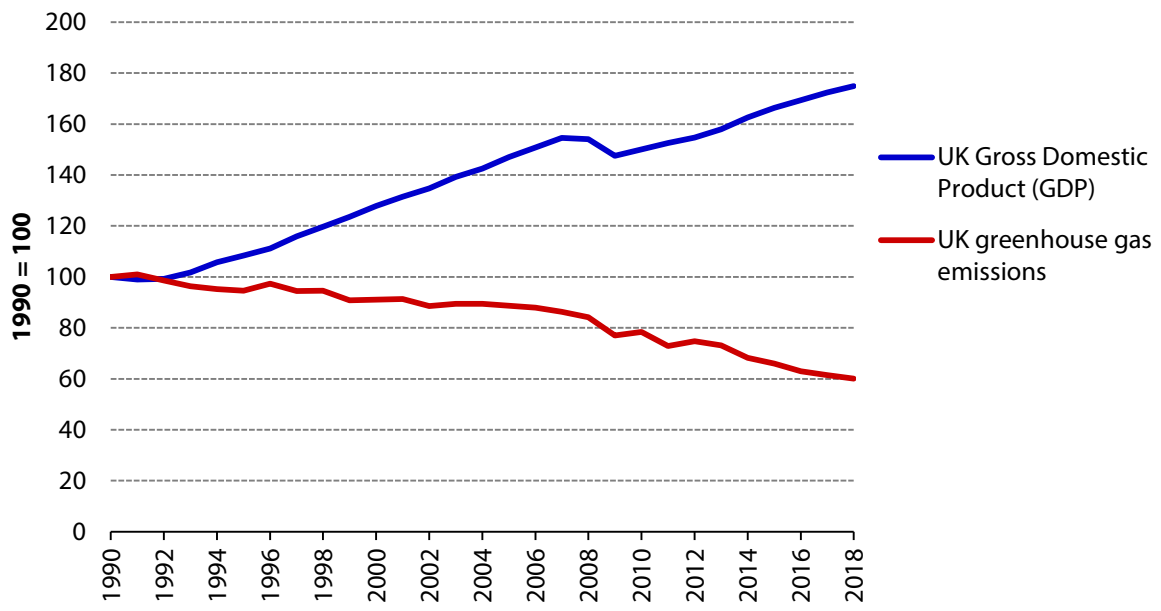
2. Economy-wide emissions trends for the UK

Actual emissions

UK greenhouse gas (GHG) emissions fell by 2.3% in 2018 to 491 $MtCO_2e$ and have fallen 40% since 1990. Over the same period, the economy has grown by 75% (Figure 1.2). Adjusting for differences in temperatures between 2017 and 2018, the underlying change in total emissions in this latest year was slightly higher, a reduction of 3.1%.

These figures include emissions from international aviation and shipping (IAS), consistent with the net-zero 2050 target. UK emissions are often stated excluding IAS.[2] This figure shows a higher rate of reduction (44%) since 1990, but overstates the overall progress in reducing total UK emissions as IAS emissions have increased by over 80% since 1990.

Figure 1.2. UK greenhouse gas emissions compared to GDP (1990-2018)



Source: BEIS (2019) *2018 UK Greenhouse Gas Emissions, Provisional Figures*; BEIS (2019) *2017 UK Greenhouse Gas Emissions, Final Figures*; ONS (2019) *Gross Domestic Product: chained volume measures: Seasonally adjusted £m*; CCC calculations.
Notes: Series indexed to start at 100. GHG emissions in 1990 were 818 $MtCO_2e$, including international aviation and shipping. In 2018 GHG emissions were 491 $MtCO_2e$ and UK GDP was £2.0 trillion.

[2] Formally, international aviation and shipping are not included in the carbon budgets. However, the budgets are set lower in order to leave 'headroom' for these emissions, consistent with their eventual inclusion in the 2050 target.

Methodology changes to the UK emissions inventory are designed to increase the transparency, accuracy, consistency, comparability, and completeness of the inventory. There are three primary sources of uncertainty in the UK inventory:

- **Uncertainty in the current GHG inventory.** This comprises the statistical uncertainty in emission factors and activity data used in estimating emissions. It is internal to the inventory, is well quantified and it is possible to formally assess the probability of errors through methods set out in IPCC guidelines. For the 2014 inventory, the uncertainty was estimated as ±3% with 95% confidence. This uncertainty was concentrated in sectors involving complex biological processes or diffuse sources such as waste, agriculture and land use, land-use change and forestry (LULUCF).[3]
- **Uncertainty in Global Warming Potentials (GWPs) assigned to GHGs.** GWPs are used to convert emissions from different gases into a single comparable metric (tonnes of CO_2-equivalent, or tCO_2e). There have been multiple changes to the GWP estimates used for methane, N_2O and F-gases since the inception of the inventory. Future changes to GWPs will significantly affect emissions as measured in $MtCO_2e$.
- **Uncertainty from other activities**. Some sources of emissions and activities (e.g. peatlands) are not currently included in the inventory but will be included in the future, thus adding to overall GHG estimates.

Changes between inventories published in 2018 and 2019 increased the estimate of emissions in 2016 - the most recent comparable year - by around 5 $MtCO_2e$ (0.6% of 1990 emissions). There are two known changes to future emissions inventories that could add over 40 $MtCO_2e$ per year to the inventory before 2025 (Box 1.1). Our recommendation for a net-zero greenhouse gas target in 2050 takes these two methodological changes into account, and we will provide further advice in due course on how these changes should be managed for existing carbon budgets.

[3] CCC (2017) *Quantifying Greenhouse Gas Emissions.*

Box 1.1. Effect of past and future methodology changes to UK inventory

UK carbon budgets are based on estimates of greenhouse gas (GHG) emissions produced by the National Atmospheric Emissions Inventory (NAEI). Changes between inventories published in 2018 and 2019 increased the estimate of emissions in 2016 (the most recent comparable year) by around 5 $MtCO_2e$.

The previous inventory estimated that emissions in 2016 were 37.6% below 1990 levels; this is now estimated to be 37.0% in the latest inventory. However, carbon budgets are set on an absolute $MtCO_2e$ basis as opposed to a percentage reduction basis. An annual increase of 5 $MtCO_2e$ to emissions could add 25 $MtCO_2e$ over the course of a five-year carbon budget (around 2% of total non-traded emissions allowed in the fourth carbon budget outside the EU Emissions Trading System).[4]

In 2017, there were both upwards and downwards revisions across several sectors, but the most significant change was in the estimate of emissions from the LULUCF sector. The estimated size of the LULUCF sink in 2016 decreased by 4.8 $MtCO_2e$ in the latest inventory, in particular due to an error correction in the BEIS inventory to address the double-counting of deadwood harvesting, which had previously overstated the size of the sink. In the past five inventories published by BEIS, net changes to total UK emissions have primarily been driven by changes to estimated size of the LULUCF sink (Figure B1.1).

There are two further changes that will be made to the emissions inventory in the near future: the addition of emissions from peatland and revision of the Global Warming Potentials (GWPs) used to calculate aggregate greenhouse gas emissions.

These inventory changes will increase the headline estimate of UK emissions, both for the present day and back to 1990:

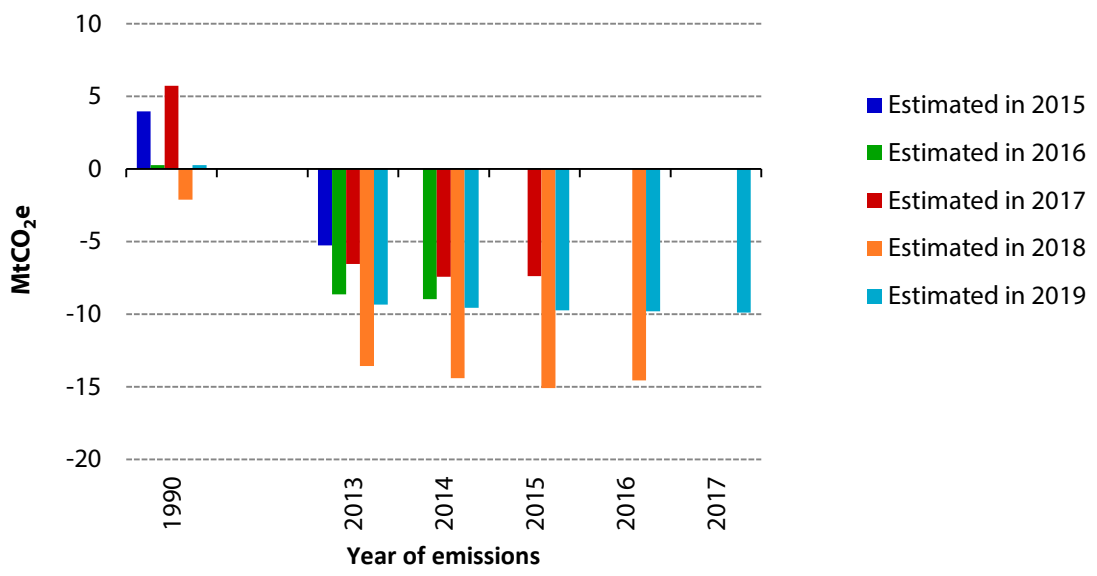
- **Peatland.** The current inventory only captures around 1.3 $MtCO_2e$ of emissions from peatlands, but all sources of peatland emissions will be included in the inventory from 2020. Work by the Centre for Ecology & Hydrology (CEH) for the BEIS Wetland Supplement project,[5] which will be used as the basis for the emissions inventory, estimates net annual emissions from all peatland sources of 18.5-23 $MtCO_2e$ in 2017 and a similar amount in 1990.
- **Global Warming Potentials (GWPs).** These are used to aggregate different greenhouse gases together into a common metric, showing their equivalence to carbon dioxide. At COP24 in December 2018 the international community decided to standardise reporting under the Paris Agreement transparency framework using the GWP100 metric. The values to be used are those from the IPCC 5th Assessment Report (AR5). There are two methodologies, and it is not yet clear which will be used. Both are different from the AR4 values used in the current emissions inventory. The decision requires national inventories to use updated GWP values by the end of 2024. The impact of this change will be to increase the headline figure for UK emissions (excluding peatland) by around 10-50 $MtCO_2e$ in 1990 and 5-20 $MtCO_2e$ for 2017, largely from sectors which have significant methane emissions (i.e. agriculture and waste).

For the longer term, the IPCC has recently published the *2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories* providing updated guidance and methodologies for compiling GHG inventories. If these are adopted by a future meeting of Parties to the Paris Agreement they will in due course have to be reflected in the UK's emissions inventory. The effect of these refinements on the UK GHG emissions inventory is not yet known but will likely bring marginal improvements in the accuracy of the inventory in a number of sectors.

[4] CCC (2010) *The fourth carbon budget - Reducing emissions through the 2020s.*
[5] Chris Evans et al. (2019) *Implementation of an Emissions Inventory for UK Peatlands.*

Box 1.1. Effect of past and future methodology changes to UK inventory

Figure B1.1. Comparison of UK LULUCF emissions estimates between inventories published in 2015-2019



Source: BEIS (2019) *2017 UK Greenhouse Gas Emissions, Final Figures* BEIS (2018) *2016 UK Greenhouse Gas Emissions, Final Figures*; BEIS (2017) *2015 UK Greenhouse Gas Emissions, Final Figures*; BEIS (2016) *2014 UK Greenhouse Gas Emission, Final Figures*; BEIS (2015) *2013 UK Greenhouse Gas Emissions, Final Figures*; CCC calculations.

The net carbon account

Under the Climate Change Act, performance against carbon budgets is not measured by actual emissions but by the 'net carbon account'. This account excludes emissions from international aviation and shipping, and allows for international trading of carbon allowances in sectors (i.e. power and industry) covered by the EU Emissions Trading System (EU ETS).

We estimate that net carbon account emissions fell by 2% in 2018 from 488 $MtCO_2e$ to 478 $MtCO_2e$ (Figure 1.3). This reflects a combination of changes in the allocation of EU ETS allowances (-7 $MtCO_2e$) and emissions in the non-traded sector (-4 $MtCO_2e$). Actual UK emissions covered by the EU ETS fell by marginally more (-8 $MtCO_2e$) than the UK share of EU ETS allowances (Box 1.2).

Box 1.2. The net carbon account

Under the Climate Change Act, performance against carbon budgets is measured not by actual emissions but by the 'net carbon account'. The net carbon account is the sum of:

- The allowances allocated to the UK through the EU Emissions Trading System (EU ETS).
- Actual emissions from sources outside the EU ETS (i.e. the 'non-traded sector').

The net carbon account will differ from actual UK emissions as sources of emissions covered by the EU ETS (i.e. the 'traded sector') typically will not equal the UK's share of the EU ETS emissions cap.

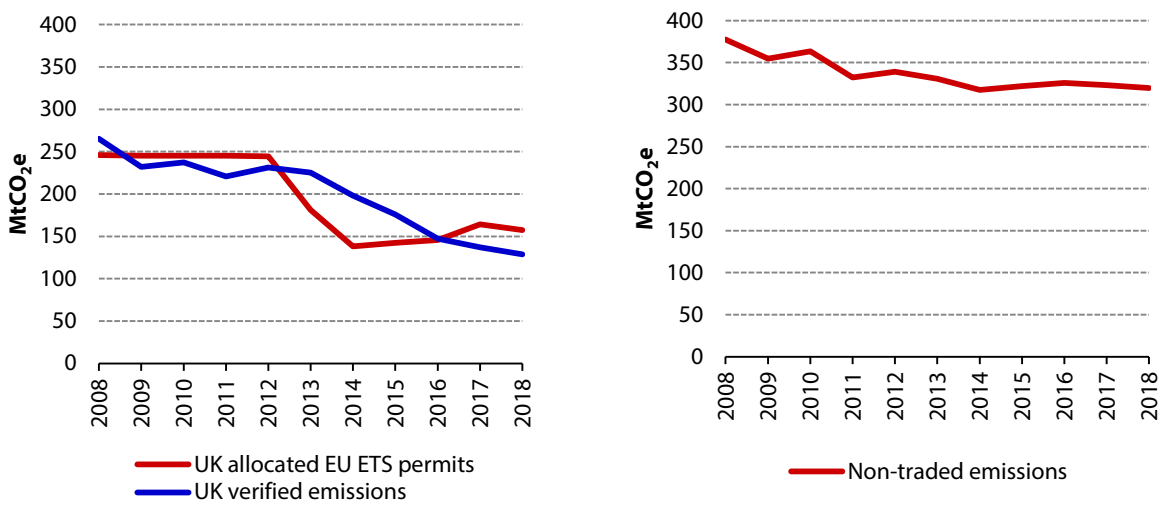
- In 2018 UK emissions in the traded sector were 129 $MtCO_2e$, while we estimate that the UK share of the EU ETS cap was 157 $MtCO_2e$.
- In effect, 28 $MtCO_2e$ of allowances that were allocated the UK were instead made available to the rest of the EU.

The UK's share of EU ETS allowances consists of the free emission allowances allocated directly to UK installations, allowances allocated to the UK Government for auction, and an estimate of allowances allocated to new UK entrants to the EU ETS.

Adding non-traded sector emissions of 320 $MtCO_2e$, we estimate the net carbon account for 2018 was 478 $MtCO_2e$ (Figure B1.2). Net carbon account emissions fell by 2% in 2018, due to a fall in EU ETS allowances allocated to the UK and a fall in non-traded sector emissions (Figure B1.2).

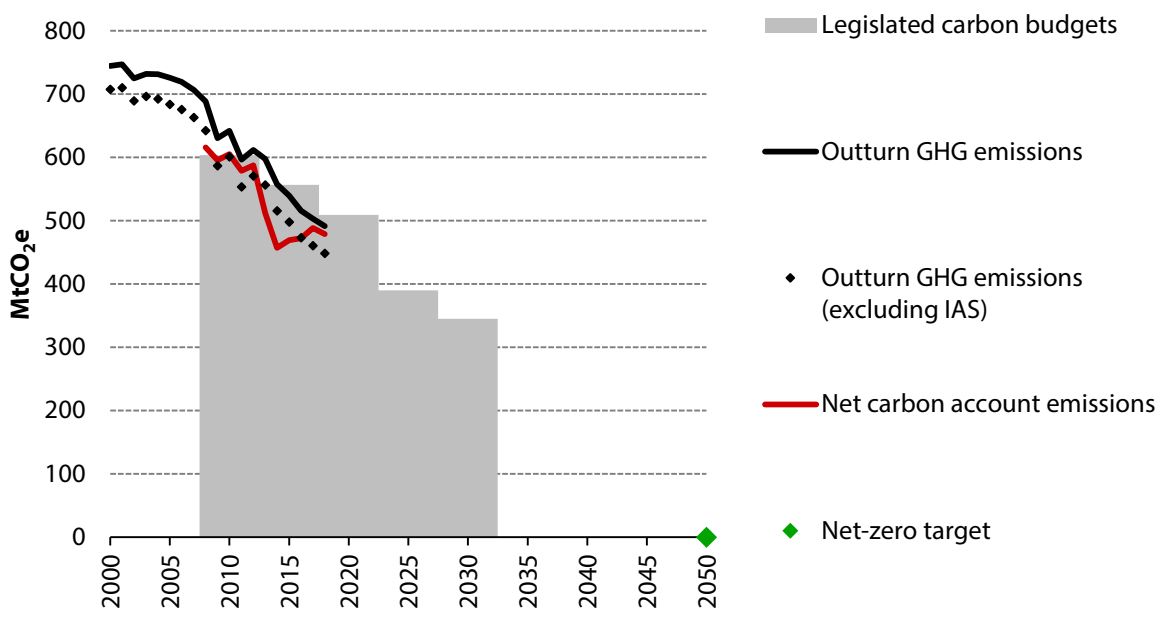
Given the vote to leave the EU, the UK's future role in the EU ETS is uncertain. If the UK were no longer to participate in the EU ETS then this would have implications for carbon budget accounting. The Government has launched a consultation on *The future of UK carbon pricing*, which the Committee will advise on this summer.

Figure B1.2. UK GHG emissions in traded (left) and non-traded sectors (right)



Source: BEIS (2018) *2017 UK Greenhouse Gas Emissions, Provisional Figures*; BEIS (2018) *2016 UK Greenhouse Gas Emissions, Final Figures*; European Environment Agency EU ETS data viewer; CCC calculations.

Figure 1.3. UK GHG emissions compared to legislated carbon budgets and the 2050 target (2000-2050)



Source: BEIS (2019) *2018 UK Greenhouse Gas Emissions, Provisional Figures*; BEIS (2019) *2017 UK Greenhouse Gas Emissions, Final Figures*; CCC calculations
Notes: GHG emissions are shown on a total (gross) basis, while carbon budgets represent the emissions under the net carbon account; IAS stands for International Aviation and Shipping. Outturn GHG emissions are based on the latest BEIS publication and therefore do not include updated peatland or GWP factors. Net carbon account emissions are from BEIS publication for 2008-2017 and CCC estimate for 2018.

3. Sector-by-sector emissions trends for the UK

In 2018,[6] for the fifth consecutive year, the sector with the largest percentage reduction in emissions was the power sector (Figure 1.4). Excluding the power sector, economy-wide progress was much less positive, with emissions falling by 1.0% on average (2.0% when temperature-adjusted). Reaching net-zero emissions in 2050 will require an average annual emissions reduction of around 15 $MtCO_2e$ (equivalent to 3% of 2018 emissions) across the economy (Figure 1.1):

- **Surface transport.** Surface transport is the largest-emitting sector in the UK, accounting for 23% of UK emissions. Following three consecutive years of growth between 2014 and 2016, emissions were stable in 2017 and fell by 2% in 2018 to 115 $MtCO_2e$. Emissions from all major modes of transport decreased in 2018, with the largest reduction of 0.9 $MtCO_2e$ (-1.3%)[7] from cars.

[6] Emissions for non-CO_2 emissions, and international aviation and shipping (IAS) is only available for 2017. The 2018 non-CO_2 emissions have been estimated by adjusting the 2017 non-CO_2 emissions total in the 1990-2017 greenhouse gas inventory in proportion to the percentage difference between the estimates for the 2017 and 2018 non-CO_2 emissions in the most recent Energy and Emissions Projections published by BEIS. Emissions from IAS are assumed to be the same as in 2017.
[7] The breakdown between road transport modes (e.g. cars, vans, HGVs) for 2018 is provisional. A detailed breakdown is only available to 2017.

Demand for car travel increased slightly, albeit at a significantly lower rate than previous years, which was more than offset by a combination of improved fleet fuel efficiency and increased use of biofuels.

From 2009 to 2016, the average CO_2 emitted per km from new cars fell, leading to an improvement in overall car efficiency across the fleet. However, this trend has reversed in the last two years, with the average new car sold in 2018 and 2017 being less carbon-efficient than the previous year (Box 3.1).

- **Industry.** Direct GHG emissions from industry, covering both traded and non-traded emissions (i.e. inside and outside the EU ETS), fell by 1% to 104 $MtCO_2e$ in 2018. Emissions were 52% below 1990 levels and accounted for 21% of all UK emissions. Manufacturing[8] contributed to 61% of direct industrial GHG emissions, and petroleum refining, fossil fuel production and fugitive emissions made up 39%. In addition to these direct emissions, industry consumed almost a third of UK grid electricity, implying indirect emissions of around 20 $MtCO_2e$.
- **Buildings.** Actual emissions from buildings increased by 3% to 88 $MtCO_2e$ in 2018. When emissions are adjusted for lower winter temperatures, in particular the extreme cold weather in February 2018, the underlying change was a 1% fall in emissions. On a temperature-adjusted basis, residential emissions fell by 2% whilst non-residential emissions increased by 1%. This small overall fall follows two consecutive increases in temperature-adjusted emissions in 2016 and 2017. Buildings emissions in 2018 remained higher than 2015 levels on both an actual and temperature-adjusted basis.
- **Power sector**. Emissions fell by 10% in 2018 to 65 $MtCO_2$ and are now 68% below 1990 levels, reflecting a 9% decrease in emissions intensity since 2017 to 242 gCO_2/kWh. Low-carbon generation in 2018 accounted for a record high of 54% of total UK generation (160 TWh). Specifically, renewable generation increased by 12% to 101 TWh in 2018. The share of coal generation decreased from 33% (114 TWh) in 2008 to 5% (16 TWh) in 2018. Electricity consumption increased slightly (1%) in 2018, against a long-term trend of a 12% fall since 2008. Despite sustained progress in the power sector, emissions reductions are slowing down compared to average annual reductions of 14% since 2012, reflecting diminishing potential to reduce emissions further by phasing out coal generation.

Emissions data for international transport and for sectors with large shares of non-CO_2 greenhouse gas emissions are produced with a one-year lag, so emissions in the following sectors are only available up to 2017:

- **Aviation.** Total aviation emissions increased by 3.5% to 36.5 $MtCO_2e$ from 2016 to 2017, the latest year for which data is available. Within this, emissions from international flights increased by 3.6% to 35.0 Mt and emissions from domestic flights by 2.6% to 1.5 Mt. Overall, emissions from aviation in 2017 were more than double 1990 levels.
- **Shipping.** Total shipping emissions fell by 5.7% to 13.8 $MtCO_2e$ from 2016 to 2017, the latest year for which data is available. Emissions from international journeys fell by 8.6% to 7.8 Mt and emissions from domestic journeys by 1.7% to 5.9 Mt. Overall, emissions from shipping in 2017 were 17% lower than 1990 levels.

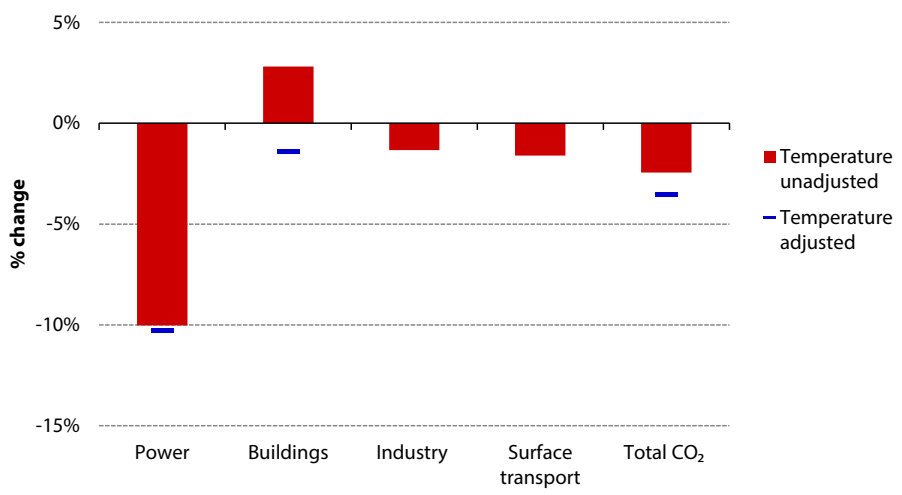
[8] For this report our definition of manufacturing includes construction and waste and water management.

- **Agriculture.** Emissions from agriculture increased by 1% from 2016 to 2017 to 45.6 $MtCO_2e$ (9% of all UK emissions). Emissions from agriculture were 16% below 1990 levels, but there has been no progress in reducing emissions from agriculture since 2008. Methane accounted for 56% of emissions from agriculture in 2017, and almost half (47%) of total agriculture emissions were from the digestive process of livestock.

  Emissions from managing agricultural soils, largely resulting from nitrogen fertiliser use, accounted for 25% of the sector's emissions, with the remainder from waste management and on-farm energy use.
- **Land use, land-use change and forestry (LULUCF).** The sector is a net carbon sink and on the basis of the latest inventory this increased by 1% to -9.9 $MtCO_2e$ in 2017. The estimated size of the LULUCF sink is around 5 $MtCO_2e$ smaller compared to last year's GHG inventory due mainly to a correction for the double counting of forestry deadwood. The inclusion of emissions from peatland in future inventories is expected to make the LULUCF sector a net source of emissions (Box 1.1).
- **Waste.** Total emissions from waste increased by 1% to 20.4 $MtCO_2e$ in 2017, and were 69% below 1990 levels. Almost 70% of emissions from waste were methane from the anaerobic decomposition of biodegradable waste in landfill sites.
- **F-gases.** F-gas emissions fell by 6% from 2016 to 2017 to 15.0 $MtCO_2e$. This is largely due to the EU-wide cap on the use of F-gases, particularly in refrigeration and air conditioning units.

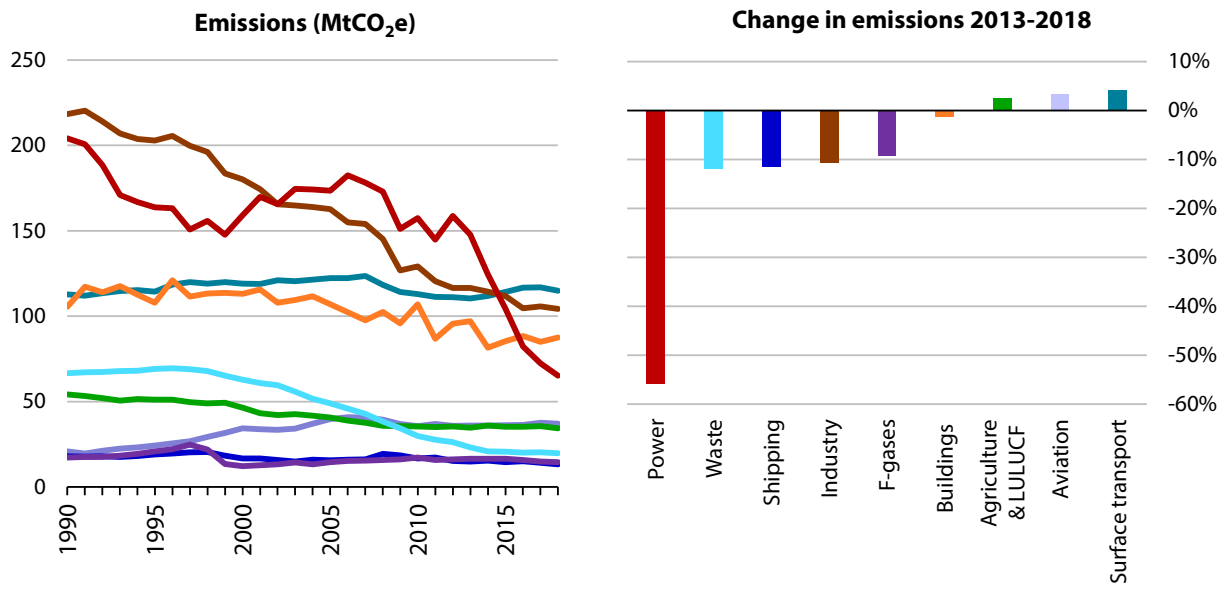
New emissions data for 2018 has shown signs of improvements in transport, industry and (temperature-adjusted) buildings emissions (Figure 1.4), but progress over the last five years has been almost entirely driven by reductions in the power sector (Figure 1.5). In order to achieve further reductions in emissions consistent with the net-zero target, the UK must deliver consistent reductions across the economy.

Figure 1.4. Change in UK CO_2 emissions between 2017 and 2018



Source: BEIS (2018) *2017 UK Greenhouse Gas Emissions, Provisional Figures*; BEIS (2018) *2016 UK Greenhouse Gas Emissions, Final Figures*; CCC calculations.
Notes: CO_2 emissions factors used for temperature-adjustment are based on energy use statistics, as published in BEIS Energy Trends. Emissions for Industry and Transport are not temperature adjusted. Total CO_2 does not include emissions from international aviation and shipping.

Figure 1.5. Trends in UK sectoral GHG emissions



Source: BEIS (2019) *2018 UK Greenhouse Gas Emissions, Provisional Figures*; BEIS (2019) *2017 UK Greenhouse Gas Emissions, Final Figures*; CCC calculations.
Notes: The chart on the right-hand side shows changes in sectoral emissions between 2013 and 2018 for all sectors except for Agriculture, LULUCF, Waste and F-Gases which cover the period 2013-2017; buildings emissions in this chart are temperature-adjusted.

4. Consumption-based accounting - the UK's carbon footprint

Emissions covered by the carbon budgets and the 2050 target are those released by activities occurring within the UK's borders only. This accounting approach is known as the 'territorial' basis.

- It is the standard accounting approach for measuring emissions internationally, as required by the UNFCCC when countries compile their annual emissions inventories.[9]
- It avoids the risks that either some emissions are missed or the same block of emissions are counted by more than one country and hence would be double-counted when aggregated to a global level.
- It also maps most closely to the levers available to the UK to reduce emissions.

Emissions can also be measured on a 'consumption' basis for which the allocation by country is based on where goods and services (which lead to emissions during their production) are eventually consumed. This is also known as the 'carbon footprint' of a country.

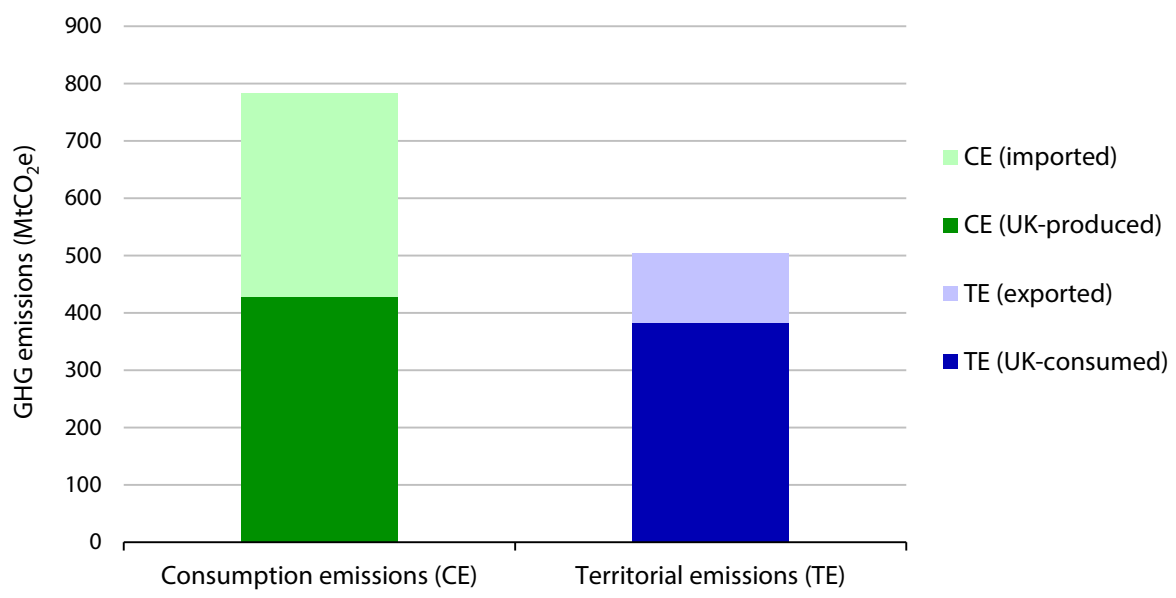
Defra release an annual publication on the level of the UK's consumption-based emissions, which are more uncertain than territorial-based emissions.[10]

[9] 2006 IPCC Guidelines for National Greenhouse Gas Inventories.
[10] Defra (2019) *UK's Carbon Footprint 1997 - 2016.*

- The statistics are classified as "experimental" due to inherent uncertainties. They are also produced with a longer lag (the latest year is 2016) given the detailed modelling of global supply chains which is required.
- While the amount of goods consumed in the UK is well known from official Government statistics on imports and exports, the total emissions associated with producing UK imports is much harder to determine: it depends on estimates of how commodities are produced in all of the countries that the UK imports from, either directly or via intermediaries, and the emissions associated with each part of those supply chains.

The UK's consumption emissions were estimated at 784 $MtCO_2e$ in 2016, around 56% higher than territorial emissions (including international aviation and shipping) of 503 $MtCO_2e$ (Figure 1.6).[11] The difference is primarily due to international trade: the production overseas of goods that are imported into the UK releases more emissions (355 $MtCO_2e$) than the production of goods within the UK that are exported (121 $MtCO_2e$).[12]

Figure 1.6. Goods and services traded internationally by the UK results in a large difference between consumption-based and territorial-based emissions



Source: CCC analysis; University of Leeds analysis; Defra (2019) *UK's Carbon Footprint 1997 – 2016*; BEIS (2019) *Final UK greenhouse gas emissions national statistics: 1990-2017*.
Notes: Includes emissions from aviation and shipping provided by UK operators, for UK consumers.

[11] All emissions statistics in this section are expressed using IPCC 5th Assessment report GWP100 values (without carbon cycle feedbacks) with F-gas emissions excluded. This is to allow for a like-for-like comparison to the UK consumption emissions statistics.
[12] In theory the difference between imported and exported emissions (234 $MtCO_2e$) should be the same as the difference between the total consumption and territorial estimates (281 $MtCO_2e$). However, the different approaches used in the two estimates mean that they make different assessments of the emissions resulting from UK production for UK consumption. This highlights the inherent uncertainty in the estimates.

The historical profile of consumption emissions shows a steep fall around the time of the 2008-09 recession: emissions rose by 16% in the decade leading up to 2007 and have since fallen by 21%. Territorial emissions, however, have fallen steadily over the entire two decades (Figure 1.7).

Action taken to decarbonise the UK economy can reduce both territorial and consumption emissions. This only holds when the outcome is the reduction of emissions from activities occurring within UK borders, rather than a transfer of emissions to overseas.[13]

- The retirement of coal-fired power generation and the increase in generation from wind and solar is an example of action that caused a substantial reduction in both territorial and consumption emissions, of 69 $MtCO_2e$ from 1997 - 2016.
- Similarly, the diversion of biodegradable waste from landfill and increased capture of methane at landfill sites in the UK was a major contributor to reductions in territorial emissions and will have helped to reduce consumption emissions.
- The picture with industrial emissions is more complicated. UK territorial emissions from industry have fallen significantly since 1990 while UK industrial output has remained fairly constant, reflecting a switch to lower-carbon fuels and improving energy intensity.[14] However, UK demand for industrial products has increased considerably, resulting in the total monetary value of net imports of manufactured goods more than doubling – this increases consumption emissions but not territorial emissions.[15]

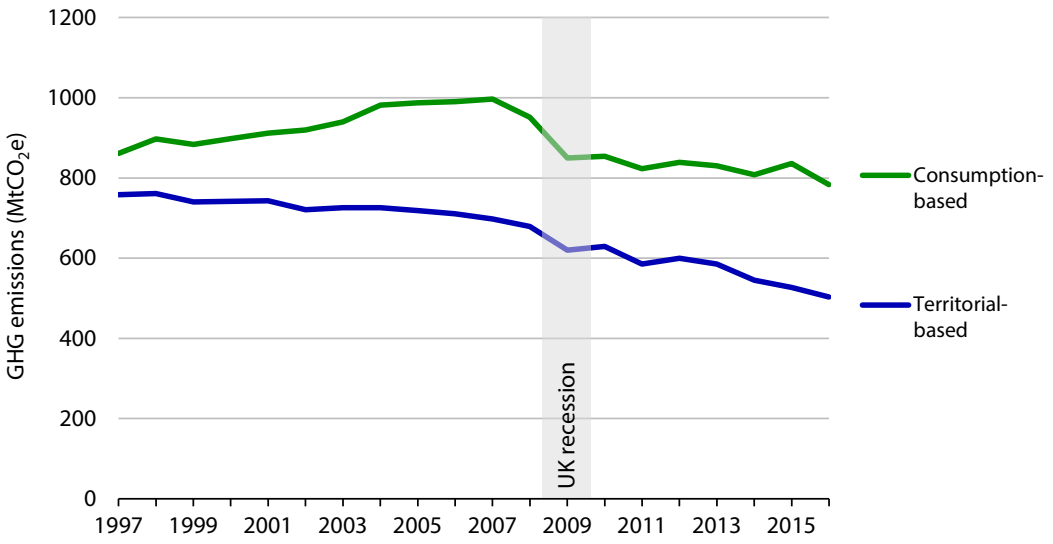
Whilst the UK-produced part of our consumption emissions has fallen (-156 $MtCO_2e$) since 1997, the *imported* part has risen (+79 $MtCO_2e$) particularly in the decade prior to 2007. This has thereby led to a more moderate fall in consumption emissions overall (Figure 1.8).

- The historical profile of consumption emissions is driven by imported emissions from non-EU countries (Figure 1.8): as of 2016 they are responsible for 79% of total UK imported emissions. This is despite only 45% of UK imports originating from these countries, implying that more carbon-intensive products tend to be imported from outside the EU (Figure 1.9).
- If the data are disaggregated by product and sector, then emissions arising during the production of agricultural goods, including food, have the largest contribution (27 $MtCO_2e$) to total imported emissions, followed by emissions released during the generation of electricity to make imported goods (25 $MtCO_2e$), and then emissions arising in the construction industry (21 $MtCO_2e$ in 2016).[16,17]
- Emissions embedded in goods depend on both the volume of production and the emissions associated with producing each unit (the carbon intensity). Furthermore, total imported emissions depend on the types of goods that the UK imports.

Between 1997 and 2016, total imports to the UK grew by 94% whilst the global carbon intensity decreased by 16% (Figure 1.9). Additional work would be needed to produce a detailed understanding of how each factor influenced overall imported emissions.

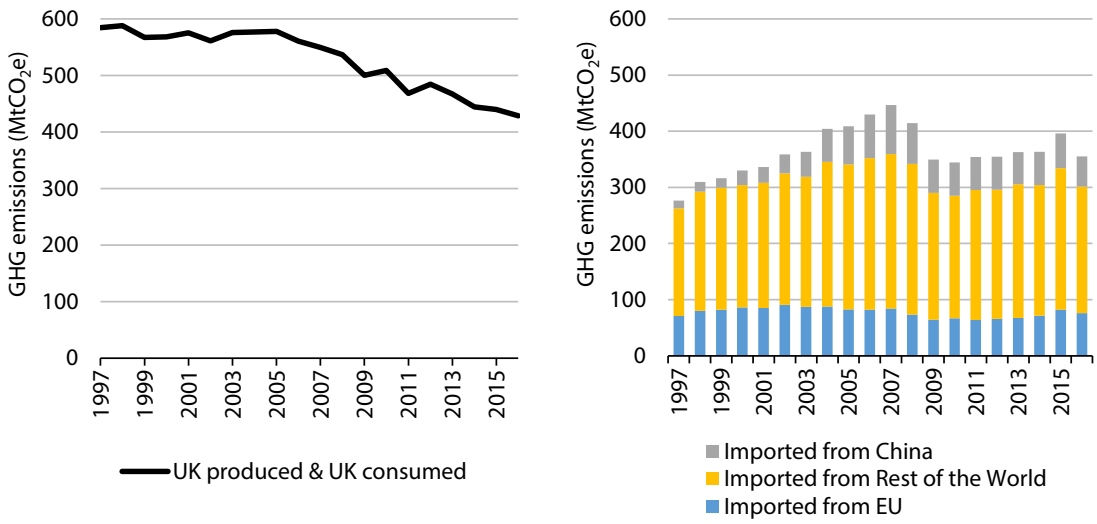
[13] Such transfer of emissions can occur for a number of reasons: businesses relocating their production overseas or the UK switching to sourcing more products from overseas rather than producing them in the UK, especially for carbon-intensive products.
[14] CCC (2018) *Reducing UK emissions - 2018 Progress Report to Parliament* (Box 4.1).
[15] ONS (2019) *UK trade in goods by classification of product by activity time series*. Released: 13 June 2019.
[16] All statistics are for 2016, the latest year available.
[17] Source: Defra (2019) *UK's Carbon Footprint 1997 - 2016*; CCC analysis.

Figure 1.7. Territorial emissions have fallen faster than consumption emissions



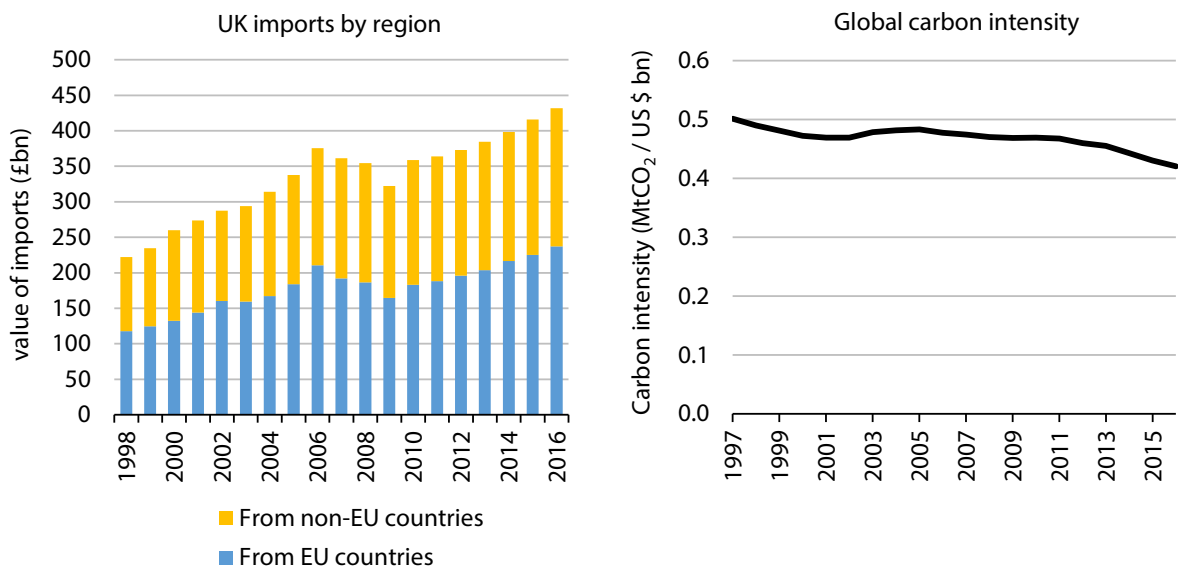
Source: Defra (2019) *UK's Carbon Footprint 1997 - 2016*; BEIS (2019) *Final UK greenhouse gas emissions national statistics: 1990-2017*; CCC analysis.
Notes: International aviation and shipping is included in the territorial emissions statistics. Both consumption and territorial emissions are expressed using IPCC 5th Assessment report GWP100 values, without carbon cycle feedbacks, with F-gas emissions excluded. This is the basis for the published consumption emissions statistics and hence adjustment of the territorial statistics allows a like-for-like comparison.

Figure 1.8. The profile of UK consumption emissions depends on their region of production



Source: Defra (2019) *UK's Carbon Footprint 1997 - 2016*; CCC analysis.

Figure 1.9. The value of imports to the UK has risen strongly over the past two decades, whilst the carbon intensity of goods produced at a global level has fallen but to a lesser extent



Source: Imports: ONS *"UK trade in goods by classification of product by activity time series"*, released 13 June 2019. Global carbon intensity uses: CO_2 emissions from the *BP Statistical Review of World Energy* 2019; GDP (in constant 2010 USD) from the World Bank Group.
Notes: Import data is in terms of chained volume measures and not seasonally adjusted. The CO_2 emissions data relates only to the combustion of fossil fuels and excludes: non-energy related emissions, other GHGs, CO_2 sequestration.

It is clear that actions such as power sector decarbonisation reduce UK consumption emissions, by addressing those emissions produced in the UK and not leading to substantial transfer of emissions overseas. Similarly, decarbonisation of how we heat our homes and travel on our roads will also substantially reduce our consumption emissions. Actions taken by our trading partners under the Paris Agreement will further reduce the carbon intensity of goods imported to the UK and hence UK consumption emissions.[18] This would also close the gap between consumption and territorial emissions.

However, there are certain goods which the UK imports in substantial volumes and whose production or use is currently more difficult to decarbonise.

- Such goods include fossil fuels,[19] industrial products (steel and cement) and foods such as red meat and dairy.
- In total, these goods were responsible for around one fifth of the UK's imported emissions in 2016 (i.e. 64 $MtCO_2e$).[20]

[18] Costs of carbon are included in the cost of some current imports to the UK, although currently a relatively small share of total.
[19] Emissions arising from the *burning* of fossil fuels which have been imported to the UK are counted within both UK territorial and consumption emissions. However, emissions associated with the *extraction* of those fossil fuels are counted only as UK consumption emissions, not as UK territorial emissions.
[20] Defra (2019) *UK's carbon footprint 1997 - 2016*; CCC analysis.

If options to decarbonise these products fail to materialise, UK demand for these goods would need to be reduced in order to lower consumption emissions further.

- In our Net Zero report[21] we identified a number of measures that could be taken to reduce consumption of these goods, such as using steel and cement-based products more efficiently and eating a diet with a lower proportion of red meat and dairy products.
- We estimated that these measures could reduce consumption emissions by almost 20 $MtCO_2e$ annually by 2050.

In line with the Climate Change Act, the Committee will continue to monitor progress primarily on a territorial basis. However, we will also monitor consumption emissions both to: ensure that action to decarbonise UK-based activities does not result in emissions moving offshore; and track progress in decarbonisation of imports to the UK.

5. Emissions trends for Scotland, Wales and Northern Ireland

In this section, we highlight trends in emission reductions in each main sector in Scotland, Wales and Northern Ireland. The devolved administrations have an important role to play in tackling climate change. Their actions contribute to meeting their own domestic targets for reducing emissions, as well as the UK's overall progress towards carbon budgets.

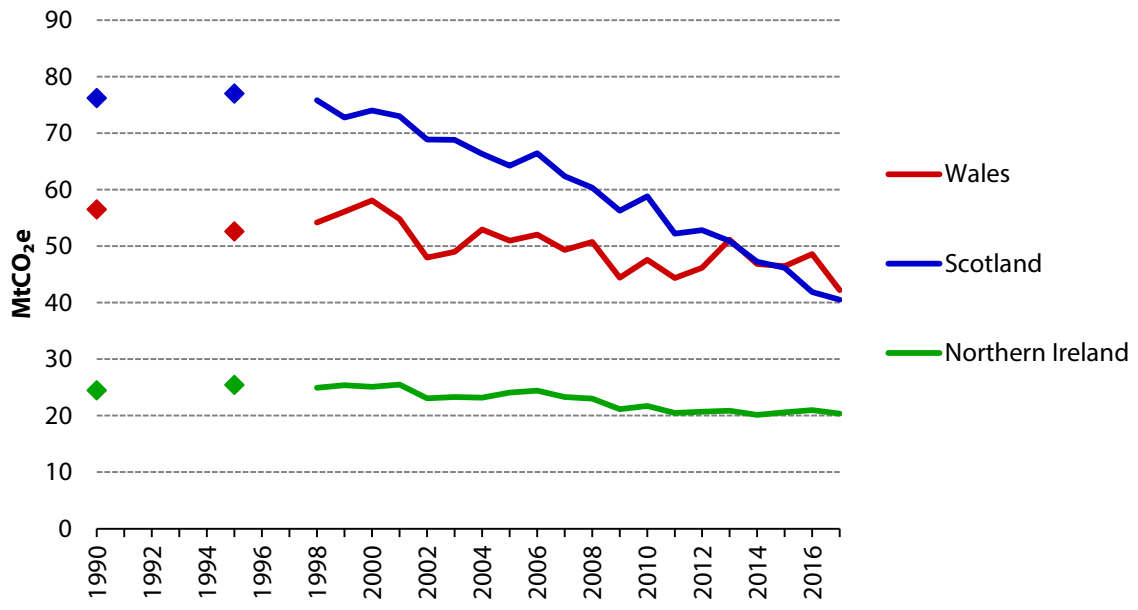
Emissions data for the devolved administrations are only available up to 2017. On a percentage basis, emissions fell by more in 2017 in Wales (-13%), Scotland (-3%) and Northern Ireland (-3%) than in the UK as a whole (-2%) (Figure 1.10). Emissions in England fell by 1%.

The different reductions in emissions across the devolved administrations in 2017 were almost entirely driven by changes in the power sector:

- Emissions across Scotland, Wales and Northern Ireland fell by 8.4 $MtCO_2e$ overall, and the power sector contributed to 7.8 $MtCO_2e$ (92%) of this fall (Figure 1.11).
- Scotland and Wales do not have devolved control of the power sector, although national planning regimes are important. Changes in emissions are largely driven by UK and EU policy.
- Northern Ireland is a member of the separate, all-island electricity network and has devolved powers over the energy sector, but the fall in emissions in 2017 may have been driven by higher carbon prices under the EU ETS.

[21] CCC (2019) *Net Zero - The UK's contribution to stopping global warming.*

Figure 1.10. Greenhouse gas emissions in Scotland, Wales and Northern Ireland (1990-2017)



Source: NAEI (2019) *Greenhouse Gas Inventories for England, Scotland, Wales and Northern Ireland.*
Notes: No inventory data are available for devolved administrations in 1991-1994 or 1996-1997. Includes emissions from international aviation and shipping.

Scotland. Emissions in Scotland fell by 3% in 2017 to 40.5 $MtCO_2e$, and were 47% below 1990 levels. This fall was almost entirely driven by continued reductions in the power sector. There is now relatively little fossil-fuelled electricity generation operating in Scotland, meaning that the scope for further reductions in power sector emissions is limited:

- Emissions fell by 1.3 $MtCO_2e$ (-54%) in the power sector in 2017. Emissions have fallen by 91% since 2012 and accounted for less than 3% of Scottish emissions in 2017. Following the closure of Longannet power station in early 2016, there was zero coal generation in Scotland in 2017. This is an important step for Scotland, but actions are now required in other sectors to ensure that overall progress is maintained.
- Surface transport emissions rose for the fourth consecutive year to 10.4 $MtCO_2e$ (+3%), and have increased by 8% since 2012. When including aviation and shipping, transport is the highest emitting sector in Scotland, contributing to 37% of total emissions.
- Emissions from buildings fell by 0.3 $MtCO_2e$ (-4%) to 8.3 $MtCO_2e$. There were smaller changes in other sectors, with emissions falling by 0.1 $MtCO_2e$ across agriculture and LULUCF (-3%), shipping (-5%), and F-gases (-5%), whilst emissions from industry (+1%) and aviation (+5%) both increased by 0.1 $MtCO_2e$.

- Due to the relative size of its forestry sector and land area, the Scottish inventory is more sensitive to changes in LULUCF methodology than the rest of the UK.[22] Changes to the LULUCF inventory (Box 1.1) have decreased the estimated size of the LULUCF sink in Scotland by 3.0 $MtCO_2e$ in 2016. In the previous inventory, Scottish emissions in 2016 were estimated to be 49% below the 1990 levels. This figure is now estimated to be a 45% reduction.
- Scotland missed its legislated target for 2017 of 43.9 $MtCO_2e$ against the 'net' Scottish account. Actual emissions fell by 3% but Scotland's allowances in the EU ETS increased, meaning emissions on the 'net' account used for Scotland's annual emissions targets increased by 4% to 46.4 $MtCO_2e$. The Committee has recommended that Scotland's new emissions targets are based on actual emissions without adjusting for EU ETS allowances.

Wales. Emissions in Wales fell significantly in 2017, by 13% to 42.2 $MtCO_2e$. Emissions were 25% below 1990 levels:

- The reduction in Wales was almost entirely driven by a fall in emissions from the power sector. Emissions from the power sector fell by 5.8 $MtCO_2e$ (-36%), due to large drops in its generation from coal (-62%) and gas (-17%). Uskmouth coal power station has not generated electricity since April 2017. BEIS has attributed the fall in Welsh coal generation to higher carbon prices that reduced the profitability of coal generation on the UK grid, relative to gas-fired generation.[23]
- Emissions from industry fell by 0.3 $MtCO_2e$ (-2%) to 13.7 $MtCO_2e$. Following the fall in the power sector, industry is now the largest emitting sector in Wales, responsible for 32% of all Welsh greenhouse gas emissions.
- Emissions from surface transport (-1%), shipping (-8%) and buildings (-3%) each fell by 0.1 $MtCO_2e$, and all other sectors were within 0.05 $MtCO_2e$ of the previous year.
- Wales has a legislated carbon budget for 2016-2020 that requires an average 23% reduction on 1990 levels from 2016 to 2020. In 2016 and 2017, the average reduction was 20%. Based on the current inventory, average annual emissions will have to be below 42.0 $MtCO_2e$ from 2018 to 2020 for Wales to meet its target.
- The first Welsh carbon budget will be very difficult to achieve unless power sector emissions remain much lower than 2016. Data from the EU ETS indicate that emissions from fuel combustion in the traded sector in Wales[24] fell by a further 20% in 2018 from 2017. If Wales can maintain this progress it will be on track to meet its first carbon budget.

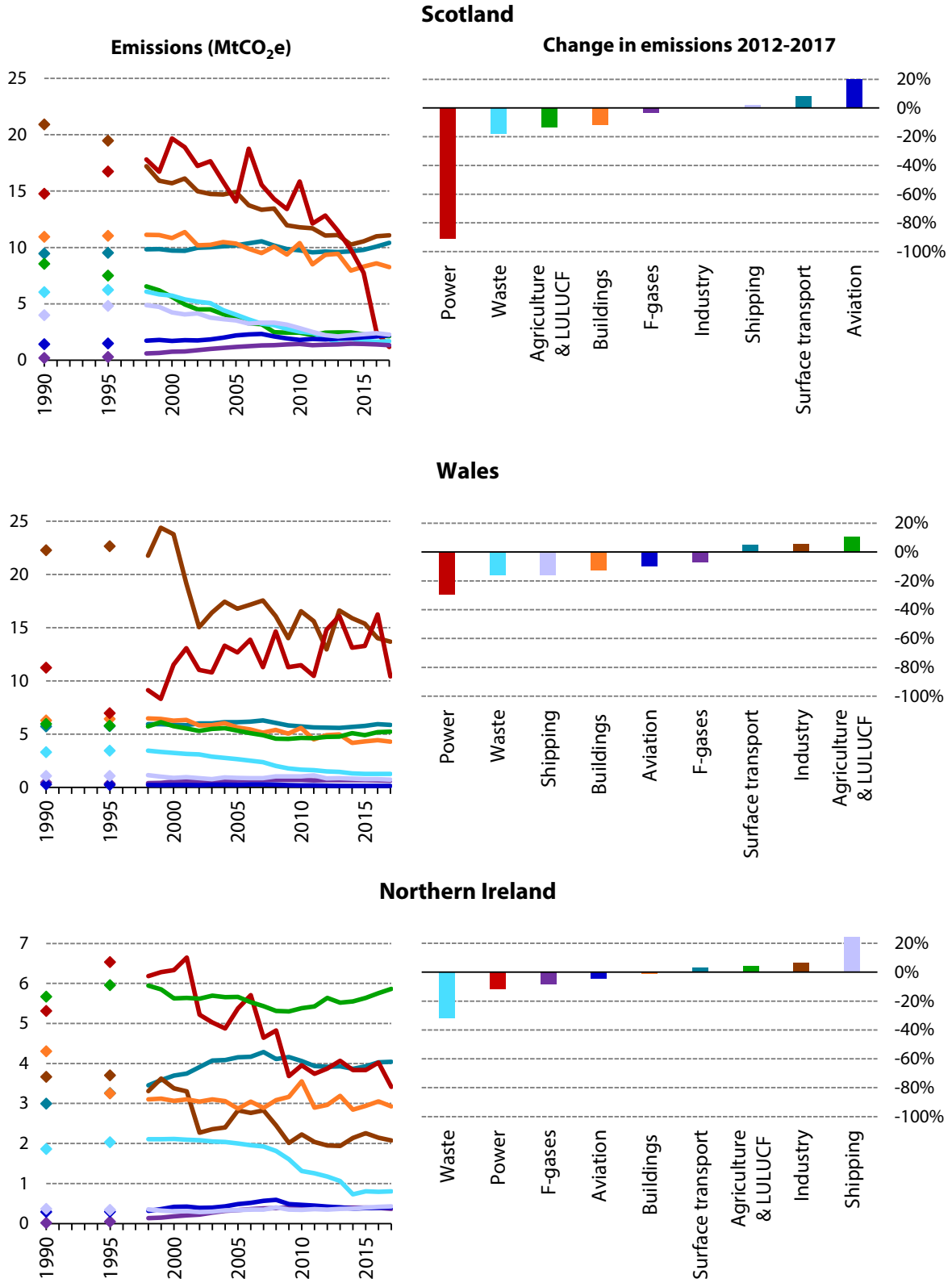
[22] CCC (2017) *Quantifying Greenhouse Gas Emissions*.
[23] BEIS (2018) *Energy Trends: December 2018, special feature article - Electricity generation and supply figures for Scotland, Wales, Northern Ireland and England, 2014 to 2017*.
[24] European Commission (2019) *Verified emissions for 2018*. This may cover emissions from both the power sector and industry.

Northern Ireland. Emissions in Northern Ireland fell by 3% to 20.3 $MtCO_2e$, and were 17% below the 1990 baseline:

- The fall was driven by emissions reductions in the power sector, which fell by 0.6 $MtCO_2e$ (-15%) to 3.4 $MtCO_2e$. Electricity generation from coal fell by 35% from 2016 to 2017. In 2018, Northern Ireland and the Republic of Ireland went a record 25 days without using coal generation on the all-island electricity network.

  Data from the EU ETS indicate that emissions from fuel combustion in the traded sector in Northern Ireland fell by a further 13% in 2018 from 2017.
- Agriculture and LULUCF emissions increased by 0.1 $MtCO_2e$ (+2%) to 5.9 $MtCO_2e$. Combined, the agriculture and LULUCF sector is the largest source of emissions in Northern Ireland, accounting for 29% of emissions in 2017. Emissions have risen in each year since 2013, and are now at the highest levels since 1998.
- There were smaller changes in other sectors. Emissions fell by 0.1 $MtCO_2e$ from each of buildings (-4%) and industry (-3%), whilst other sectors were largely flat.
- Unlike Scotland and Wales, Northern Ireland has no legislated GHG reduction targets and has not laid out a long-term plan to achieve emission reductions. Despite promising trends in the power sector, Northern Ireland is at risk of falling behind the rest of the UK. Actions to address climate change must be taken as soon as possible across all sectors of the economy.

Figure 1.11. Trends in sectoral GHG emissions



Source: NAEI (2019) *Greenhouse Gas Inventories for England, Scotland, Wales and Northern Ireland.*
Notes: No inventory data are available for devolved administrations in 1991-1994 or 1996-1997.

Chapter 2: Developments in international and European circumstances

This chapter summarises developments in international and European circumstances over the past year.

Despite expanding capacity and falling costs for renewable energy, global emissions continued rising in 2018. The UK is one of several countries and regions to set a net-zero emissions target in the last year, but overall international commitments to reduce emissions remain insufficient. The coming 18 months are a vital period for increasing global effort, and the UK must lead this process as the expected host of the UN climate talks ('COP26') at the end of 2020.

This chapter is set out in four sections:

1. Global and European greenhouse gas emissions
2. Changes in the global energy system
3. Advances in international and European climate policy
4. Next steps in international climate policy

1. Global and European greenhouse gas emissions

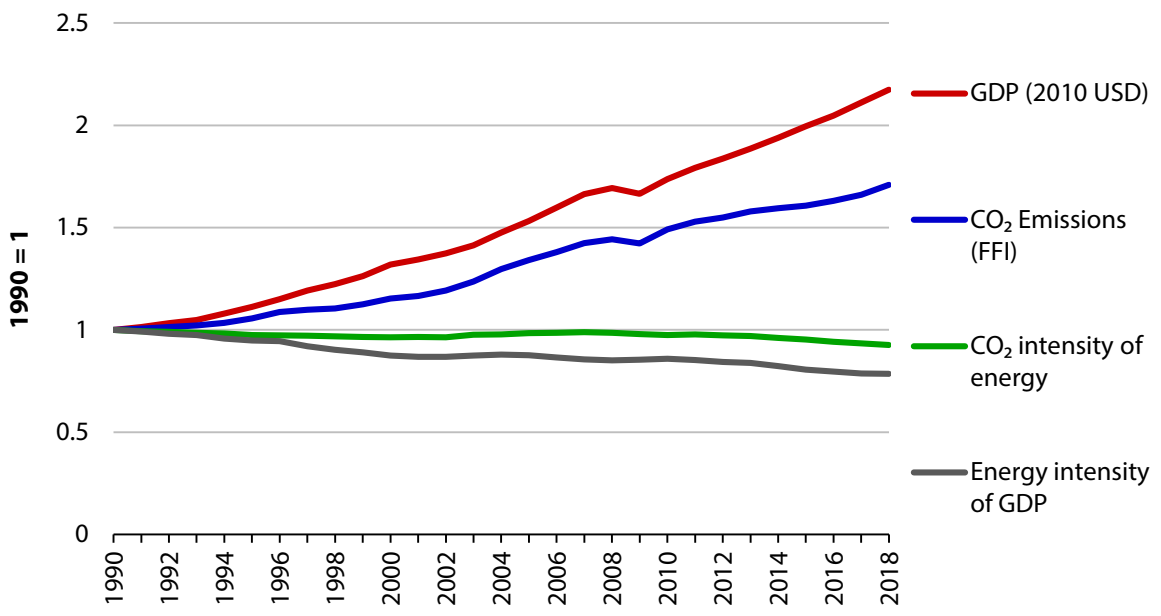
In 2018 global emissions of CO_2 from the combustion of fossil fuels and industrial processes rose, an increase of around 2% from 2017 levels.[25] This follows a 1% increase in 2017, after very small increases between 2014 - 2016.

The 2018 increase reflects the fact that improvements in carbon intensity and energy intensity were not enough to offset the effects of economic growth (Figure 2.1):

- The carbon intensity of energy decreased 1% in 2018 relative to 2017. This follows similar annual decreases since 2011, prior to which global average carbon intensity of energy had been essentially flat since 1990.
- The energy intensity of the global economy only fractionally improved in 2018, reducing 0.1%, a significantly smaller improvement than that seen in recent years. Improved energy intensity has been the dominant driver of the slight decoupling between CO_2 emissions and economic growth since 1990.
- However, the effect of global economic growth in 2018 (3%, slightly higher than 2.8% per year averaged over 2013 - 2017) more than offset these improvements.[26]

[25] BP (2019) *Statistical Review of World Energy*.
[26] World Bank (2019) *Global Economic Prospects: June 2019*.

Figure 2.1. Improvements in the carbon and energy intensity of the global economy means that global CO_2 emissions are not rising as fast as GDP, but emissions have not yet peaked



Source: BP (2019) *BP Statistical Review of World Energy*; World Bank (2019) *World Development Indicators*.
Notes: CO_2 emissions here only include those arising from fossil fuel use in the energy system but not other sources of emissions such as land-use change.

Many regions contributed to the increase in global emissions:

- **China**'s estimated CO_2 emissions grew by around 2.2% in 2018, although historical Chinese energy statistics are often subject to substantial revisions. This increase was driven by emissions from the burning of coal, supplemented with increasing oil and gas consumption.
- The **USA**'s CO_2 emissions increased 2.6% in 2018, driven in part by relatively large heating and cooling demands of a cold winter and warm summer along with strong economic growth. US CO_2 emissions are projected to fall in 2019 and 2020 by a leading US energy agency.[27]
- **India**'s CO_2 emissions grew strongly at 7% in 2018, underpinned by strong economic growth. Although renewable energy deployment continues rapidly, it is being outstripped by energy demand growth, leading to rapidly growing coal consumption.
- In the **EU** emissions of CO_2 decreased by about 2% in 2018 relative to 2017 levels, the first fall since 2014.
  - This is underpinned by a wide range of changes across member states ranging from a 7% decrease (Bulgaria) to a 5% increase (Estonia).

[27] EIA (2019) *Short-Term Energy Outlook*.

- Based on 2017 data for emissions of all aggregated greenhouse gases (GHGs) - the latest year available - the UK has slightly lower GHG emissions per person[28] (7.65 tCO_2e per person per year) than the average for the EU as a whole (8.67 tCO_2e per person per year).[29]

- The **Rest of the World**[30] also increased CO_2 emissions in 2018 by 1.7% on 2017 levels.

Global aggregated GHG emissions (using GWP_{100} values from the IPCC 4th Assessment Report) rose 1.3% in 2017 (the latest year available) to 55.1 $GtCO_2e$ per year when including emissions from land-use change.[31]

- Anthropogenic methane (CH_4) emissions increased to 9.3 $GtCO_2e$ per year (a 1.2% increase on 2016 levels), with China accounting for one-third of the increase. There were particularly large increases in global emissions from coal production (4.2%) and natural gas transmission (3.3%).
- Nitrous oxide (N_2O) emissions rose to 3.0 $GtCO_2e$ per year (a 1.4% increase). Manure and fertilizer use were the largest sources contributing to this increase. The largest regional increase in N_2O emissions was in India.
- F-gas emissions continued to grow, increasing 4.1% in 2017, but slower than in recent years (5.6% per year on average over 2004 - 2014). F-gas emissions reached 1.6 $GtCO_2e$ per year in 2017 with HFCs making up two-thirds of this total.

In 2017, 56% of aggregated global GHG emissions came from China (27%), the USA (13%), the EU (9%) and India (7%), the four biggest emitters.[32] 2.5% came from international aviation and shipping.

Projected economic growth for 2019 at around 2.6%[33] will tend to drive a continued increase in global CO_2 and GHG emissions this year. However, with falling costs of renewable energy, increasing retirements of coal capacity and pledged efforts to reduce emissions, there is potential for the trend to be reversed.

Actions in the UK to set and pursue vigorously ambitious emissions reduction targets can help support an increase in global effort to start reducing emissions. Already the UK is sending positive international signals by demonstrating that it is possible to cut emissions while growing the economy and to run a power system without relying on coal. Longer term, the UK can play an important role by developing and deploying technologies, institutions and business models to decarbonise harder-to-abate sectors, such as carbon capture and storage in industry, which can then be deployed internationally.

[28] Aggregated using GWP_{100} values from the IPCC 4th Assessment Report.
[29] European Environment Agency (2019) - Emissions from international aviation and shipping are included.
[30] All other countries except for China, the USA, the EU and India.
[31] Olivier, J. & Peters, J. (2018) *Trends in global CO_2 and total greenhouse gas emissions*.
[32] Excluding emissions from land-use, land-use change and forestry (LULUCF).
[33] World Bank (2019) *Global Economic Prospects: June 2019*.

2. Changes in the global energy system

Global energy demand grew by 2.9% in 2018, its largest increase since 2010.[34] China, India and the USA together accounted for over two-thirds of the global increase. Large demands for heating and cooling due to weather effects contributed significantly to this large increase in energy demand (estimated to be around one-quarter of the annual growth).

Around 70% of this increase was met with fossil-based energy:

- Global **coal** capacity and generation both grew in 2018. Consumption grew at the fastest rate since 2013, but capacity is growing at a slowing rate with 51 GW of new capacity added and 31 GW retired across the globe.[35] Projections from a range of agencies indicate coal capacity and generation remaining close to constant between now and 2030.[36]
  - The number of national governments that are members of the *Powering Past Coal Alliance* increased to 30 in 2018. In Germany, a government appointed commission has suggested a phase-out of coal-fired electricity generation by 2038.
  - Globally, the pipeline of planned future coal plants has shrunk by over 60% since 2015 as the falling costs and rising deployment of renewables is changing the cost-competitiveness of new coal plants.[37]
- **Gas** was the energy source (across high carbon and low carbon sources) that grew the most in 2018, growing at the fastest rate since 2010. This indicates both the increasing demand for energy around the world and switching between coal and gas. It accounted for over 40% of the net increase in global energy demand.
- **Oil** consumption grew in 2018 increasing by 1.5% above 2017 levels. This was slightly slower than the 1.7% increase in 2017 (above 2016 levels), in part due to higher oil prices.

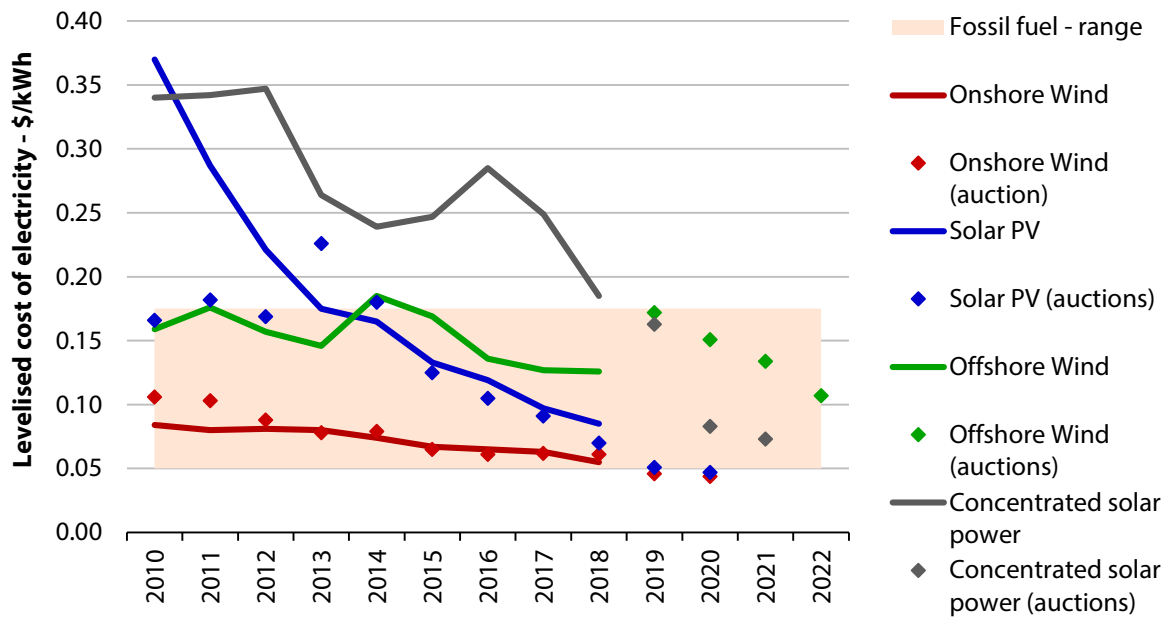
Variable renewable energy was by far the largest growing source of new low-carbon energy in 2018:

- **Renewable** generation increased again in 2018 (14.5% above 2017 levels), but at a slightly slower rate than in 2017 (17.6% above 2016 levels). It met around 33% of the additional demand for electricity. The fraction of global primary energy demand met by renewables (4%), is now approximately equivalent to that met with nuclear energy.
  - Renewable energy continues to fall in price and is now the cheapest source of new electricity generation in most parts of the world (Figure 2.2).[38]
  - Since 2017 the global average levelised cost of solar PV and onshore wind has fallen by 13%. By 2020 these two sources are expected to be less expensive than the cheapest fossil fuel alternative in a wide range of geographies according to the latest auction results (Figure 2.2).

[34] BP (2019) *BP Statistical Review of World Energy*; IEA (2019) *Global Energy & CO_2 Status Report*.
[35] Global Energy Monitor (2019) *Global Coal Plant Tracker*.
[36] IEA (2018) *World Energy Outlook*; BP (2019) *Energy Outlook*; McKinsey (2019) *Global Energy Perspective*.
[37] Global Energy Monitor (2019) *Global Coal Plant Tracker*.
[38] IRENA (2019) *Renewable Power Generation Costs in 2018*; Bloomberg New Energy Finance (2019) *New Energy Outlook 2019*. These costs use a generation cost basis, which does not include the systems costs of variable renewables.

- **Nuclear energy**'s generation increased by 2.4% in 2018, but its share of electricity generation remained largely unchanged (10%) due to growing global electricity demand. China accounted for about 75% of the increase.
- **Hydroelectricity** contributes around 16% of global electricity generation, a fraction which has remained approximately constant over the last decade.

Figure 2.2. Global average renewable costs continue to fall



Source: International Renewable Energy Agency (2019) *Renewable Power Generation Costs in 2018*.
Notes: Solid lines indicate global weighted-average levelised costs of energy, dots indicate global weighted-average for auction prices for projects set to start in a particular year. All costs are in 2018 US dollars.

The demand for electricity increased by around 3.7% in 2018, significantly more than the increase in total demand for primary energy. Developments continue to suggest significant potential for future road transport electrification due to the continuing fall in the cost of electric vehicles' (EVs) battery packs. These costs fell by around 18% between 2017 and 2018, and have fallen by around 85% since 2010.[39] Global sales of EVs in 2018 almost doubled from 2017 levels, remaining a small, but rapidly growing, fraction of total light vehicle sales (around 2%).[40] EVs are currently more expensive than petrol and diesel vehicles, but recent analysis indicates that cost-parity in both lifetime and purchase cost is likely to be reached before 2030 in several developed countries including the UK.[41]

[39] Bloomberg New Energy Finance (2019) *Electric Vehicle Outlook 2019*.
[40] IEA (2019) *Global EV Outlook 2019*; EV-volumes.com (2019).
[41] CCC (2019) *Net Zero: Technical Report*; Deloitte (2019) *New market. New entrants. New challenges*; ICCT (2019) *Update on electric vehicle costs in the United States through 2030*.

Future trends in the global energy system indicate that the strong growth of renewables is expected to continue. However, emissions from fossil fuel combustion are also generally expected to continue to grow slowly over the next decade due to rising gas and oil demand alongside broadly constant coal consumption.[42]

3. Advances in international and European climate policy

In October 2018, the IPCC Special Report on Global Warming of 1.5°C (IPCC-SR1.5) was published as requested in the Paris Agreement. It assessed a large body of new literature on global emissions pathways consistent with keeping warming below 1.5°C above pre-industrial levels and the climate impacts at this level of warming. We reviewed many of the relevant insights in our recent report *Net Zero: The UK's contribution to stopping global warming*. Observed changes in the climate system have continued to evolve in line with the IPCC's assessment (Box 2.1).

The 24th Conference of Parties (COP24) of the United Nations Framework Convention on Climate Change (UNFCCC) was held in Katowice, Poland in December 2018. The rulebook for the Paris Agreement was largely completed at COP24. This provides the internationally-agreed rules and processes to operationalise the Paris Agreement. Key features include:

- Rules for harmonising future Nationally Determined Contributions (NDCs - national commitments to emissions reductions prior to 2030), creating a common system for expressing and comparing pledged mitigation commitments.
- The requirement for all Parties to submit biennial reports to allow monitoring of progress towards achieving their NDCs and other climate obligations as part of the Paris Agreement Transparency Framework.
- Common rules and obligations for the reporting of climate finance.

Agreement on rules for international market-based mechanisms to share mitigation efforts and accounted emissions reductions between countries could not be reached so will be returned to this year.

Box 2.1. Changes in key climate indicators

Emissions projections suggest the world is beginning to move away from a 'business-as-usual' pathway, slowing the increase of climate risks in the longer-term, but the climate continues to change rapidly today. Observations of the state of the global climate over the past year are consistent with longer-term trends of a climate that is changing due to human influence and in line with IPCC projections:

- **Global mean surface temperature** in 2018 was measured as the fourth warmest year in all major observational datasets. Temperatures in the early part of 2018 were suppressed slightly due to a natural, small La Niña event.
- **Human-induced warming** has continued to increase, rapidly approaching 1.1°C above pre-industrial levels when calculated consistently with the method used in IPCC-SR1.5. This is a measure of the warming created by past and present human activities and is independent of temporary warming and cooling from natural climate oscillations, volcanic eruptions and changes in solar output. IPCC-SR1.5 concluded that human-induced warming is currently increasing at around 0.17°C per decade.

[42] IEA (2018) *World Energy Outlook*; BP (2019) *Energy Outlook*; McKinsey (2019) *Global Energy Perspective*.

Box 2.1. Changes in key climate indicators

- **Atmospheric concentrations of greenhouse gases** continued to increase. In 2018, global average CO_2 concentrations rose to 407 ppm, CH_4 concentrations to 1858 ppb and N_2O concentrations to 331 ppm (46%, 157% and 23% above pre-industrial levels respectively). The concentrations of all three gases increased from 2017 to reach record highs. The increase in atmospheric methane was the second largest increase this century - the contributions of changing natural and human sources of methane emissions causing this increase remains unclear.
- **Ocean heat content** increased to record levels in 2018. More than 90% of the additional energy trapped in the climate system by raised greenhouse gas concentrations ends up in the oceans, making ocean heat content a more consistent indicator of human influence on the climate than global mean surface temperature. Absorbing CO_2 from the atmosphere is increasing the acidity of the oceans, leading to a decrease in pH of around 0.1 since the pre-industrial period. This is around a 25% increase in acidity, which can affect the ability of coral organisms to build shells creating knock-on effects on whole marine ecosystems.
- **Sea levels** continue to rise, with the global average sea level around 3.7 mm higher than in 2017. The rate at which global sea-levels are rising is increasing over time.

Evidence of changing climate extremes in the UK continues to be documented and linked with changes in the global climate. For example:

- The annual average number of 'warm spell' days have more than doubled between 1961 - 1990 and 2008 - 2017.
- The total amount of rainfall falling on 'extremely wet days' has increased by around 17% over the same period.
- In 2018, late spring and early summer were dominated by a long-lasting period of heat and drought, particularly in the south of England. It was the UK's equal warmest summer on record. Climate change means that the UK average summer temperature is now expected to exceed 2018 levels in around 12% of years. Without human influence on the climate, such extremes would only occur in around 0.5% of years. Around 2050 a summer as warm as or warmer than 2018 would be expected in around 50% of years due to continued GHG emissions.

Source: WMO (2019) *Statement on the State of the Global Climate in 2018*; Met Office (2018) *State of UK Climate 2017: Supplementary Report on Climate Extremes*; Met Office (2018) *Chance of summer heatwaves now thirty times more likely*; IPCC (2018) *Special Report on Global Warming of 1.5°C*; globalwarmingindex.org
Notes: 'Warm spell' days are defined as the number of days in sequences of six or more consecutive days with daily maximum temperatures exceeding the 90th percentile of the 1961 - 1990 climatology. 'Extremely wet days' are those in which total rainfall is greater than the 99th percentile of the 1961 - 1990 climatology.

Following advice from the Committee, the UK Government recently legislated for a net-zero target for greenhouse gas emissions by 2050. Putting in place policies to achieve this target domestically will be key to demonstrating a commitment to achieving this goal. Alongside this, the UK must also continue to play a leading role in supporting efforts to combat climate change outside the UK through a wide-range of initiatives and mechanisms (Box 2.2).

Several countries and regions around the world are setting or considering net-zero emissions targets. As set out in our *Net Zero* report, these include the European Union, California, France, Sweden, Norway, Denmark and New Zealand.

Recent additional developments include:

- Further discussions of the European Commission's 2050 net-zero GHG emissions proposal. The European Parliament has endorsed the proposal, along with several member states. However, agreement has not yet been reached in the European Council.
  - The net-zero goal has received explicit backing from a large number of EU countries, with a recognition that "for a large majority of Member States, climate neutrality must be achieved by 2050" at the June 2019 EU Council. However, unanimous agreement could not be reached with Czechia, Estonia, Hungary and Poland opposing a net-zero target for 2050.
  - France has formalised its target for net-zero GHG emission by 2050 into law, becoming the second G7 country (after the UK) to do so.
  - Germany has set up a 'climate cabinet' to consider ways to reach carbon neutrality by 2050 and has backed a wider EU target for net-zero GHG emissions by 2050.
  - The Finnish government has committed to legislate to become carbon-neutral by 2035, intending not to rely on the use of imported emissions credits.
  - Ireland has announced an aspirational target for net-zero emissions by 2050 as part of its Climate Action Plan, which includes a proposal for a new Climate Act. Over 180 actions are also included within the plan to move the country back towards a path to achieve its climate goals.
- The government of Japan has approved a plan to reach 'a carbon neutral society' as early as possible in the second half of the century.
- The government of New Zealand has proposed an amendment bill to legislate to reduce all greenhouse gases (except biogenic methane) to net zero by 2050 and to reduce emissions of biogenic methane within the range of 24 – 47% below 2017 levels by 2050.
- New York State has passed a bill that commits to a 100% net reduction in greenhouse gases (relative to 1990 levels) by 2050 with at least an 85% reduction to be achieved by reducing in-state emissions.

Box 2.2. Progress in supporting the global effort to combat climate change

The UK undertakes a range of activities to support efforts abroad to tackle climate change. We highlighted a range of these in our *Net Zero* report. Recent developments include:

- **Governance and capacity building**. In 2018, the UK launched the Partnering for Accelerated Climate Transitions (PACT) programme, a £60 million bilateral initiative to support institutional change, and assist with infrastructure and capital building in a range of targeted countries.
- **Diplomacy and negotiations.** Along with other members of the *High Ambition Coalition*, the UK committed to raising NDC ambition by the end of 2020. The UK is expected to be the host of COP26, an important diplomatic role for facilitating increased global ambition.
- **Technology development and sharing**. BEIS has committed to publish a Green Finance Strategy in 2019. A recent report from the UK Parliament Environmental Audit Committee criticised the current UK Export Finance (UKEF) portfolio for over 99% of support for energy projects in low and middle-income countries going to fossil fuels, although UKEF no longer supports coal-based projects.

Box 2.2. Progress in supporting the global effort to combat climate change

- **Climate finance**. The UK Government has committed to spending £5.8 billion over 2016 - 2021 on supporting efforts to tackle climate change abroad as part of the Official Development Assistance budget. The UK's aid spend was assessed broadly positively by an independent review in 2018.
- **Carbon markets**. The UK was an advocate for strong rules on 'additionality' and 'no double counting' in the eligibility guidelines for the CORSIA offsetting scheme for the aviation industry, published in March 2019. The UK should continue to support the highest possible standards for market-based mechanisms under the Paris Agreement at COP25 and beyond.

We will continue to monitor and evaluate the UK's actions to support international efforts. It is essential that these internationally-focused efforts are additional to putting in place robust and effective policies to achieve net-zero GHG emissions domestically in the UK and are not an alternative for doing so.

Source: CCC (2019) *Net Zero: The UK's contribution to stopping global warming*; ICAO (2019) *CORSIA Emissions Unit Eligibility Criteria*; ICAI (2019) *International Climate Finance: UK aid for low-carbon development*; Environmental Audit Committee (2019) *UK Export Finance*.

4. Next steps in international climate policy

The United Nations Framework Convention on Climate Change (UNFCCC) is now beginning the first 'ambition round' under the Paris Agreement, with all countries required by the end of 2020 to resubmit their first NDC. Countries are also required to submit 'long-term low greenhouse gas emission development strategies' (focused on mid-century) by the same date. The UK should aim to maximise the international impact of setting a net-zero emissions target to help move the world towards a lower-carbon future at this crucial time in the international process.

Upcoming milestones in this process include:

- The UN Climate Action Summit, to be held in New York on 23 September 2019. This offers the first opportunity for countries to gather and signal their intentions for increasing NDC ambition. The UK is leading a focus area on climate resilience at this summit.
- The publication of IPCC special reports on *Climate Change and Land* and *The Ocean and the Cryosphere in a Changing Climate* in August and September 2019 respectively, which will inform negotiations at COP25.
- COP25 in Chile in December 2019, which will offer another opportunity for countries to communicate enhanced NDCs. It will have a particular focus on the effect of climate change on the oceans.
- COP26 (at the end of 2020), which is expected to be the major focus point for efforts to raise NDC ambition.

It now appears probable that the UK will host the COP26 talks, having agreed a partnership bid with Italy. These are crucial talks and represent a major opportunity to increase global effort and ambition to cut emissions. The UK should use all the tools at its disposal to ensure that these talks are successful. That includes diplomatic efforts in advance of the talks (we note that a large part of the success of the Paris talks in 2015 reflected work put in prior to the conference), effective leadership of the talks and leadership by example in the UK's actions - most notably by ensuring that the UK backs up the setting of a net-zero target with a credible pathway and policies to deliver it.

The UK is currently represented in the international process by the EU NDC. Agreement on EU-wide targets for renewable energy, energy efficiency and governance in 2018 suggest that the EU would be able to increase its NDC ambition to at least a 45% reduction in GHG emissions relative to 1990 levels.[43] Several member states and the EU Parliament have called for the EU to signal increased NDC ambition by the time of the UN Climate Action Summit in September, but this will require unanimous agreement in the Council of Ministers.

Upon leaving the EU, the UK is likely to require its own NDC for emissions reduction to 2030. This could initially be set, at the very least, at the level of the fifth carbon budget,[44] and should then be strengthened based on the more ambitious pathway required to reach net-zero GHG emissions in 2050 that the Committee will advise on in 2020. Delivering effective policies to connect near-term ambition with the net-zero long-term target will be essential for the UK to show international leadership as the expected COP26 host.

[43] The current NDC is for a 40% reduction.

[44] A 57% reduction in aggregated GHG emissions (using GWP_{100} values from the IPCC 4th Assessment Report) relative to 1990 levels including emissions from international aviation and shipping and based on the current inventory methodology.

Chapter 3: Underlying progress in the UK towards deep emissions reduction

Future emissions reductions depend on policies and actions taken now. In this chapter we review progress against our indicators for measures to reduce emissions and implementation of policies to drive future reductions.

We assess this underlying progress against indicators and milestones that we set out in previous progress reports to Parliament to deliver against the legislated carbon budgets and the previous 2050 target for an 80% reduction in greenhouse gas emissions. However, the adoption of a net-zero target for greenhouse gas emissions in 2050 means that emissions will need to reduce further and faster than under the previous target.

We consider progress towards future carbon budgets and deep decarbonisation by 2050, in three sections:

1. Actions to reduce emissions
2. Progress in policy development
3. The net-zero challenge – what is needed from policy now

1. Actions to reduce emissions

We track progress towards meeting carbon budgets and the 2050 target through the use of indicators, which both help to explain progress to date in reducing emissions and provide a guide to likely future reductions. The indicators are based on our assessment of the cost-effective path to meeting the targets, based on the Committee's scenario work. They are not intended to be prescriptive – as long as sufficient overall progress is made, it may be appropriate to outperform some indicators and underperform on others. The indicators will need to be revised in future to align to the new net-zero target for 2050.

Progress is generally off-track in most sectors, with only seven out of 24 of the indicators on track in 2018 (Table 3.1). Outside the power and industry sectors, only two indicators were on track:

- Progress in deploying measures to reduce emissions is off-track across transport, buildings, agriculture and land use. In these areas, progress to date is behind virtually every indicator we track, often by a wide margin.
  - Reductions in the CO_2 emissions of new vehicles have fallen well short of our indicators. Lack of progress over several years has contributed significantly to surface transport now being the highest-emitting sector in the UK (Box 3.1).
  - Deployment of energy efficiency measures in buildings are running at less than 20% of the rate under our indicators, having fallen sharply since policy changes in 2012. Deployment of non-bioenergy low-carbon heat (e.g. heat pumps) remains weak.
  - Progress is falling short of all of our indicators across agriculture and land use, where policy has been lacking or ineffective in driving the necessary emissions reductions.
- There has been good progress in the power sector, driven by strong policy. Policy has incentivised renewable power generation and driven down costs in doing so, pushed coal to the margins of the electricity system through carbon pricing, and reduced demand through efficiency improvements mostly driven by regulation and product standards. Although isolated, this represents a significant success and is clear evidence that emissions can be driven down by a well-designed, comprehensive policy package.

- At a high level, progress in industry has been good, but it is important to look beneath this to understand whether progress is due to action to decarbonise or wider shifts in technology and the economy. Our decomposition analysis, which seeks to attribute changes to different drivers of emissions, suggests that over the period 2012-2017 industrial output grew 14%, and that the 12% fall in direct CO_2 emissions can be attributed to a structural movement towards a less carbon-intensive mix of industrial output (accounting for 20% of the change), improvements in energy intensity (40%) and changes in fuel mix (40%). It is not clear whether these reductions were driven by policy.

Despite the lack of progress in deploying measures to reduce emissions, overall emissions are below the level required to meet the second and third carbon budgets. As we explain in Chapter 4, this is because of lower economic activity than expected when the first three budgets were recommended in 2008, together with changes in the EU emissions trading system that affect emissions accounting under carbon budgets.

We plan to update our indicator set once we have assessed the pathway towards net-zero emissions by 2050 as part of advising on the sixth carbon budget. This is likely to entail both reassessment of the level of indicators to reflect the need for more rapid deployment (e.g. of electric vehicles) and a broadening of the indicator set (e.g. on the demand side).

Table 3.1. Assessment of key indicators required to meet carbon budgets

Sector	Measure	2018 indicator	Actual	Unit	Met?
Transport	New car CO_2 emissions	107.5	124.5	gCO_2/km	✗
	New van CO_2 emissions	159.5	167.1	gCO_2/km	✗
	Electric car registrations	3.4%	2.5%	% market share	✗
	Biofuel uptake	6.6%	3.1%	% of fuel sales by energy	✗
	Vehicle distance driven	550.6	549.1	Billion-kms	✓
Industry	Direct combustion CO_2 emissions from manufacturing and refining	8%	13%	% below 2012 levels	✓
	Energy intensity of direct manufacturing and refining combustion emissions	9%	13%	% below 2012 levels	✓
	Manufacturing and refining energy intensity of output	5%	12%	% below 2012 levels	✓
Buildings	Lofts insulated	545,000/year	43,000	Installations	✗
	Cavity walls insulated	200,000/year	82,000	Installations	✗

Table 3.1. Assessment of key indicators required to meet carbon budgets

Sector	Measure	2018 indicator	Actual	Unit	Met?
	Solid walls insulated	90,000/year	18,000	Installations	✗
	Heat pumps installed*	Not set on an annual basis, but annual sales to 2020 >30,000 needed	22,000	Installations	✗
	Low-carbon heat*	6%	8.5%***	% of heat demand	✓
Power	Total renewable generation	85	96	TWh	✓
	Emissions intensity	326	242	gCO_2/kWh	✓
Agriculture*	Non-CO_2 emissions	37.2	40	$MtCO_2e$	✗
	Soil emissions	10.3	11.5	$MtCO_2e$	✗
	Enteric emissions	20.4	21.5	$MtCO_2e$	✗
	N_2O emissions	13.3	14.3	$MtCO_2e$	✗
	Methane emissions	23.9	25.7	$MtCO_2e$	✗
Land use & forestry	Afforestation	15,000	13,400**	Hectares per year	✗
Waste*	Landfill emissions	-74%	-62%	% below 2007 levels	✗
	Biodegradable waste to landfill	-64%	-55%	% below 2007 levels	✗
F-gases*	Emissions	-9%	-4%	% change vs 2007 levels	✗

Source: CCC analysis.
Notes: * 2017 data; ** 2018/19 data; *** On low-carbon heating, 8.5% of heat was from low-carbon sources in 2017 (exceeding the indicator of 6%). However, this increase (from 4.5% in 2016) has predominately been due to a revision in statistics to include reversible air-to-air heat pumps (RAAHP) in commercial buildings. RAAHP are generally installed for cooling, but can contribute to heating often alongside a boiler. Residential heat pump sales remained below the levels needed.

2. Progress in policy development

Our previous progress reports have set out the 'policy gap' to meeting the fourth and fifth carbon budgets, both of which were set on the cost-effective path to achieving an 80% reduction in emissions by 2050. These budgets will need to be outperformed on the way to achieving net-zero emissions by 2050.

Over the last year, Government estimates of the policy gap to the fourth and fifth carbon budgets have gone up due to increases in their projections of 'baseline' emissions (i.e. before policy) outweighing additional savings due to new policies:

- Projections of future overall UK emissions out to 2035 are largely unchanged in the 2018 edition of the Government's Energy and Emissions Projections (EEP), published in April 2019, compared to the previous edition. However, within this total there has been a shift from emissions covered by the EU emissions trading system (i.e. the 'traded' sector) towards non-traded sectors. Because of emissions accounting rules under carbon budgets (see Box 1.2), this has increased the projected shortfall in meeting the fourth and fifth carbon budgets.
- Only three new policies have been quantified and newly included within these projections: Boiler Plus, Streamlined Energy and Carbon Reporting for Business, and Industrial Heat Recovery Support. The savings newly included from these policies amount to less than 5 $MtCO_2e$ across each of the five-year fourth and fifth carbon budget periods. There remain many other areas in which significant ambitions were outlined by the Government in the Clean Growth Strategy in October 2017, but where policy has not yet been finalised.

Overall, the shortfalls to meeting the fourth and fifth carbon budgets have each increased by 40-50 $MtCO_2e$ across each of the respective five-year periods. This approximately reverses the downward change to the projections made in the preceding edition of EEP, meaning that the policy gaps to the fourth and fifth carbon budgets are likely to be similar to our assessment of 65 $MtCO_2e$ made January 2018 (prior to these two updates to the projections). It remains urgently necessary to close the policy gap to these carbon budgets and to get onto a path to meet the net-zero target.

In our June 2018 progress report we set out a range of actions required over the following year (i.e. by now) to get on track to meeting the fourth and fifth carbon budgets and the 80% target for 2050. In the intervening 12 months there has been disappointing overall progress, with only one milestone out of 25 delivered in full. There are 10 without even partial progress (Table 3.2), including strengthening incentives for uptake of electric vehicles and policy to drive improvements to energy efficiency for 'able-to-pay' households.

Transport

Transport is now the highest-emitting sector and must be a key contributor towards the reductions in greenhouse gas emissions needed over the period to 2030. Delays in making policy progress present a significant risk to meeting the fourth and fifth carbon budgets and are also likely to lead to higher costs and worse air quality. Policy progress over the last year has been very limited:

- Necessary progress has not been made on standards for new car and van CO_2 emissions nor on strengthening incentives to purchase cleaner vehicles. The Road to Zero strategy was published last year, but was insufficiently clear about what cars and vans would be permitted to be sold after conventional cars and vans are phased out. The phase-out date of 2040 is too late to ensure that the fleet is fully switched over to zero-emission vehicles by 2050 and fails

to grasp the opportunity of electric vehicles that are expected to be cheaper to buy, cheaper to run and less polluting from before 2030.

- A voluntary commitment has been made by the freight sector to reduce emissions by 15% by 2025. However, it remains unclear how this target will be achieved: greater incentives and monitoring will be needed to ensure progress. Whilst there have been positive developments in terms of awarding funding for low-emission buses and for sustainable transport improvements in a select number of cities, bus usage has continued to decline.
- The Government launched a consultation in December 2018 on its long-term vision for aviation. Within this, it accepted the Committee's long-standing planning assumption that for an economy-wide target of an 80% emissions reduction, aviation emissions in 2050 should be no higher than those in 2005 (i.e. 37.5 $MtCO_2e$). However, the final Aviation Strategy has not yet been published and the Government has not set out the implications of limiting emissions for aviation demand.

Box 3.1. Progress in reducing emissions from cars

Efficiency

New-car CO_2 emissions is an important indicator that car manufacturers are making progress in introducing less carbon-intensive vehicles. Following improvements in the average CO_2 emitted per km from new cars from when regulations were introduced in 2009 to 2016, gCO_2/km rose over the past two years.

- In 2018 the average test-cycle CO_2 intensity of cars sold in the UK has risen from 121.1 to 124.5 gCO_2/km, a 2.9% increase.
- There has been a significant shift towards large vehicles, which now represent 31% of new car sales, compared to 21% in 2010. This change in the size of cars alone contributed a 1.8% increase in new car CO_2 intensity.
- The market share of hybrid, plug-in hybrid and electric vehicles increased from 4.7% to 6% in 2018. Without this change in market share, average new car CO_2 intensity would have been 0.6% higher.
- In 2018, 68% of new cars were tested under the old test-cycle regime (the New European Driving Cycle) and 32% under the new regime (the Worldwide Harmonised Light Vehicle Test Procedure), which makes true comparisons difficult. Emissions intensity excluding the new test results would have been 122.7 gCO_2/km, a 1.3% increase from 2017, lower than the 2.9% increase when all values are included.[45]
- New diesel car sales fell from a 42% share to 32%, with a corresponding increase in petrol sales to 62%. The majority of the increase in petrol sales has been in larger vehicles, leading to a rise in the overall average CO_2 intensity of petrol vehicles.
- Diesel cars had a higher average carbon intensity than petrol for the first time since 2010. The new test regime has led to car manufacturers reporting intensities around 10% higher for new diesel vehicles compared to vehicles tested under the old test regime. There has been a 5% increase for petrol vehicles.

[45] The European Commission has provided an analytical tool to convert new test-cycle figures into old versions for comparison purposes. Although independent measurements suggest that this conversion is broadly appropriate, values reported using the new test-cycle are generally much higher than those using the old test-cycle, which may relate to how the tests have been implemented.

Box 3.1. Progress in reducing emissions from cars

However, as there are no vehicles tested using both tests in the reported measurements it is not possible to say how much of this increase is due to changes in the measurement process, or whether there are also underlying changes in new car CO_2 intensities.

Whilst the transition to the more rigorous test-cycle is welcome, it has introduced new sources of uncertainty. Nevertheless, it is clear that UK average new car CO_2 intensity is increasing. The EU-wide new car average carbon intensity target is 95 gCO_2/km by 2020/21. Whilst provisional data from the EU indicates that new car CO_2 is currently lower across the EU (compared to the UK) at 120.4 gCO_2/km in 2018, the EU has also experienced an increase for the second year running. These increases mean that achieving this target on a UK-basis now requires a reduction of 8.6% each year for the next three years, which the UK is not currently on track to deliver.

Electric vehicles

Electric vehicle market share rose in 2018 to 2.5%, an increase of 35% over the previous year. Of these, plug-in hybrid electric vehicles represented 74%, with pure battery electric vehicles representing 26%. The Committee's indicator to be on track for the fifth carbon budget had a 3.4% market share for electric vehicles in 2018.

The number of electric vehicle models available for sale has remained approximately stable between June 2018 and July 2019, but the electric range of the vehicles on offer has improved, with 9 models now available with over 200 miles of range. In November 2018, the Government cut the Plug-in car grant to a maximum of £3,500 for battery electric vehicles, and removed the grant for plug-in hybrid vehicles. Whilst it is too early to ascertain the impact of this on the electric vehicle market, it remains important to provide support in the near term. A significant number of manufacturer announcements have indicated that a much larger range of electric vehicle models will become available for sale before the end of 2020, the majority of which will have over 200 miles of range.

Electric vehicle charging infrastructure has also improved, with 23,500 chargers available in June 2019, compared to 16,700 in June 2018. Rapid charger numbers have increased from 3,500 in 1,100 locations in June 2018 to 5,100 chargers available in 1,500 locations in June 2019. The UK's first 350 kW ultra-rapid charge point was opened in April in Sunderland. Councils have begun to provide infrastructure for drivers without an off-street parking space in which to install a charger, with 28 councils taking up funding from the Office for Low Emission Vehicles for installing public chargers near homes.

Demand

Demand for car travel rose by 0.2% in 2018, a slower rise than in the previous four years. Statistics for walking, cycling and bus usage are reported separately by each devolved administration:

- The number of local bus journeys declined in 2018 in England (1.6%) and Scotland (5.1%), and increased in Wales (0.7%) and Northern Ireland (1%).[46]
- In England, the number of parts of journeys walked and cycled increased from the previous year by 3% and 15% respectively in 2017, the latest year for which data are available.
- In Wales, the number of people cycling at least once a week as a means of transport rose by 20% in 2017/18, whereas the number of people walking at least once a week as transport fell by 5%.
- For Scotland and Northern Ireland, data is not currently available on the number of walking or cycling trips for 2017 or 2018.

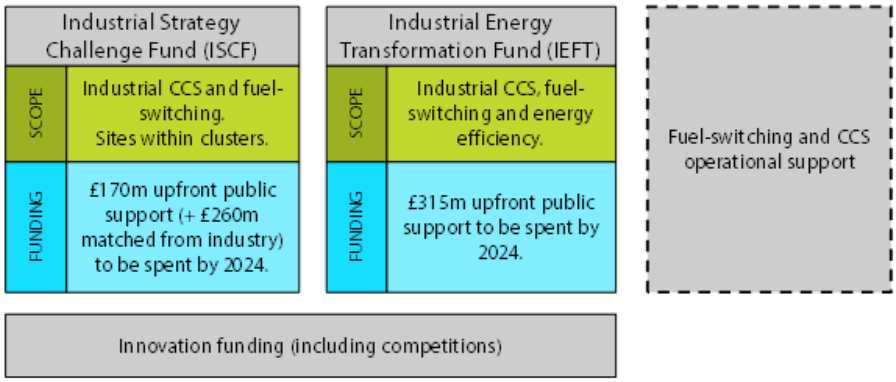
[46] Northern Ireland bus statistics are for 2017/18.

Industry

There has been a surge in policy activity for industrial decarbonisation in the past year, including the setting of the Government's industrial decarbonisation clusters mission, which aims to establish the world's first net-zero carbon industrial cluster by 2040 and at least one low-carbon cluster by 2030. Despite this activity, proposals and ambitions need to be turned into clear and concrete policies and further ambition is required.

- Two significant decarbonisation funds for capital expenditure were announced in the past year: the Industrial Energy Transformation Fund (IEFT) and the Industrial Strategy Challenge Fund (ISCF) (Figure 3.1). The Government plans to consult formally on the design of the IETF in autumn 2019 and the ISCF plans to launch an expression of interest in autumn 2019. Both schemes will have a significant challenge deploying large-scale fuel switching or carbon capture and storage (CCS) in industry unless ongoing support for operational expenditure is provided to complement the schemes, which Government is currently considering.
- The UK CCUS[47] Action Plan was published in November 2018, setting out Government's plans on industrial CCS, including a commitment to consult on a market-based industrial carbon capture framework in 2019. In June 2019, Government awarded £26m of innovation-level funding for nine carbon capture, usage and storage projects.
- There have been a number of further policy developments on energy efficiency. The Environmental Reporting Guidelines have been in force since April 2019, including streamlined energy and carbon reporting guidance. Climate Change Levy rates increased in April 2019 by 45% for electricity and 67% for gas. The first round of funding from the Industrial Heat Recovery Support project started in December 2018. The Government initiated an evaluation of the Climate Change Agreements, expected to conclude later in 2019.[48] However, the Government has not set out how the improvements of 20% in business energy efficiency committed to in the Clean Growth Strategy will be achieved.

Figure 3.1. Industrial funding mechanisms under development or consideration



Notes: Innovation funding includes the £20m Industrial fuel-switching competition, £20m Carbon Capture and Usage Demonstration and £24m CCUS innovation competition; the CCU and CCUS competitions awarded £5m and £21m respectively in June 2019. Potential recycling of revenue from a future ETS is not included here.

[47] Carbon capture usage and storage.

[48] In March 2019, Government outlined how its schemes are supporting industry to reduce their energy use and cut bills. This included the revision of the Climate Change Agreements (CCA). BEIS (2019) *Helping business to improve the way they use energy: Government response*.

Buildings

All of the key buildings policy gaps identified in our 2018 progress report remain unaddressed or only partially met. It remains unclear how the Government will deliver its target for all houses to be made EPC band C by 2035. In contrast, Scotland provides a good example of setting trajectories across the existing building stock (Box 3.2). In other areas there has been progress, but it falls short of what is needed:

- Government published *Clean Growth – Transforming Heating* in December 2018, committing BEIS to the publication of a Heat Roadmap in summer 2020 and leading to a planned £16.5m demonstration project heat the electrification of heat, expected to launch in 2019. In the Spring Statement, the Government committed to increasing the proportion of green gas in the grid. Further detail is needed on the support framework, including the types of gas (e.g. biomethane, hydrogen) to be included. Work is planned or underway on market framework arrangements for heat networks, including regulatory consumer protections, enabling investment and supporting low-carbon networks. However, plans for phasing out fossil fuel heating in properties off the gas grid and support for heat pumps from 2021 remain unclear.
- How the Government's target for all houses to be made EPC band C by 2035 will be delivered remains largely unclear. BEIS are undertaking a number of supply-chain demonstrators focused on 'able-to-pay' households (i.e. close to two-thirds of all homes below EPC band C)[49] along with a £9.4m Whole House Retrofit Competition.
- Amendments to the domestic private rented sector (PRS) regulations introduced a £3,500 cap on costs to landlords for energy efficiency improvements. While a higher cap than originally proposed, it still materially limits the scope and impact of the policy, with only 48% of F- and G-rated properties in scope expected to reach Band E. This limits costs for landlords at the expense of higher running costs for renters - including many fuel poor households.[50] A trajectory for future tightening (as in Scotland – Box 3.2) has yet to be set.
- The Government plans to review Building Regulations alongside reviewing a method for reducing overheating risk. In the Spring Statement a strong commitment was made to "introduce a Future Homes Standard by 2025, so that new build homes are future-proofed with low-carbon heating and world-leading levels of energy efficiency". Policy is needed and must ensure that regulations are set now, which require all homes to meet our recommended standards (including on climate adaptation). [51] All new homes built from 2025 at the latest should be ultra-energy efficient and should not be connected to the gas grid, instead relying on low-carbon heating.
- Whilst good headway has been made on fire safety, there has been limited progress to suggest the lessons learned from the Hackitt Review will be used to develop stronger compliance and enforcement procedures that extend beyond fire safety, to make material improvements to enforcement of building regulations across the stock.

[49] Based on estimates of the number of owner occupied, able-to-pay homes in the UK below band C. Taken from Energy efficiency infrastructure group and Frontier Economics (2017) *Affordable warmth, clean growth*.
[50] Government's Final Stage Impact Assessment acknowledges that even with a £5,000 cap, a majority of landlords would be unlikely to introduce significant rent rises. See BEIS (2018) *Final Stage Impact Assessment: Amending the Private Rented Sector Energy Efficiency Regulations*.
[51] See the second volume of our progress report: *Progress in Preparing for Climate Change – 2019 Report to Parliament*.

- In March 2019, Government set out some policies (e.g. Boosting Access for SMEs to Energy Efficiency (BASEE) competition) and intentions to consult. A call for evidence is looking at options to assist SMEs in improving energy efficiency. However, other areas have not progressed - notably the trajectory for tightening the non-domestic PRS regulations is yet to be consulted on.

Box 3.2 Framework of standards to drive buildings energy efficiency in Scotland

The Scottish Government has set out a comprehensive framework of standards with clear trajectories for improving energy efficiency across the housing stock in their March 2019 consultation on the Energy Efficient Scotland programme. The trajectories are underpinned by concrete steps for implementation including legislative instruments:

- **Private-rented sector regulations.** These are being phased so that the energy efficiency requirements need to be met on new tenancies from an earlier date and in all rental properties by back-stop dates (i.e. Band E for all new tenancies from April 2020 and all properties by end March 2022 and then Band D for all new tenancies from April 2022, and all properties by end March 2025). The proposed cap is £5,000 for meeting Band E, an additional £5,000 for meeting Band D. Proposals are being consulted on for setting a level of EPC Band C at point of rental from 2025.
- **Owner occupiers.** All owner-occupied homes are required to meet EPC band C by 2040 (where technically feasible and cost-effective). The intention is to support and encourage owners to take action by 2030, with the possibility of regulating to require action from 2030 if progress has not been sufficient. Scottish Ministers have said that where targets can go faster and support a Just Transition to a decarbonised economy then they will.
- **Social-rented sector.** The revised standard published in June 2019 requires all social housing to meet EPC Band B (or be as energy efficient as practically possible) by the end of 2032 and within the limits of cost, technology and necessary consent. The standards also set a minimum floor of EPC Band D from 2025 below which no social house may be re-let.

Power

There has been important progress on auctions and ambition for offshore wind, but there remains no route to market for onshore wind and solar, the lowest-cost forms of generation. Although the Committee have recommended since 2016 that contingency plans are made in case projects (e.g. for nuclear plants) fail to progress as intended, the Government has not set out any such plans.

- In March 2019, the offshore wind sector deal stated an ambition to achieve 30 GW of offshore wind in the UK by 2030, contracted via auctions every two years, which offers visibility of future Contracts-for-Difference (CfD) rounds. The third CfD allocation round commenced in May 2019, for up to 6 GW of projects commissioning between 2023 and 2027. Nevertheless, Government has still not developed a route to market for the lowest-cost forms of low-carbon generation such as onshore wind and solar, which are currently excluded from CfD auctions. This limits the potential speed of decarbonisation and adds to costs.

- The consultation on future electricity market design has not yet taken place. In November 2018, the Secretary of State outlined four principles for the future electricity market. Our power sector recommendations are aligned to these principles.[52] We now await the publication of an Energy White Paper in summer 2019 to outline the future of the electricity market, whilst recognising the increased ambition of the net-zero target.
- Of six proposed new nuclear projects, three were abandoned in 2018/19, despite a Government offer of a one third equity stake in the Wylfa project, alongside debt financing and a CfD with a £74/MWh strike price. The Government is considering a Regulated Asset Base model to finance prospective projects, under which investors would begin to recoup costs from the start of project construction. Contingency plans have still not been set out in case new nuclear projects are not delivered. Contract prices for nuclear projects remain significantly higher than those of mature renewable technologies such as wind and solar.
- There has been continued progress in improving system flexibility. Government's Smart Systems and Flexibility plan is on track to be completed by 2022.

EU ETS

In 2018 the Government set out plans for the continuation of UK carbon pricing in the case that the UK leaves the EU ETS.

- In the case of the UK leaving the EU with a deal, the Government has laid out plans for a transition period during which the UK would remain in the EU ETS. The Government is now consulting on options to replace the EU ETS, with a preference for a UK ETS to come into place from 2021, which is linked to the EU ETS.
- In the case of the UK leaving the UK without a deal, Government plans to introduce a carbon tax to maintain a stable carbon price for those stationary emitters currently covered by the EU ETS.

The Committee will provide advice on the consultation proposals during the summer.

CO_2 transport and storage infrastructure

In November 2018, the Government published a Carbon Capture, Usage and Storage (CCUS) Action Plan, which included a range of measures to enable UK deployment in the middle of the next decade. However, it has not yet proposed concrete approaches to tackle the challenges in deploying CCS in the UK. Many of these have been well understood for some time and should progress more quickly than proposed in the Action Plan – for example the model for developing infrastructure for CO_2 transport and storage could have been agreed already, rather than by the end of 2019. Urgent progress is required to ensure that CO_2 transport and storage infrastructure is operational at multiple industrial clusters by the mid-2020s.

[52] See Box 2.4 in CCC (2019) *Net-Zero - Technical Report*.

Agriculture, Forestry and Land Use

There have been no new policies to reduce emissions and continued reliance on the voluntary approach across the UK saw the sector's emissions rise in 2017.

- Defra's Farm Emissions Reduction Plan, and Scotland's updated Climate Change Plan, both due out in 2020, must set out a stronger policy framework in order to safeguard the emissions reductions required for meeting the fourth and fifth carbon budgets.
- The first tranche (£20 million) of the funding under the Industrial Strategy's Transforming Food Production Challenge was released last year for innovation projects to improve productivity and sustainability, although details on the projects being funded have not yet been announced.
- The 2018 Agriculture Bill confirmed that actions to mitigate climate change will qualify for public money under the proposed Environmental Land Management (ELM) system. This should be in place by 2021 to deliver emissions reduction and a range of other environmental benefits such as soil and livestock health.

The last year saw a significant increase in tree planting, particularly in Scotland. However, aggregate planting rates across the UK remain well below current combined Government targets and even further below levels required to contribute to the net-zero target:

- Streamlining the application process under the Woodland Creation Scheme in England boosted applications for tree planting in 2017 and 2018.
- However, afforestation rates in England and across the UK, of around 13,400 hectares/year in 2018/19, continue to fall short of the respective Governments' combined stated ambitions across the UK for 20,000 hectares/year, with only Scotland now starting to perform strongly.
- The ELM system set out in the Agriculture Bill proposes to pay public money for a range of public goods such as clean water and clean air that can be delivered by trees. It is essential that this, combined with other policy mechanisms, delivers annual tree planting across the UK of at least 30,000 hectares each year (and up to 50,000) needed to achieve net-zero emissions by 2050.

Waste

Defra's Resources and Waste strategy published in late-2018 proposes to work towards eliminating biodegradable waste to landfill by 2035, and food waste by 2030. This is less ambitious than Welsh and Scottish ambitions (Box 3.3), and inconsistent with the CCC pathway towards achieving net-zero emissions in 2050 by stopping most bio-waste streams being sent to landfill no later than 2025.

The ambition in England on recycling other waste must be strengthened to achieve 70% recycling rates by 2025, which should also cover plans to reduce food waste. A consultation next year will cover the infrastructure requirements needed to deal with the additional waste diverted from landfill. This needs to ensure that sufficient incentives are in place for private sector investment in alternative waste treatment facilities that the ambition on landfill waste reduction imply.

The Government has not made sufficient progress over the last year to ensure that the fourth and fifth carbon budgets – on track to an 80% emissions reduction by 2050 – are met.

The net-zero target for 2050 means that it is not only necessary to implement this set of policies in a timely manner, but also go further in taking policy action to enable deeper long-term emissions reductions (see section 3).

Box 3.3. Policy developments in the waste sector

Waste policy is a devolved matter, and there is an overall ambition shared by England and the DAs to have a zero-avoidable-waste economy by 2050. As part of this there have been a number of announcements on policy development in the last year to reduce waste sector emissions:

- **England:** Defra's Waste and Resources Strategy[53] published in 2018 set out plans to minimise and better manage waste, promote resource efficiency and move towards a circular economy in England. The Strategy's key targets on reducing waste include:
  - Work towards zero food waste going to landfill by 2030.
  - Increase recycling rates of municipal solid waste from around 45% to 65% by 2035.
  - Explore policies to work towards eliminating the landfill of all biodegradable waste by 2035.
- A follow-up consultation[54] on improving the quantity and quality of what is recycled considered proposals for all local authorities to introduce separate food waste collections for households by 2023, and free garden waste collections. In recognition of the costs involved, it is proposed that extra resources will be given to fund the additional upfront transition and ongoing operational costs of setting up the new service. A second consultation due out next year will consider the infrastructural requirements that will be needed to deal with the waste that is diverted from landfill, and a consideration of the regulatory changes to implement the measures.
- **Wales:** The Welsh Government's strategy[55] on climate change, published in 2018, includes an ambition for zero-landfill by 2025, and zero waste by 2050. A consultation due out later this year on a new Waste Strategy will include proposals to reduce food waste by half by 2025 compared to 2005 from post-farm gate to households, while new regulations will require that all businesses and public bodies separate recyclable waste at source.
- **Scotland:** The Climate Change Plan, which sets out how the Scottish Government plans to meets legislated emissions targets over the next 15 years, will be updated in 2020 following the Scottish Parliament's legislation of Scotland's net-zero target. It remains to be seen whether the existing targets for waste (e.g. a 50% reduction in food waste by 2030) will be tightened.

[53] Defra (2018) *Waste and Resources Strategy*.
[54] Defra (2019) *Consultation on consistency in household and business recycling collections in England*.
[55] Welsh Government (2019) *Prosperity for all: A low carbon Wales*.

Table 3.2. Delivery of policy action required over the past year			
Sector	**Action**	**Timing**	**Done?**
Transport	Clarify the UK regulatory approach to the EU 2020/21 new car and van CO_2 targets.	First half of 2019	✗
	Set stretching CO_2 targets for new cars and vans beyond 2020, requiring a high electric vehicle market share. A real-world testing regime must be used alongside standardised tests.	First half of 2019	✗
	Implement policies, including fiscal instruments, to strengthen incentives to purchase cleaner vehicles. Current purchasing trends are undermining new car and van emissions targets and must be reversed.	2018	✗
	Set stretching targets for CO_2 emissions reductions from new HGVs to address the rise in emissions and exploit opportunities to improve logistics and increase uptake of eco-driving.	First half of 2019	Partly
	Publish a plan to limit UK aviation emissions to the level assumed when the fifth carbon budget was set (i.e. around 2005 levels in 2050, implying around a 60% potential increase in demand), supported by strong international policies.	First half of 2019	Partly
Industry	Make the ambition to improve business energy efficiency by 20% into specific, concrete and measurable policies with clear timings and outcomes, showing how the projected savings add up to 20% and any assumptions on fuel shares.	Summer 2018	✗
	Develop the Industrial Energy Efficiency Scheme, confirm funding and start implementation.	End 2018	Partly
	Set out plans for ensuring a continued carbon price in the UK, in the case that the UK leaves the EU ETS.	Spring 2019	✓
	Publish (a) additional milestones on the timeline for the 'framework to support industrial decarbonisation', including for consulting on the framework (b) a call for evidence on the potential options for a mechanism to support investment in industrial decarbonisation.	2018	Partly
Buildings	Establish support framework for heat pumps and biomethane post-2021, as well as support for low-carbon technologies in heat networks. Rebalance subsidies for heat pumps and other capital-intensive technologies towards a capital grant, in line with international best practice.	Decision on RHI successor in 2018	Partly
	Publish concrete policies to deliver the Government's ambition on retrofit (EPC band C by 2035) - including firm policies for able-to-pay (ATP) homeowners and a delivery mechanism for the social housing minimum standards.	2018	✗

Table 3.2. Delivery of policy action required over the past year			
Sector	**Action**	**Timing**	**Done?**
	Address major delivery risks around the Private Rented Sector (PRS) regulations - in particular, the exemptions capping landlord contributions which severely limit the scope and impact - and set out a trajectory for tightening to EPC band C by 2030.	Risks to be addressed in 2018; longer-term framework in 2019	Partly
	Strengthen new-build standards to ensure they are designed for a changing climate, are future-proofed for low-carbon heating and deliver high levels of energy efficiency.	Consultation in 2018 and standard announced in 2019	Partly
	Strengthen compliance and enforcement framework so that it is outcomes-based, places risk with those able to control it, provides transparent information and a clear audit trail, with effective oversight and sanctions.	First half of 2019	Partly
	Set out concrete policies to deliver the ambition on non-residential buildings, and address existing policy risks including tightening non-domestic PRS regulations.	2018	Partly
Power	Continue to run auctions for low-carbon power beyond the May 2019 Contracts-for-Difference auction to reach an emissions intensity of 50 gCO_2/kWh by 2030, including a route to market for the cheapest forms of low-carbon generation.	2019 onwards	Partly
	Develop robust contingency plans that allow for additional low-carbon generation to be brought forward in the event of delay or cancellation of planned projects, or imports of electricity below projected levels.	2019	✗
	Consult on future electricity market design. This should include consideration of technology neutrality, subsidy-free Contracts for Difference and mechanisms for re-powering.	2019	✗
CCS	Publish the CCS Deployment Pathway, and the review of CCS delivery and investment models, consistent with having the first CCS cluster operational by 2026.	Deployment Pathway by end of 2018	Partly
Agriculture	Replace voluntary industry-led framework, which has so far failed to meet emissions targets in England, Wales or Scotland, with a stronger framework to deliver GHG abatement to take effect from 2019.	Early 2019	✗
	Allocate the £90m Industrial Strategy Challenge Fund to projects that deliver GHG emissions reduction in addition to Government's other stated objectives, demonstrating action prior to the introduction of a post-CAP framework.	2018	Partly

Table 3.2. Delivery of policy action required over the past year			
Sector	**Action**	**Timing**	**Done?**
	Set out in the 2018 Agriculture Bill a post-CAP framework that links financial support to agricultural emissions reduction and increased carbon sequestration, to take effect from 2022.	2018	Partly
Land use	Act on the commitment to plant 11 million trees in England between 2017 and 2022 (equivalent to over 2,000 hectares per annum). Remove non-financial barriers to rapid afforestation.	2018	Partly
Waste	Set out in the new Waste and Resource Strategy a commitment to ban the landfilling of most bio-degradable waste streams including food by 2025 at the very latest.	2018	✗
F-gases	Publish a plan to restrict the use of F-gases to the very limited uses where there are currently no viable alternatives.	Spring 2019	✗

3. The net-zero challenge – what is needed from policy now

In May 2019, the Committee recommended that the UK set a net-zero greenhouse gas emissions target for 2050. The Government and Parliament accepted this advice and on 27 June 2019 the target became law. Consistent with the Committee's advice, the Government were clear that net-zero emissions must be reached across the whole economy (including emissions from international aviation and shipping) and that the aim is to achieve the target entirely through action in the UK without recourse to international credits (or 'offsets').[56]

The new target is achievable with known technologies, alongside improvements in people's lives, and within the expected economic cost that Parliament accepted when it legislated the existing 2050 target for an 80% reduction from 1990.

- The last decade has seen dramatic improvements in the performance and costs of some key technologies (e.g. wind and solar power, batteries and electric vehicles) through deployment, although some other key technologies have not been able to benefit significantly from such learning-by-doing.
- Over this period we have also developed a considerably better understanding of the range of ways in which emissions can be reduced deeply. For example, the Committee's Net Zero analysis identified considerably greater potential for emissions reduction in the industry sector, including through deployment of hydrogen, resource and energy efficiency, wider applications of carbon capture and storage (CCS) and electrification.

In a range of areas (e.g. CCS, low-carbon heating, electric vehicles, afforestation), the technologies are available but an effective policy framework to drive extensive deployment is lacking. This will need to change rapidly if the UK is to get on track to achieving net-zero emissions by 2050.

[56] House of Commons Hansard (12 June 2019) *Net Zero Emissions Target, Volume 661, Columns 673 and 682.* Available at: https://hansard.parliament.uk/commons/2019-06-12/debates/A348AE4C-8957-42C8-8180-0F59E597E3EA/NetZeroEmissionsTarget

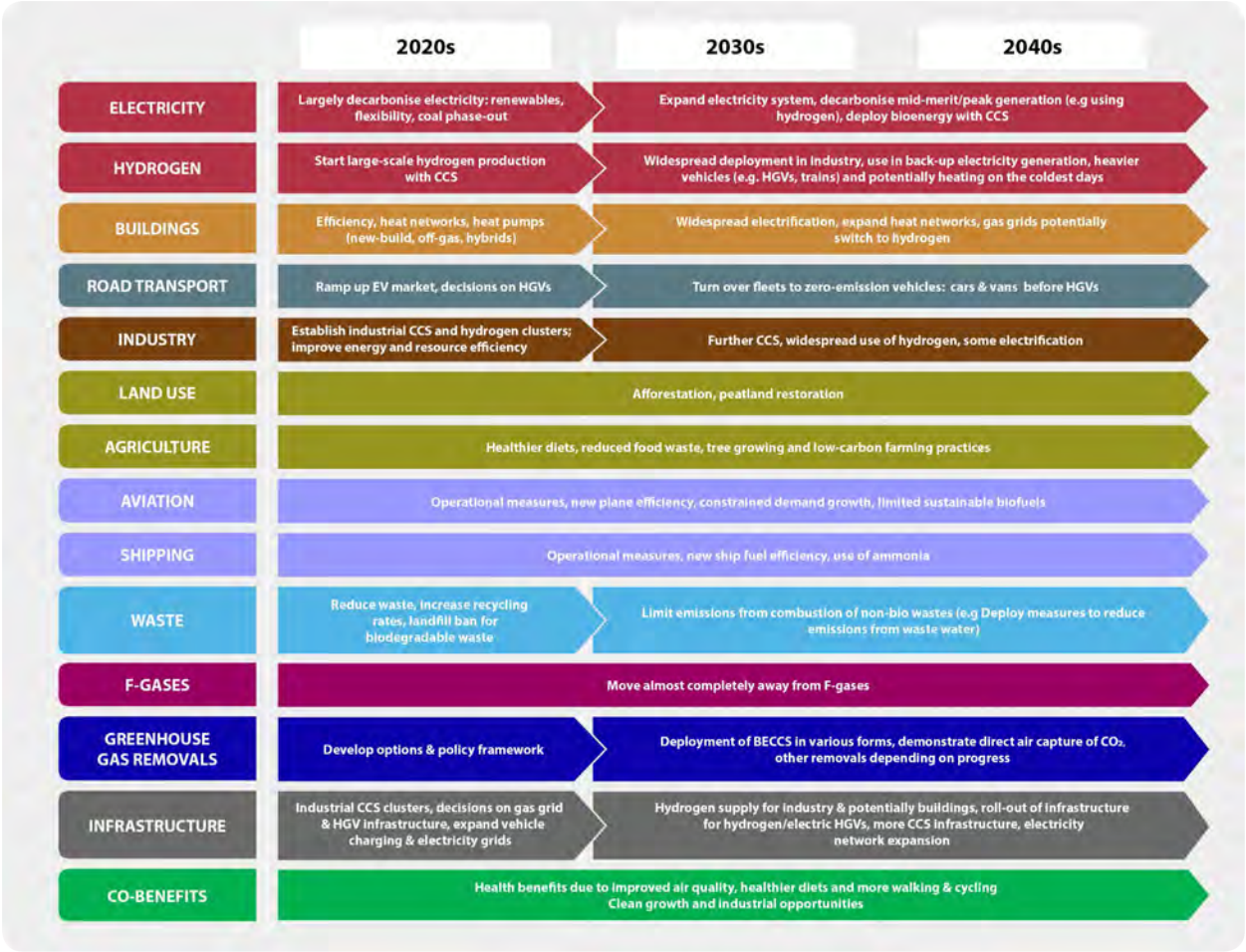
There have been encouraging developments in greenhouse gas removals (Box 3.4), but these will need deployment support to reduce costs and make a significant contribution to reaching net-zero emissions.

Reaching net-zero GHG emissions requires extensive changes across the economy (Figure 3.2), with complete switchovers of several parts of the UK capital stock to low-carbon technologies and development of new industries for carbon capture and storage and low-carbon hydrogen production. Major infrastructure decisions need to be made in the near future and quickly implemented. The public will need to be engaged in making the required changes.

- **Delivery must progress with far greater urgency.** Many current plans are insufficiently ambitious; others are proceeding too slowly, even for the current 80% target:
  - 2040 is too late for the phase-out of petrol and diesel cars and vans, and current plans for delivering this are too vague.
  - Over ten years after the Climate Change Act was passed, there is still no serious plan for decarbonising UK heating systems or improving the efficiency of the housing stock, while no large-scale trials have begun for either heat pumps or hydrogen. The low-carbon skills gap has yet to be addressed.
  - Carbon capture and storage (CCS), which is crucial to the delivery of net-zero GHG emissions and strategically important to the UK economy, is yet to get started. While global progress has also been slow, there are now 43 large-scale projects operating or under development around the world, but none in the UK.
  - Afforestation targets for 20,000 hectares/year across the UK nations (due to increase to 27,000 by 2025), are not being delivered, with less than 10,000 hectares planted annually on average over the last five years, although the strong increase in Scotland over the last year is encouraging.
  - The voluntary approach that has been pursued so far for agriculture is not delivering reductions in emissions.
  - There remains no route to market for onshore wind and solar PV, which are the lowest-cost forms of low-carbon electricity generation and can contribute significantly to cost-effective near-term decarbonisation.
- **Challenges that have not yet been confronted must now be addressed** by Government. Industry and heat must be largely decarbonised, heavy goods vehicles must also switch to low-carbon fuels, emissions from international aviation and shipping cannot be ignored, and a fifth of our agricultural land must shift to alternative uses that support emissions reduction: afforestation, biomass production and peatland restoration. Where there are remaining emissions these must be fully offset by removing CO_2 from the atmosphere and permanently sequestering it, for example by using sustainable bioenergy in combination with CCS.
- **Clear leadership is needed, right across Government, with delivery in partnership with businesses and communities.** Emissions reduction cannot be left to individual departments, such as BEIS and Defra, or to the Treasury. It must be vital to the whole of Government and to every level of Government in the UK. Policies must be fully funded and implemented coherently across all sectors of the economy to drive the necessary innovation, market development and consumer take-up of low-carbon technologies, and to drive societal change.

Without strong near-term action, it would quickly become infeasible to decarbonise sufficiently to reach net-zero GHG emissions by 2050 without resorting to major scrappage schemes and/or much greater disruption to lifestyles, which may not be deliverable.

Figure 3.2. The transition required for Net Zero over the period to 2050



Source: CCC (2019) *Net Zero - The UK's contribution to stopping global warming*.

Based on the Further Ambition scenario presented in our *Net Zero* advice, there is a set of required near-term actions that are on the 'critical path' towards achieving net-zero emissions by 2050:

- **Buildings.** The progress made on buildings remains insufficient even to meet the previous target for an 80% reduction in emissions relative to 1990 levels (see section 2). In order to go further to meet net-zero ambitions, bold and decisive action is urgently needed from Government. Clear leadership will be necessary across Government, with delivery in partnership with businesses and communities. The priorities now must be to:
  - Develop a fully-fledged strategy in 2020 for decarbonised heat. The strategy must be designed to decarbonise buildings fully across the UK in line with the net-zero goal. It is essential HM Treasury commits to working with BEIS on this and allocates sufficient funding to deliver over the full period to 2050.

- Set a clear trajectory of standards. This includes setting regulations now, which require all homes built from 2025 to meet a Future Homes Standard consistent with our recommendations; ambitious standards for new non-residential buildings; delivering commitments on energy efficiency standards across the existing stock; phasing out the installation of high-carbon fossil fuel heating, and a long-term regulatory approach for delivering low-carbon heat. From 2035 all replacement heating systems should be low-carbon.
- Tackle performance and compliance issues to ensure that new buildings and measures retrofitted in existing buildings perform as they should. This includes ensuring strengthened compliance and enforcement extends beyond fire safety to regulations more widely; funding building control adequately; and developing appropriate training and implementing accreditation schemes to tackle the skills gap.

- **Agriculture and land use:** As we prepare to leave the European Union, there is now an ideal opportunity to define a post-CAP (Common Agricultural Policy) framework for the 2020s that incentivises the take-up of low-carbon farming practices and the transition to alternative uses of land to reduce emissions and increase removals. Action will also deliver a wide range of co-benefits important for building climate resilience and wider environmental goals set out in the government's 25-year Environment Plan (see the second volume of this progress report: *Progress in Preparing for Climate Change – 2019 Report to Parliament*).
  - **Agriculture.** There is a strong need to implement a policy framework to translate existing proposals and ambition into firm delivery plans, with new policies that cover the range of measures across soils and livestock required to reduce emissions on-farm.
  - **Afforestation.** Reaching the necessary level of CO_2 removal through afforestation by 2050 requires an early and sustained increase in tree-planting rates, more than doubling to at least 30,000 hectares per year across the UK. The recent sharp rise in tree-planting rates in Scotland to over 11,000 hectares in 2018/19 is very welcome, but must be sustained and increased over time. Tree planting elsewhere in the UK remains very low relative to required progress and must be increased as a matter of urgency. Given the time required for trees to grow, slow progress now cannot simply be made up in later years.
  - **Peatland.** Increase the restoration of degraded peatland, and develop sustainable management practices for those lowland peat areas that remain in agricultural production.
- **Public engagement.**
  - **Healthy lifestyle choices.** People can take action immediately to improve their diet and increase the amount of walking and cycling they do. These changes can cut emissions and improve health. The Government must engage with people over why and how they can make these improvements, and take supporting actions (e.g. ensuring that road infrastructure encourages people to view cycling as a safe option).
  - **Future of heating.** Currently the general public has a low awareness of the need to move away from natural gas heating and what the alternatives might be. There is a limited window to engage with people over future heating choices, to understand their preferences and to factor these into strategic decisions on energy infrastructure. This is especially important if solutions to heat decarbonisation could differ in different parts of the UK.

- **Market development.** Accelerated take-up of technologies is needed in the 2020s, for example rapid electrification of transport and heating accompanied by the growth of charging infrastructure for electric vehicles and strengthening of electricity networks:
  - **Electric vehicles.** The need to switch the entire fleet of light-duty vehicles to ultra-low-emission vehicles (ULEVs) by 2050 means that by 2035, at the very latest, all sales of new cars and vans will need to be ULEVs. If possible, an earlier end to sales of petrol and diesel vehicles would be preferable (e.g. by 2030 if feasible), as this will have lower financial costs, lower cumulative CO_2 emissions and lead to better air quality. This means a rapid ramping up of the market share of EVs, from 2.5% in 2018, during the 2020s.
  - **Heat pumps** are an established solution in many other countries, but not yet in the UK. Establishing them as a mass-market solution will take some time, with strong progress required during the 2020s. There are particular opportunities in new-build properties, homes off the gas grid, non-residential buildings and for hybrid heat pump systems retrofitted around existing gas boilers.
- **Power sector decarbonisation.** More rapid electrification must be accompanied with greater build rates of low-carbon generation capacity, accompanied by measures to enhance the flexibility of the electricity system to accommodate high proportions of variable generation (e.g. wind). The Energy White Paper planned for summer 2019 should aim to support a quadrupling of low-carbon power generation by 2050. This means deployment of more low-carbon capacity in the 2020s, potentially consistent with a carbon-intensity of $50gCO_2/kWh$ by 2030 (Box 3.5). While key options like offshore wind look increasingly as though they can be deployed without subsidy, this does not mean they will reach the necessary scale without continued Government intervention (e.g. continued auctioning of long-term contracts with subsidy-free reserve prices).
- **Industrial Decarbonisation.**
  - **Incentive mechanism.** The Government must urgently establish a mechanism to incentivise widespread uptake of near-zero emissions technologies in industry, including the use of hydrogen, electrification, CCS and BECCS, as well as support for energy and resource efficiency. The design of this mechanism must ensure it does not drive industry overseas, which would not help to reduce global emissions, and be damaging to the UK economy.
  - **Innovation in industrial decarbonisation technologies.** Innovation will be essential across technologies to decarbonise industrial combustion. Industrial hydrogen-using technologies, across heat and off-road mobile machinery, are not yet commercially available, and should be developed, as they will likely play an important role in decarbonising industry. BECCS (bioenergy with carbon capture and storage) and electrification are also likely to play a role in some industrial sectors and applications. Innovation across these technologies is urgent given the need to prepare for abatement in line with refurbishment and replacement cycles. These constraints also mean that the development of hydrogen-ready technologies is an urgent priority.

- **Infrastructure.** Development of new infrastructure will be important in opening up new avenues for decarbonisation.
  - **Hydrogen production.** In order to develop the hydrogen options, which are vital in our net-zero scenarios, significant volumes of low-carbon hydrogen must be produced at multiple industrial clusters by 2030, for use in industry and in applications that would not initially require major infrastructure changes (e.g. power generation, injection into the gas network and depot-based transport).
  - **CO_2 transport and storage infrastructure.** Plans for early deployment of CO_2 transport and storage infrastructure linked to industrial clusters must be delivered with urgency - CCS is a necessity not an option for reaching net-zero GHG emissions.
  - **Expansion of electric vehicle charging networks** and electricity grid capacity will be important in facilitating strong growth in electric vehicles.
  - **Decisions** will be required on the future pathways for heating buildings and decarbonisation of heavy goods vehicles during the 2020s, with important implications for infrastructure roll-out.
- **Greenhouse gas removals.** Deployment of sustainable bioenergy with CCS (BECCS) will need to start sufficiently early (e.g. by 2030) to build up to a potentially large contribution from BECCS in the longer term, with policy mechanisms and CO_2 infrastructure key priorities in delivering this (Box 3.5).

We set out medium-term milestones to be on track for net-zero emissions by 2050 in Table 3.3, focusing on enabling actions on the 'critical path' to achieving that target. Necessary action in the next year is presented in Table 3.4.

We also identify four strategic priorities for the Government:

- **Embed net-zero policy across all levels and departments of government, with strong leadership and coordination at the centre.** This is likely to require changes to the Government's overall approach to driving down emissions. For example, the Prime Minister could chair regular meetings of a Climate Cabinet that includes the Chancellor and relevant Secretaries of State, with transparent public reporting of progress and plans.
- **Make policy business-friendly.** It will be businesses that primarily deliver the net-zero target and provide the vast majority of the required investment. UK business groups have strongly welcomed the setting of the net-zero target and are already acting to reduce emissions. Policy should provide a clear and stable direction and a simple investable set of rules and incentives that leave room for businesses to innovate and find the most effective means of switching to low-carbon solutions.
- **Put people at the heart of policy design.** Over half of the emissions cuts to reach net-zero emissions require people to do things differently. The public must be engaged in the challenge and both policy and low-carbon products should be designed to reflect this. We welcome the programme of Citizens Assemblies being convened by a group of Parliamentary Select Committees to discuss the pathways to net-zero emissions and the establishment of the Youth Steering Group announced alongside the net-zero target.

- **Support international increases in ambition and celebrate the UK ambition.** Global carbon-intensity of energy has improved every year since 2011 but total emissions still grew in 2018 to record levels, over 55 $GtCO_2e$. Many countries are currently considering revised pledges of effort ahead of the UN climate summit in late-2020 (COP26), which the UK expects to co-host with Italy. The UK should use its new net-zero target and probable position as host of COP26 to help encourage increased effort elsewhere, including adoption of similar targets by other developed countries in the EU and beyond.

To be an effective host of the UN talks and an influential climate leader, the UK Government must now back its net-zero emissions target with a coherent national policy package to deliver it. The key elements should be developed over the next 12-18 months, ahead of the UN talks.

Box 3.4. Developments on greenhouse gas removals

Our *Net Zero* report highlighted that greenhouse gas removal (GGR) from the atmosphere will be essential to achieve a net-zero GHG emissions target in the UK. We highlighted the need for actions to be taken now to ensure that domestic GGR is available at scale by 2050. In particular, this will require the development of carbon capture and storage (CCS) infrastructure for bioenergy with CCS (BECCS) and direct air capture of CO_2 with storage (DACCS). Alongside this the Government will need to develop governance rules, incentives and market mechanisms to ensure that an at-scale removals market can develop with appropriate environmental safeguards.

Other the past year several relevant developments have occurred within the UK:

- Drax power station has begun to capture biogenic CO_2 in a BECCS pilot plant, initially at a scale of 1 tCO_2 per day. It has announced an ambition, together with Equinor and National Grid to scale up this pilot to develop a zero-carbon cluster by 2030.
- The Royal Society and the Royal Academy of Engineering published the *Greenhouse gas removal* report, outlining the potential for GGR in the UK and globally. We considered the findings in Chapter 10 of our recent *Net Zero: Technical Report*.
- The Government has commissioned a study on incentivising GGR deployment in the UK and other countries.
- UK Research and Innovation (UKRI) held a community dissemination event in April 2019 to help scope a potential funding programme to establish GGR demonstrator facilities in the UK.

Internationally, DACCS companies based in Canada (Carbon Engineering) and Switzerland (Climeworks) have both concluded large investment rounds to secure private equity funding to help commercialise their technologies.

We have previously suggested a number of actions for the Government on greenhouse gas removals:

- The UK should have a strategy to develop greenhouse gas removal options.
- A new Government bioenergy strategy should be published and implemented.
- A Government review is required of ways to encourage low-GHG and GHG-removing materials in construction (e.g. through building regulations).
- Funding for research, development and demonstration should be available for GGR options (covering priority areas such as total potential, monitoring and verification, safety and wider impacts, and capture methods).

Box 3.5. Increasing power sector ambition in the 2020s

In the past, the Committee assessed progress towards reaching an emissions intensity of under 100 gCO_2/kWh by 2030 in the power sector, and presented scenarios for achieving an emissions intensity of 50-100g/kWh by 2030.[57] This target was a suitable objective to meet the previous 2050 target for a reduction of 80% of emissions, at least cost. Achieving net-zero emissions by 2050 could require earlier electrification and/or earlier power sector decarbonisation, increasing the level of low-carbon generation that would need to come online in the 2020s.

- The Committee's scenarios for 100gCO_2/kWh in 2030 require around 270 TWh of low-carbon generation to be online by 2030, comprising around 75% of generation. Of this, 180 TWh has already been built or contracted, and a further 75 TWh could be achieved by delivering the ambition in the offshore wind sector deal. This would leave a gap of around 15 TWh of low-carbon generation.
- In our recent *Net Zero* report we recommended an end to sales of petrol and diesel cans and vans by 2035 at the latest and early deployment of hybrid heat pumps, increasing electrification in the 2020s. A heat decarbonisation strategy could imply further electrification beyond this.
- Without an increase in low-carbon generation, meeting new electricity demands would likely increase UK gas-fired power generation, increasing power sector emissions.

The Committee now recommends the Government pursue pathways consistent with also meeting these potential new demands with low-carbon generation, which implies a level of low-carbon generation consistent with our previous 50g/kWh scenarios for 2030.[58] This would add 45-50 TWh to the policy gap in 2030, leaving a total of around 60 TWh additional uncontracted low-carbon generation required during the 2020s (Figure B3.5).

This new ambition can be delivered under the current electricity market arrangements, by making use of competitive auctions and applying a technology-neutral approach wherever possible.

- The current system is working well. The package of instruments – notably the carbon price support, Contract-for-Difference mechanism and capacity market[59] – introduced under the Electricity Market Reform have delivered low-cost emissions reductions whilst maintaining security of supply. Government still has an important role to play in offering long-term contracts to mitigate risks and reduce project costs. Contracts could be offered to a pipeline of mature renewables such as onshore wind, solar PV and offshore wind, which can meet new electricity demands at low cost.[60]
- We do not expect renewables without a Government-backed contract (so-called 'merchant' renewables) to be deployed at sufficient scale to meet the generation gap in 2030. Analysis by Aurora Energy Research projects that merchant renewables could contribute 13 TWh of generation in 2030. Moreover, additional low-carbon generation from long-term contracts will affect the marginal value of new generation and the volatility of revenue (i.e. 'price cannibalisation'), which could further diminish the role of merchant renewables in the decade to come.

[57] See CCC (2018) *Progress Report to Parliament*.
[58] Our emissions intensity indicator is based on UK generation, excluding imports. If an estimated 32 TWh of imports in 2030 (BEIS (2018), E*nergy and Emissions Projections)* were met by UK based gas-fired generation, emissions intensity would reach 130 gCO_2/kWh instead of the 81 gCO_2/kWh in the Government's projections.
[59] As a response to consultations, BEIS published *Technical Amendments to the Capacity Market* in February 2019 where Government confirmed that the Capacity Market remained the right mechanism to ensure security of supply.
[60] See, for example, Vivid Economics & Imperial College (2019) *Accelerated Electrification and the GB Electricity System.*

Box 3.5. Increasing power sector ambition in the 2020s

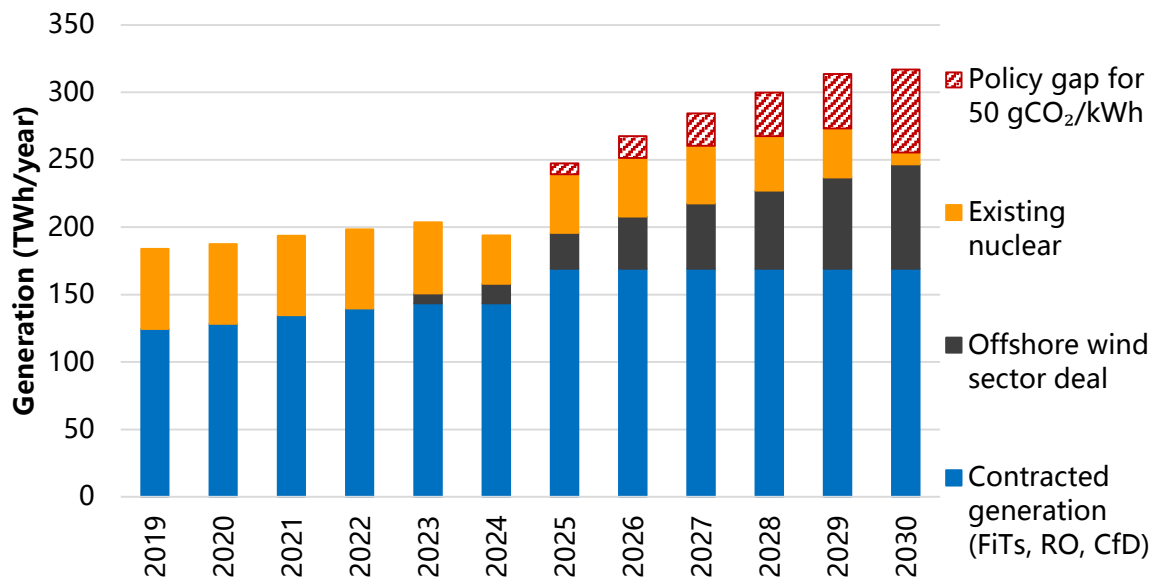
- Alongside new renewables, technologies which can offer firm and flexible power, such as nuclear and CCS, will be required for a power system in 2050 contributing fully to achieving overall net-zero emissions. The scale of deployment required by 2050 will necessitate continued investment in these options between now and 2050.

Increased deployment of variable renewables and increasing electricity demand will require continued improvements in system flexibility, and widespread upgrades to the UK's distribution networks.

- Analysis by Vivid Economics for the Committee suggests that as upgrading distribution network capacity is relatively insensitive to the size of the capacity increase, future-proofing networks as and when they are upgraded can enable greater electrification at lowest cost.
- It is essential, therefore, that when network capacity is increased, this is to a sufficient level to avoid having to upgrade the capacity again prior to 2050.

Moreover, an increasing amount of low-carbon generation will require significant improvements in system flexibility in order to function effectively. Progress is being made and will need to continue at pace in the 2020s.

Figure B3.5. Deployment of low-carbon generation to reach 50 gCO_2/kWh in 2030



Source: CCC estimates based on: Low Carbon Contracts Company (2019) CfD Register, Aurora Energy Research (2019) GB Renewables Forecast H1 2019, BEIS (2019) Renewables Energy Planning Database, CCC analysis.
Notes: 'Offshore wind sector deal' is the remaining capacity to be contracted to reach 30 GW of commissioned offshore wind in 2030. FiTs = Feed-in-Tariffs, RO = Renewables Obligation, CfD = Contract-for-Difference. Our merchant renewable estimate is based on Aurora's projected 8.6 GW capacity from merchant solar and onshore projects in 2030.

Table 3.3. Medium-term milestones to be on track to net-zero emissions by 2050		
Sector	**Action**	**Timing**
Transport	Development of infrastructure and policy to enable sales phase-out of petrol and diesel cars, vans and motorbikes by 2030, if feasible	2020s
	Decisions about how to switch to zero-emissions (e.g. hydrogen or electric) HGVs will be required in the second half of the 2020s.This will necessitate small-scale trial deployments of hydrogen HGVs in a variety of fleets prior to this, in the UK or elsewhere.	Second half of the 2020s
Industry	CO_2 transport and storage infrastructure operational, and hydrogen available, at multiple industrial clusters.	Mid-2020s
	Implement resource efficiency measures in line with the milestones from the Resources and Waste Strategy.	Early 2020s
	Demonstration of a range of industrial fuel-switching technologies including electrification, hydrogen and BECCS.	Early 2020s
	Award first support for industrial fuel switching and CCS through an incentive mechanism designed to enable widespread industrial fuel switching and CCS.	End 2021
	Enable delivery of substantial improvements in industrial energy efficiency in line with the upper end of ambition in the *Industrial Decarbonisation and Energy Efficiency Roadmaps to 2050*.	2020s
Buildings	Strategic decisions on the future of the natural gas grid and the future balance between hydrogen and electrification for heating, taking into account the views of the public. Transition to sustainable heat networks market.	Mid-2020s
	Implement a clear trajectory of standards covering owner-occupied, social- and private-rented homes and non-residential buildings, announced well in advance. Alongside trajectories for energy efficiency, all new heating systems to be low-carbon from 2030 in off-gas properties and 2035 across the building stock.	2020-2035
	Review professional standards and skills across the building, heat and ventilation supply trades with a nationwide training programme to upskill the existing workforce.	2019-2022
	Reform monitoring metrics and certification to reflect real world performance, rather than modelled data (e.g. SAP). Accurate performance testing and reporting must be made widespread, committing developers to the standards they advertise.	2020-2022

Table 3.3. Medium-term milestones to be on track to net-zero emissions by 2050		
Sector	**Action**	**Timing**
Power	Deliver plans to decarbonise the power system consistent with a level of ambition for an emissions intensity towards 50 gCO_2/kWh in 2030.	2030
	Develop clear plans to ensure adequate resilience of energy supplies as heat and transport become more electrified	2020
	Continue to improve system flexibility through the implementation of all actions in the Smart Systems and Flexibility plan.	2022
Hydrogen	Low-carbon hydrogen production at scale, for use initially in applications that would not require major infrastructure changes (e.g. applications in industry, power generation, injection into the gas network and depot-based transport)	Second half of the 2020s
	Trials and pilot projects to establish the practicality of switching to hydrogen across a range of sectors and applications. It is also necessary to demonstrate that hydrogen production from CCS can be sufficiently low-carbon to play a significant role	2020s
Agriculture	To increase the take-up of low-carbon farming practices, develop a strong regulatory baseline that includes low-regret options, with further measures incentivised by the Environmental Land Management System, and a wider policy framework.	Early 2020s
	Innovation and investment in R&D and testing and piloting of options to deliver sustainable agricultural productivity improvements in crops and livestock; low-carbon technologies and options for low-carbon agricultural machinery e.g. tractors and robotics	2020s
Land use	Ensure the post-CAP framework promotes transformational land use change and measures for deep emissions reductions including afforestation and peat restoration.	2020s
	Targeted investment in R&D and innovation to deliver productivity improvements in trees and energy crops.	2020s
Greenhouse gas removals	Initial deployment of engineered greenhouse gas removals, driven by incentives and enabled by CO_2 infrastructure development	Second half of the 2020s

Table 3.4. Milestones for the coming year (2019-20)		
Sector	**Action**	**Timing**
Transport	Bring forward the ban on new conventional vehicle sales to 2035 (or ideally earlier) and clarify that only battery electric (or other zero-carbon) vehicles will be permitted to be sold after this point.	2020
	Clarify the UK regulatory approach to the EU 2020/21 new car and van CO_2 targets and set stretching CO_2 targets for new cars and vans beyond 2020, requiring a high electric vehicle market share. A real-world testing regime must be used alongside standardised tests.	2019
	Implement policies, including fiscal instruments, to strengthen incentives to purchase cleaner vehicles. Current purchasing trends are undermining new car and van emissions targets and must be reversed.	2019
	Set stretching targets for CO_2 emissions reductions from new HGVs to address the rise in emissions and exploit opportunities to improve logistics and increase uptake of eco-driving.	2019
	Set out policies to address the decline in bus usage and develop new schemes to increase levels of walking and cycling.	2019
Industry	Consult on mechanisms to incentivise widespread industrial fuel switching and CCS. Alongside this, BEIS should identify when those industrial sites that will require CCS and/or fuel switching would need to install them in order to fit with their refurbishment cycles.	2019
	Secure (e.g. taxpayer or consumer) funding for mechanism to incentivise widespread industrial fuel switching and CCS.	2020
	Deliver near-term capital support for industrial decarbonisation, through the IEFT and ISCF. Where necessary this should be accompanied by bespoke support for operational expenditure for these projects.	2019
	Make explicit how current and future policies will achieve a 20% reduction in energy use for businesses by 2030.	2019
	Publish the results of the evaluation of Climate Change Agreements to inform any successor scheme for 2023.	2019
	Establish policies to reduce methane leakage and venting, and to develop near-zero GHG emission technologies for off-road mobile machinery.	2020

Table 3.4. Milestones for the coming year (2019-20)		
Sector	**Action**	**Timing**
Buildings	Develop a fully-fledged strategy for decarbonised heat. This must be designed to fully decarbonise buildings across the UK in line with the net-zero goal. HM Treasury must commit to working with BEIS, undertake a review of where the costs of the transition should fall, and allocate sufficient funding to deliver over the full period from now to 2050.	2020
	Publish detailed plans to phase out the installation of fossil fuel heating in off-gas properties in the 2020s, ensuring there is no policy hiatus in 2021.	2019
	Strengthen new-build standards to ensure that all new homes built from 2025 at the latest are designed for a changing climate, are ultra energy efficient and use low-carbon heat. No new homes built from 2025 should be connected to the gas grid. Ambitious standards for non-residential buildings must also be set.	Regulations set by 2020 (with recommended energy/carbon standards in force by 2025 at the latest)
	Set clear trajectories of standards across the building stock and firm policies to drive delivery. This includes introducing concrete policies for able-to-pay homeowners, addressing the major delivery risks which remain around the Private Rented Sector (PRS) regulations and setting out a trajectory, a delivery mechanism for the social housing minimum standards, and concrete policies to deliver the ambition for non-residential buildings.	Consultation in 2019
	Tackle performance and compliance issues to ensure that new buildings and measures retrofitted in existing buildings perform as they should. This includes consulting on strengthened compliance and enforcement measures which extend beyond fire safety to regulations more widely; funding building control adequately; and developing a nationwide training programme to upskill the existing workforce, alongside implementation of low-carbon accreditation.	2019
Power	Develop contingency plans that allow for additional low-carbon generation to be brought forward in the event of delay or cancellation of planned projects, or imports of electricity below projected levels.	2019
	Develop and deliver a plan, in coordination with Ofgem, to upgrade networks in the 2020s to accommodate new electricity demands (e.g. from electric vehicles), and future-proof them in order to limit costs.	2019
	Outline in the forthcoming Energy White Paper a level of ambition compatible with achieving net-zero emissions. This should include the outline of a subsidy-free route to market for the cheapest low-carbon generation from 2020.	2019

Table 3.4. Milestones for the coming year (2019-20)		
Sector	**Action**	**Timing**
CCS	Set out preferred mechanism for CO_2 transport and storage infrastructure.	2019
	Set out plan to enable multiple CCS facilities to be operational by the mid-2020s.	2019
Agriculture	England's Farm Emissions Reduction Plan and Scotland's updated Climate Change Plan, both due out in 2020, should set out firm policies and an implementation plan to reduce GHG emissions in agriculture.	By mid-2020
	The Industrial Strategy's Transforming Food Production Challenge Fund: ensure the £20m of funding already committed to under the first call made in 2018 and subsequent calls are allocated to projects that deliver supporting emissions reduction and clean growth in the food and agriculture sectors.	2019 and 2020
	Post-CAP framework: ensure the on-going design of the Environmental Land Management System, including the testing and trialling of options will incentivise the take-up of low-carbon farming measures and changes in land use to increase carbon removals.	2020
Land use	Develop strategies for each part of the UK to increase overall annual afforestation rates to at least 30,000 hectares in the 2020s.	2020
	Publish England's Peatland Strategy to deliver peat restoration, and sustainable management practices for lowland peat that remains in agricultural production.	2019
Waste	In England, set out a commitment to ban the landfilling of most bio-degradable waste streams including food by 2025 at the very latest. In the forthcoming consultation, set out proposals for the mandatory measurement and reporting of food waste in England by all large businesses in the food supply chain (e.g. food retail, caterers and hospitality).	2019
	In Wales, publish a new Waste Strategy including proposals to reduce food waste substantially and regulations requiring that all businesses and public bodies separate recyclable waste at source.	2020
F-gases	Publish a plan to restrict the use of F-gases to the very limited uses where there are currently no viable alternatives.	2019
Public engagement	Develop a strategy – building on the planned Citizens' Assemblies and Youth Steering Group – to engage with the public over the choices they can make, especially on heating, diet and transport, that will reduce emissions and bring other benefits like improved health.	2020

Chapter 4: UK performance in reducing emissions over the second carbon budget period

After the end of a carbon budget the Committee is required to assess how the budget was or was not met, and the actions taken to reduce greenhouse gas emissions over the budget period. The second carbon budget finished in 2017 and final data are now available. This Progress Report therefore assesses performance over that budget.

Overall, our assessment is that although the second carbon budget was met, this was primarily due to accounting changes in the EU Emissions Trading System (EU ETS) and the impact of the financial crisis, and not due to policy. Had the EU ETS cap and economic conditions been in line with original expectations, the budget would have been missed by more than 2%.

This chapter sets out this assessment. It includes an analysis of key factors driving changes in emissions over the second carbon budget period. It is organised in three sections:

1. The net carbon account for the second carbon budget
2. The impact of policies on emissions reduction over the second carbon budget
3. Assessment of non-policy factors underpinning the second carbon budget surplus

1. The net carbon account for the second carbon budget

The second carbon budget was legislated at 2,782 $MtCO_2e$, which set the maximum level of the net carbon account for the UK over the period 2013-2017.

The net carbon account is defined as the level of UK greenhouse gas (GHG) emissions, excluding emissions from international aviation and shipping, and net of any trading of emissions allowances in the EU Emissions Trading System (EU ETS) (see Chapter 1, Box 1.2):

- For sectors covered by the EU ETS (the 'traded sector', primarily electricity generation, energy-intensive industry, and domestic aviation), their share of the net carbon account is defined by the UK's share of the EU ETS cap, not their actual level of emissions.
- For sectors not covered by the EU ETS (the 'non-traded sector'), their share of the net carbon account is defined by their actual level of emissions.

Final emissions figures indicate that the second carbon budget has been met by 384 $MtCO_2e$ (Table 4.1):

- The second carbon budget was legislated at 2,782 $MtCO_2e$.
- The net carbon account for the second carbon budget period was 2,398 $MtCO_2e$.
- The budget was therefore met by 384 $MtCO_2e$ (around 14% of the budget).

If a carbon budget has been met, the Climate Change Act also requires Government to seek the advice of the Committee before making a decision on whether any resulting surplus emissions should be carried forward and used to meet future carbon budgets. In February 2019 the Committee gave unequivocal advice that the surplus should not be carried forward to the third carbon budget, given that it is not due to overachievement of policy.[61] In relation to this, the Government has sought further advice from the Committee on how to deal with the uncertainties associated with regular revisions in the emissions inventory data, which we will provide in due course.

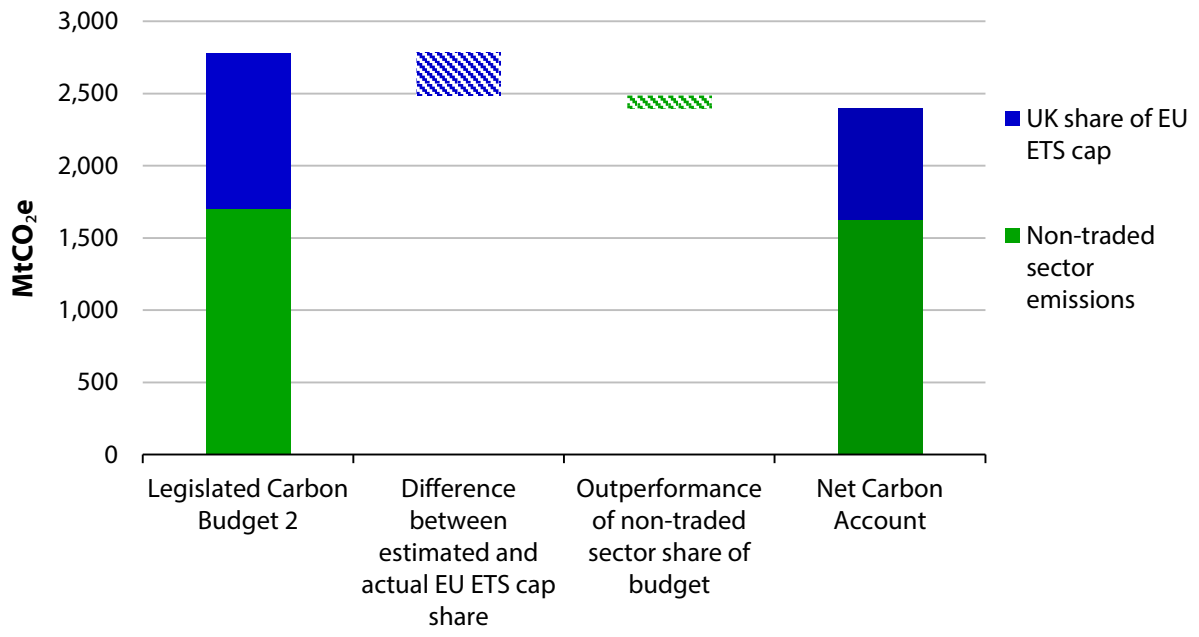
[61] 18 February 2019. *Carry-forward of surplus emissions: Letter from Lord Deben to Claire Perry.*

Table 4.1. The net carbon account for Carbon Budget 2 (2013-2017)

$MtCO_2e$	2013	2014	2015	2016	2017	Total (2013-2017)
Total UK greenhouse gas emissions (excluding international aviation and shipping)	556	516	498	473	460	2,503
Net UK purchases/(sales) of emissions allowances	44	59	29	1	(28)	105
UK net carbon account	512	457	469	472	488	2,398
Legislated carbon budget						2,782

Source: BEIS (2019) *2017 UK Greenhouse Gas Emissions, Final Figures*; CCC calculations.

Figure 4.1. Difference between the legislated Carbon Budget 2 and the actual net carbon account



Source: CCC (18 February 2019) *Carry-forward of surplus emissions: Letter from Lord Deben to Claire Perry.*
Notes: The net carbon account estimate for traded sectors includes domestic aviation; the net carbon account equals final gross emissions figures, net of surrendered EU ETS allowances.

Figure 4.1 shows the surplus comes from two sources: the difference between the estimated and actual EU ETS cap, and the difference between expected and actual emissions in the non-traded sector.

The majority (around three-quarters) of the surplus has occurred due to accounting changes in the UK's share of the EU ETS cap, rather than as a result of lower emissions in sectors outside the EU ETS:

- The UK share of the EU ETS cap estimated for setting the second carbon budget was 1,078 $MtCO_2e$. However, the actual cap was lower by 296 $MtCO_2e$ reflecting a range of factors:
  - The UK's actual share of the EU ETS cap in 2013 when the second carbon budget started was around 40 million allowances lower than assumed when the budget was set. This reflects the fact that the budget had to be set in advance of the rules for Phase III of the EU ETS being finalised.
  - The UK's share of the EU ETS cap fell further in 2014 due to the EU-wide 'backloading' policy, a technical measure aimed at reducing surplus allowances, which limited auctioning of EU ETS allowances over 2014-2016.[62]
- Non-traded emissions (i.e. actual emissions in sectors not covered by the EU ETS) were slightly below the level of the budget. This is largely a result of entering the budget period at a lower emissions level than expected due to the recession. Emissions have been roughly flat thereafter.

Emissions on a sectoral basis are set out in Chapter 1.

The Committee has consistently emphasised the importance of tracking underlying progress – the progress in implementing changes that reduce emissions. The next section considers progress in the actions required to reduce emissions and compares these to expectations when the second carbon budget was set.

2. The impact of policies on emissions reduction over the second carbon budget

The second carbon budget was legislated in line with the level recommended by the Committee in our first report in 2008.[63] Our analysis identified that the budget could be met by implementing a series of policy actions.

Underpinning our recommendation on the level of the second carbon budget, we developed a scenario in 2008 setting out the actions that would be required in each sector in order to meet the second budget, given expected levels of economic growth and other socio-economic factors. We monitor progress against these. It is not necessary for exactly this scenario to be followed, but under-performance in one area should be compensated by over-performance elsewhere in order to deliver the aggregate ambition in the budget.

[62] These withheld allowances will be placed into the EU ETS Market Stability Reserve, and are likely to be cancelled in 2024 under the rules of the reserve.
[63] CCC (2008) *Building a low-carbon economy – the UK's contribution to tackling climate change*.

Overall our policy indicators for 2017, the last year of the second carbon budget, suggest there was limited progress in most areas outside of the EU ETS (Table 4.2):

- **Transport.** None of our high-level indicators were met. New car emissions, registrations of electric vehicles, uptake of biofuels, and distances travelled were all behind schedule.
- **Industry.** Our overarching indicator for the sector (i.e. direct combustion CO_2 emissions) has been met. This largely reflects growth in the manufacturing sector being significantly lower than expected in 2008 when the budget was set (see Section 1.3), as well as other factors such as plant closures, improvements in energy intensity and changes in the fuel mix.
- **Buildings.** Most of our high-level indicators have not been met. Insulation rates fell very significantly after installation programmes (i.e. Carbon Emissions Reduction Target, CERT and Community Energy Saving Programme, CESP) ended in 2012, with the replacement obligation (ECO) less ambitious than its predecessors and the Green Deal failing to deliver. Whilst low-carbon heating appears to exceed the indicator, much of this is either bioenergy in the form of domestic biomass (which is not the long-term best use of finite bioenergy resources) or reversible air-to-air heat pumps in commercial buildings (generally installed for cooling). Residential heat pump sales remained below the levels needed.
- **Power.** Both our indicators for grid emissions intensity and total renewable generation have been met, reflecting the progress made in decarbonising electricity generation.
- **Agriculture, land use and forestry.** None of our indicators were met, reflecting the lack of firm government policy in this area.
- **Waste.** Good progress was made reducing waste emissions.
- **F-gases.** Our F-gas emissions indicator was not met. The main policy instrument, the EU F-gas Regulation, only came into effect in 2015.

Overall, we conclude that UK policies did not deliver ahead of schedule in the second carbon budget period. Progress was mostly confined to sectors covered by the EU ETS. In particular, policies have contributed significantly to reducing emissions in the power sector.

Outside the EU ETS policies fell short of our indicators and delivered well behind schedule in the second carbon budget period.

Table 4.2. Assessment of key indicators required to meet Carbon Budget 2

Sector (% share of total emissions in 2017)	Measure	CB2 indicator (2017)	Actual	Unit	Met?
Transport* (34%)	New car CO_2 emissions	110	121	gCO_2/km	✗
	Electric car registrations	230,000	47,150	Vehicles per year	✗
	Biofuel uptake	7.9	3.1	% of fuel sales by volume in 2017	✗
	Car distance driven	419	426	Billion-kms	✗
Industry (21%)**	Direct CO_2 emissions	-2%	-29%	(% vs 2007)	✓
Buildings (17%)	Lofts insulated	1.2	0.0	Million installations	✗
	Cavity walls insulated	0.8	0.1	Million installations	✗
	Solid walls insulated	0.1	0.0	Million installations	✗
	Heat pumps installed	>30,000	22,000	Installations	✗
	Low-carbon heat	4	8	% of heat demand	✓
Power (14%)	Grid emissions intensity	390	265	gCO_2/kWh	✓
	Total renewable generation	80	85	TWh	✓
Agriculture (9%)	Non-CO_2 emissions	37	40	$MtCO_2e$	✗

Table 4.2. Assessment of key indicators required to meet Carbon Budget 2

Sector (% share of total emissions in 2017)	Measure	CB2 indicator (2017)	Actual	Unit	Met?
	Soil emissions	10	11	$MtCO_2e$	✗
	Enteric emissions	20	21	$MtCO_2e$	✗
	Nitrous oxide emissions	13	14	$MtCO_2e$	✗
	Methane emissions	24	26	$MtCO_2e$	✗
Land use & forestry* (-2%)**	Afforestation	At least 21,000 from 2015	<18,000 in 2016/17	Hectares per year	✗
Waste (4%)	Landfill emissions	25 to 37	62	% below 2007 levels	✓
	Biodegradable waste to landfill	38 to 84	55	% below 2007 levels	✓
F-gases (3%)	Emissions	-23	+4	% change vs 2007 levels	✗

Source: CCC analysis.
Notes: *Includes surface transport, and domestic and international aviation and shipping. **Industry indicator reflects high growth projections for the sector in 2008; due to the economic recession actual growth is estimated 22% lower in 2017 than expected in 2008 (see Section 1.3). ***Rates include baseline planting of 11,000 hectares per year. Indicators and actuals shown for value in year at end of budget period, except building insulation and heat pump installation indicators which are shown on an annualised basis; indicators for 2017 are representative of those set at the outset of Carbon Budget 2. Total emissions used to compute sectoral shares include international aviation and shipping (IAS). Actual emissions in power and industry do not count towards the net carbon account. This table tracks progress up to 2017 against the indicators underpinning our 2008 budget advice. It differs from Table 3.1 in Chapter 3 which instead tracks progress in 2018 against our updated set of indicators.

In addition to our policy indicators, we have also looked at performance over the second carbon budget period in the development and use of clean technology in key areas needed to achieve deep decarbonisation by 2050. Domestically, UK policy has significantly reduced the cost of offshore wind but progress on carbon capture and storage (CCS) has stalled. The UK has benefitted from international progress in battery technology and in electric vehicles.

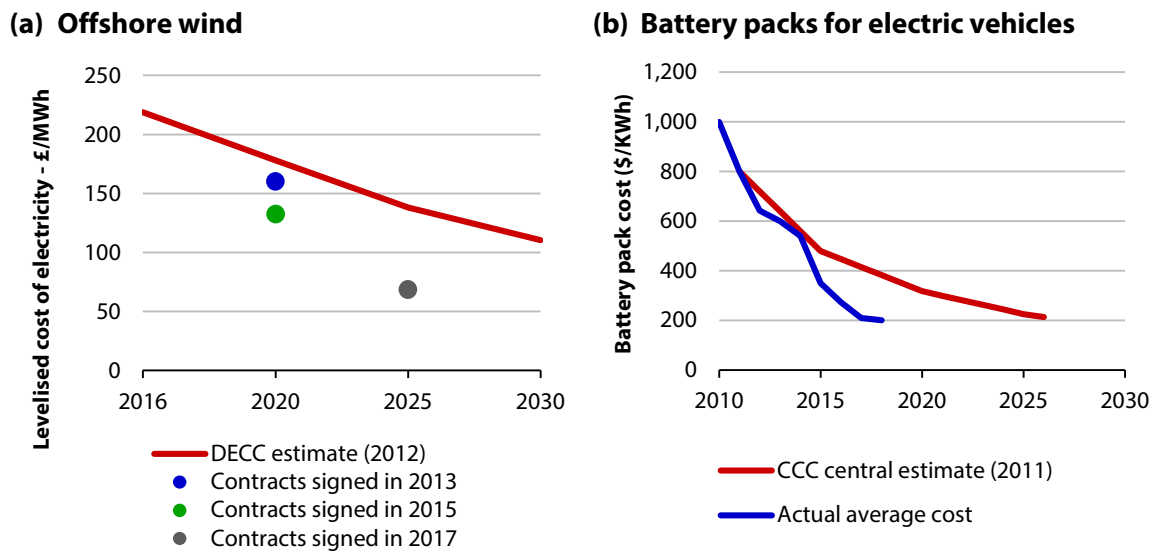
- **Domestically, UK power sector policies (e.g. Contracts for Difference introduced under the Electricity Market Reform, EMR) have contributed to driving down the cost of renewables (especially offshore wind):**
  - The share of electricity generated from fossil fuels fell from 64% to 48% between 2013 and 2017 as renewable generation expanded from 16% to 30% of total generation, largely as a result of policies including Contracts for Difference (CfD) and Feed-in Tariffs (FiT).
  - Progress was most significant for offshore wind, where auction prices went from over £145/MWh to under £65/MWh between 2013 and 2017 (for projects commissioning between 2020 and 2025 respectively, see Figure 4.2.a).[64] Levelised costs of onshore wind decreased by a third while solar levelised costs almost halved between 2013 and 2016 alone.[65]
  - Wider developments under EMR, including beginning construction of the first nuclear power plant since 1995, show the emphasis the UK has put on electrification and low-carbon power generation.
- **Progress on CCS has stopped and only recently became a policy priority again:**
  - In 2012 a Government competition was underway for the commercialisation of CCS. This was aiming to fully develop multiple CCS demonstration projects by 2020. Up to £1bn was to be made available in capital funding with additional support through guaranteed price contracts.
  - In 2015 the Government withdrew the fund, leading to the cancellation of the competition and to a hiatus in CCS development.
  - A replacement policy is only slowly beginning to emerge, following the Government's commitments in the 2017 Clean Growth Strategy. These led to the 2018 CCUS (Carbon Capture Usage and Storage) Cost Challenge Taskforce's recommendations report and the subsequent Action Plan setting out a deployment pathway for CCUS for the 2030s.
- **The UK has benefitted from falling costs internationally of batteries and an expansion in the supply of electric vehicles (EVs):**
  - Between 2010 and 2017, the average cost of battery packs (Figure 4.2.b) fell much faster than expected, from 1,000 $/kWh down to less than 210 $/kWh. The international market for electric vehicles has grown by a multiple of over 20 since 2011, from less than 50,000 sales to over 1.2 million in 2017.[66]
  - The variety of vehicles available and their electric range have steadily increased. In 2011 there were five fully electric vehicle models available in the UK with real-world ranges below 100 miles.[67] By June 2017, the number of electric car and van models available in the UK had increased to 46, with real-world ranges reaching above 200 miles.[68]

[64] Expressed in 2012 prices.
[65] Based on DECC (2013) *Electricity Generation Costs* and BEIS (2016) *Electricity Generation Costs*.
[66] International Energy Agency (2018) *Global EV Outlook 2018*.
[67] Element Energy for the CCC (2013) *Pathways to high penetration of electric vehicles.*
[68] www.nextgreencar.com

– UK electric vehicle market share rose to 1.9% in 2017, an increase of nearly 39% over the previous year. Plug-in hybrid electric vehicles represented the majority of these at 1.3% of all car sales, with pure battery electric vehicles representing 0.5%.[69]

We therefore conclude that some policy foundations to reduce UK emissions rapidly in future are in place, reflecting the importance of low-carbon power and electrification and their progress to date. However, a major ramp-up in policy effort is required across all sectors in order to reach net-zero GHG emissions in 2050, with progress extending beyond the power sector to all emitting sectors of the economy.

Figure 4.2. The cost of clean technologies has been falling much faster than expected



Source: CCC (2019) *Net Zero. The UK's contribution to stopping global warming.*

[69] SMMT (2019) *Electric vehicle and alternatively fuelled vehicle registrations.*

3. Assessment of non-policy factors underpinning the second carbon budget surplus

We commissioned Cambridge Econometrics to analyse the impact of non-policy factors on reducing emissions during the second carbon budget period (Box 4.1).

The study provides an estimate of how much key factors (e.g. GDP and fossil fuel prices) have contributed to actual emissions being below the level anticipated when recommending the budget level in 2008 (Figure 4.3).

The key message from the study is that had the EU ETS cap and economic conditions turned out as originally expected, the second carbon budget would have been missed by around 65 $MtCO_2e$, showing that policies did not deliver as much as planned:

- Around 296 $MtCO_2e$ (equivalent to three-quarters) of the outperformance over the second carbon budget period is explained by accounting changes in the EU ETS.
- Other than these accounting changes, consistently lower economic growth than expected is the main factor which led emissions to meet the budget. UK GDP was 14.5% lower by 2017 than the Government expected it to be in 2008 (Figure 4.4).
- The impact of the recession was even more severe in the manufacturing sector, where output in 2017 was 22% lower than the level expected in 2008.
- The combined impact of accounting changes in the EU ETS and lower economic growth more than offsets the surplus from the second carbon budget, by around 65 $MtCO_2e$. This implies the budget has not been met due to policy measures but rather due to external circumstances.

Overall, the results of the study are consistent with the Committee's earlier analysis.[70] They show that, without emissions reduction from the financial crisis and from accounting changes in the EU ETS, the second carbon budget would have been missed by over 2%. These findings support our previous conclusions that the surplus should not be carried forward as it is not due to policy being ahead of schedule.

Box 4.1. Research project on the factors driving emissions reductions over the first and second carbon budget

We commissioned Cambridge Econometrics to look at the key factors underpinning the outperformance of the second carbon budget. The report from this project is published alongside the Progress Report. The aim of the study was to provide:

- A detailed quantitative assessment on the impact of 'conditions', or non-policy factors (e.g. GDP, fossil fuel prices, temperature), on emissions over the period 2013-2017, with a focus on the second carbon budget.
- Insight on whether the main changes in those factors driving emissions down are permanent or transitory.
- Practical lessons learned from the first ten years of carbon budgets for future budget setting.

[70] 18 February 2019. *Carry-forward of surplus emissions: Letter from Lord Deben to Claire Perry.*

Box 4.1. Research project on the factors driving emissions reductions over the first and second carbon budget

The analysis focuses on energy-related CO_2 emissions in sectors outside of the EU ETS. It is based on a 'counterfactual approach', achieved by running an econometric model for energy and emissions and comparing projections using two different sets of assumptions for GDP, fossil fuel prices and temperature:

- The level for these factors expected in 2008 when recommending the budget level.
- The actual outturn levels for these factors.

The results show the largest share of outperformance of the second carbon budget is explained by accounting changes in the UK's EU ETS cap. Amongst the non-policy factors assessed, lower economic growth was the key driver for emissions being below expected levels:

- Accounting changes in the EU ETS account for 296 $MtCO_2e$ of outperformance.
- The reduction in emissions over the second carbon budget period was mostly explained by slower than anticipated economic growth. The estimated impact of lower economic activity on the net carbon account was to reduce CO_2 emissions by around 110 $MtCO_2$ compared to the counterfactual.
- Changes in fossil fuel prices and air temperature also had an impact on emissions, though they were less of a driving force. Over the second carbon budget the combined impact of actual fossil fuel prices and temperature resulted in emissions being around 40 $MtCO_2$ lower compared to the counterfactual.

The study also considers the impact of sources of uncertainty on carbon budget performance assessment (e.g. modelling uncertainty, revisions to emissions inventory data). The findings suggest that the scale of the uncertainty related to regular data revisions is significant. It will be important to take these into account when assessing performance against future budgets.

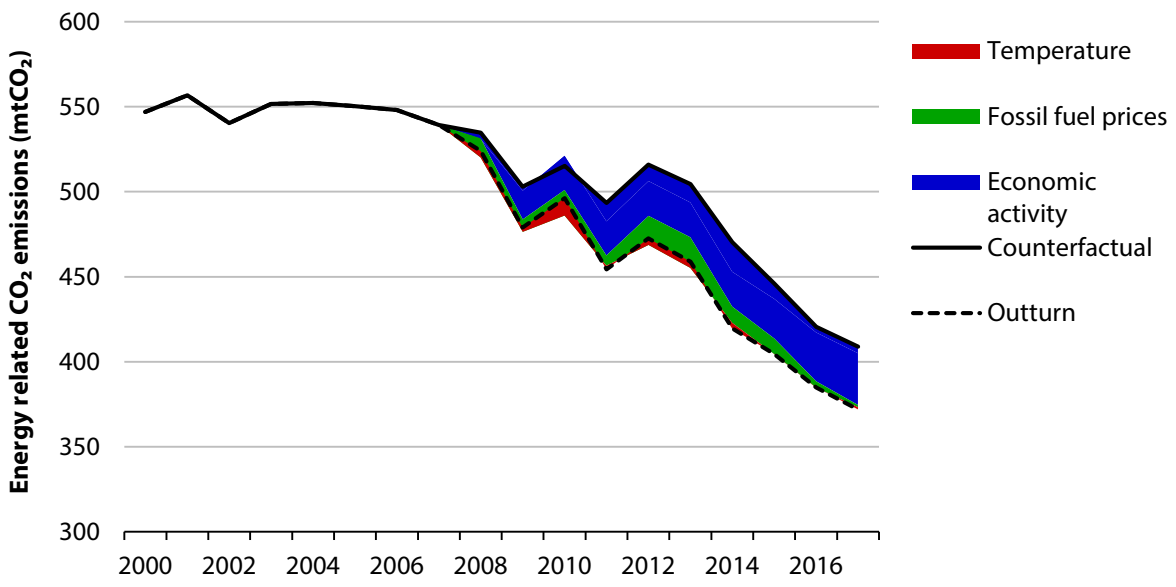
The study findings suggest some practical lessons learned from the first 10 years of carbon budgets, with implications for future carbon budget setting and for carrying forward any surplus emissions:

- **Approach to future budget setting.** Emissions projections will need to reflect the fact that, for most sectors, economic activity will matter less as we approach 2050, as economic growth will need to be decoupled from emissions in a net-zero emissions world. Measuring progress in terms of carbon intensity of the carbon emitting capital stock (e.g. thermal efficiency of buildings, efficiency of the vehicle fleet) will become increasingly important.
- **Implications on carrying forward surplus emissions**. The weak economic activity that has been observed is now thought to be permanent rather than temporary, this suggests the emissions surplus will not be required in the future to compensate for a strong catch-up growth for the economy. Carrying forward surplus emissions will loosen future budgets, which will potentially undermine the steady, long-term actions needed on the path to 2050.

We will consider those insights as part of our work for the sixth carbon budget advice, which we will provide by the end of 2020.

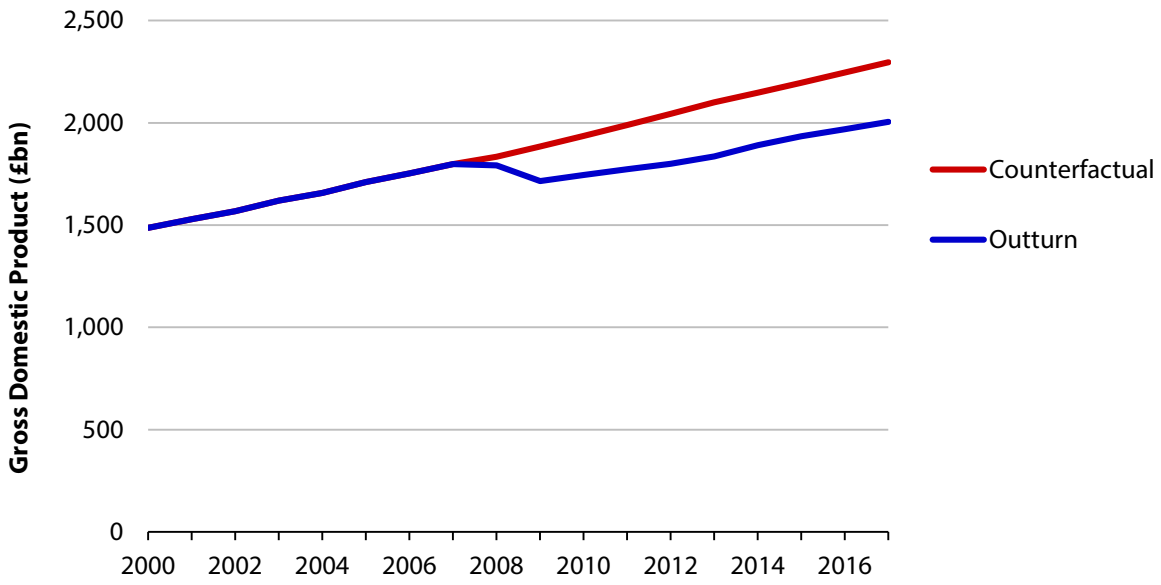
Source: Cambridge Econometrics for the CCC (2019) *How the UK met its carbon budgets.*

Figure 4.3. Key factors causing emissions to be lower than expected in 2008



Source: Cambridge Econometrics for the CCC (2019) *How the UK met its carbon budgets.*

Figure 4.4. Actual GDP growth was significantly lower than was anticipated in 2008



Source: Cambridge Econometrics for the CCC (2019) *How the UK met its carbon budgets;* ONS (May 2019) *Gross Domestic Product: chained volume measures: Seasonally adjusted £m;* CCC (2008) *Building a low-carbon economy – the UK's contribution to tackling climate change.*

Committee on
Climate Change

Committee on Climate Change
7 Holbein Place
London
SW1W 8NR

www.theccc.org.uk

@theCCCuk