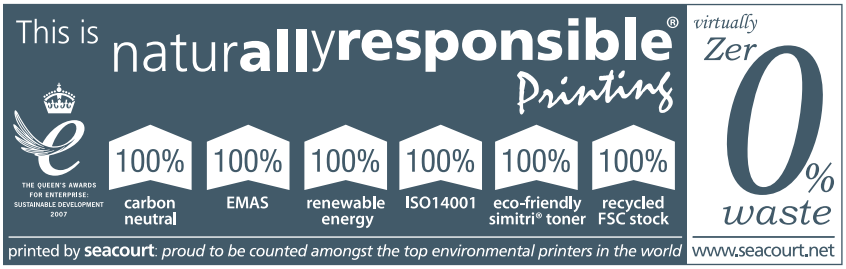
Meeting Carbon Budgets - Progress in reducing the UK's emissions

2015 Report to Parliament

Committee on Climate Change
June 2015



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of the Climate Change Act 2008

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The team that prepared the analysis for this report. This was led by Matthew Bell and Adrian Gault and included: Owen Bellamy, Ute Collier, Taro Hallworth, Mike Hemsley, Gemma Holmes, Jenny Hill, David Joffe, Alex Kazaglis, Ewa Kmietowicz, Eric Ling, Amy McQueen, Stephen Smith, Jack Snape, Kavita Srinivasan, Indra Thillainathan, Mike Thompson and Ladislav Tvaruzek.

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Contents

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Overview

1. Overview of greenhouse gas emissions
2. Underlying progress towards reducing greenhouse gas emissions
3. The contribution of infrastructure to carbon budgets
4. Meeting the fourth carbon budget and preparing for the 2050 target
5. Public sector expenditure on meeting carbon budgets
6. Recommendations

Key messages and recommendations

This Progress Report fulfils our statutory duty under the Climate Change Act 2008. It sets out our views on the progress made towards meeting the UK's carbon budgets, and the further progress needed to meet future budgets and the UK's statutory 2050 target to reduce emissions by at least 80% from 1990 levels.

Two further reports are being published alongside this report:

- Our statutory report on whether adequate measures are being taken to adapt to inevitable climate change caused by continuing emissions, *Progress in preparing for climate change: 2015 Report to Parliament*; and
- A high-level summary combining both this and the report on adapting to climate change, *Reducing emissions and preparing for climate change: 2015 Progress Report to Parliament*.

The UK is on track to meet the second and third carbon budgets, and in 2014 emissions decreased 8% compared to the previous year. However, concerns remain about underlying progress, and about whether progress can be sustained through the 2020s. Significant action is required in the new Parliament in order to meet the fourth carbon budget and to stay on track to the 2050 target.

The key risk to future progress is the current uncertainty over the long-term policy framework. Many existing policies or associated funding for the transition to a low-carbon economy are due to end by 2020. There is a need for these to be extended as soon as possible to give confidence to investors and to support low-carbon innovation and consumer choices.

Some areas are underperforming, like low-carbon heat. Actions are needed in these areas to ensure policies fully address the barriers to change in order to increase uptake. Actions are also needed to maintain existing strong progress in areas such as deployment of low-carbon electricity generation capacity and take-up of efficient new vehicles. Effective policy should aim to reduce emissions now and to develop options for reducing emissions in future. We set out detailed policy recommendations in Tables 6 and 7 at the end of this summary.

Our **key messages** on progress towards carbon budgets are:

- **Provisional statistics indicate that domestic greenhouse gas emissions decreased 8% in 2014,** compared to the previous year, to 520 $MtCO_2e$. Some of the decrease is due to **higher average winter temperatures**, without which the overall reduction in emissions would have been around 6%. This is far higher than reductions since the financial crisis, which averaged around 1% annually from 2009 to 2013, and goes beyond the 3% annual reductions required by carbon budgets. However, it should be interpreted with some caution. It largely reflects a reduction in coal use in the power sector. While this is welcome, emissions reductions will be needed across the economy to meet carbon budgets and the 2050 target.
- **Underlying progress has been mixed.** Some sectors have successfully implemented changes that will lock in emissions reductions, but there remain areas with little evidence of progress.
  - There has been good progress in expansion of renewable electricity generation, installation of efficient boilers and loft insulation, deployment of low-carbon heat in industry, and new car and van CO_2.

1 All 2014 figures are based on preliminary data from DECC Provisional UK greenhouse gas emissions national statistics 2014. They are subject to revision.

Key messages and recommendations

  - There has been limited progress in other areas, for example deployment of low-carbon heat in buildings, take-up of the most efficient domestic appliances, and schemes to reduce travel demand.

- **The devolved administrations account for 22% of the UK's emissions and will play an increasingly important role. They already lead the UK in reducing emissions in a number of areas but there remain areas where stronger action is required.**

  - Emissions are likely to have fallen in 2014 across Scotland, Wales and Northern Ireland, in line with the UK, reflecting a further reduction in the carbon intensity of electricity generation through increased renewables.

  - In some policy areas the devolved administrations lead the UK, with stronger targets and additional allocated funding, in particular in residential energy efficiency and waste.

  - The devolved administrations are also making good progress in renewable electricity, accounting for 40% of the UK's total renewable capacity in 2014. However, progress in renewable heat deployment is slow and targets are not being met.

  - Stronger action will be required in key areas in order to meet future targets. This includes energy efficiency programmes, encouraging greater uptake of electric vehicles and travel behaviour change, increasing tree-planting rates and ensuring waste targets are met.

We monitor progress against our indicator framework. This is composed of a set of trajectories for actions that, taken together, would put the UK on track to future carbon budgets and the statutory 2050 target. It reflects our best assessment of the **cost-effective path** which minimises the economic cost of meeting the 2050 target. To the extent that some areas underperform against our indicator framework, others will need to overperform to meet carbon budgets.

To succeed in this transition to a low-carbon economy, Government needs to lead on three key issues: investment to support growth in low-carbon sectors, developing future options and enabling low-carbon choices:

- **Low-carbon investment:** Many low-carbon policies and funding streams have no certainty beyond the next few years. That prevents efficient investment in low-carbon technologies and their supply chains, which often have long lead-times and payback periods and in many cases are not yet economic without Government intervention. To enable those investments, Government will need to extend existing policy approaches and funding commitments into the 2020s. Specific examples covered in this report include funding for low-carbon electricity, the approach to low-carbon heat and energy efficiency in buildings and emissions regulations for vehicles.

- **Developing future options and innovation:** Many of the technologies that could contribute to meeting the 2050 target are still developing in terms of their cost and performance, the ability of suppliers and financiers to deliver them and the willingness of consumers to adopt them. Public support should be targeted to areas that the market will not or cannot provide, including some elements of R&D and infrastructure spending. To support private innovation, Government must ensure that there is a clear future market for low-carbon products through credible policy commitments that "price in" a rising cost of carbon. There is scope for substantial benefits for UK industry which is well placed to compete in many areas of green innovation. Specific examples include offshore wind, carbon capture and storage (CCS), low-carbon heat, electric vehicles, and many earlier-stage technologies needing research, development and demonstration.

Key messages and recommendations

- **Low-carbon choices:** How lifestyles – which have changed considerably over the past 35 years – continue to change and the decisions people make in response to new products will increasingly determine whether we continue to reduce emissions. Government has a role to address barriers to change, through effective policy design and evaluation to build the evidence base for "what works". Specific examples include setting incentives and information provision to increase take-up for new products such as electric and low-emission vehicles, home insulation measures and heat pumps, and behavioural choices such as travel behaviour and food consumption.

This assessment leads to four main recommendations for this Parliament:

1. Electricity: Ensure the power sector can invest with a 10-year lead time. As soon as possible, set the Government's carbon objective for the power sector in the 2020s and extend funding under the Levy Control Framework to match project timelines (e.g. to 2025 with rolling annual updates).

2. Buildings: Develop plans and policies that deliver low-carbon heat and energy efficiency.

a. Develop an action plan to address the significant shortfall in low-carbon heat, ensuring a better integration with energy efficiency and fuel poverty. Commit to the Renewable Heat Incentive to 2020, or until a suitable replacement is found.

b. Set out the future of the Energy Company Obligation (ECO) beyond 2017, ensuring it delivers energy efficiency while also meeting fuel poverty targets.

c. Implement the zero carbon homes standard without further weakening, ensuring investment in low-carbon heat.

3. Transport: Maintain support for the up-front costs of electric vehicles, while they remain more expensive than conventional alternatives and push for stretching 2030 EU CO_2 targets for new cars and vans.

4. Infrastructure: Make decisions that help reduce emissions. A range of infrastructure decisions to be made this Parliament could have significant impacts. Foremost amongst these is the need for carbon capture and storage (CCS). Others include requirements for infrastructure support for heat networks and electric vehicles. Decisions taken now need to avoid 'lock-in' to high carbon pathways.

We make some additional, detailed recommendations across these themes. They are summarised in Tables 6 and 7.

In this overview we review progress across the whole of the economy, including policies that affect multiple sectors:

- **Section 1: Overview of greenhouse gas emissions** documents the changes in UK domestic greenhouse gas (GHG) emissions between 2013 and 2014, and sets these changes in the context of the second carbon budget and future targets.
- **Section 2: Underlying progress towards reducing greenhouse gas emissions** summarises underlying progress made towards meeting carbon budgets, based on the assessments set out in Chapters 1-7. This assessment is against our indicator framework which monitors specific actions at sector level that, taken together, would keep the UK on track to meet its carbon budgets.
- **Section 3: The contribution of infrastructure to carbon budgets** assesses the extent to which plans for development of infrastructure across the UK are consistent with meeting carbon budgets and the cost-effective path to the 2050 target. We also consider the emissions impact of the Government's National Infrastructure Plan.
- **Section 4: Meeting the fourth carbon budget and preparing for the 2050 target** summarises our evaluation of current policies (set out in Chapters 1-7), identifying those that are expected to achieve their intended reduction in emissions and those that are at risk. This shows that there are significant risks to delivery and a "policy gap" between emissions projections under current policies and the cost-effective path that would meet the fourth carbon budget and put the UK on track to the 2050 target. This section also discusses other uncertainties affecting the emissions path, including the impact of the recent fall in fossil fuel prices.
- **Section 5: Public sector expenditure on meeting carbon budgets** sets out current public sector expenditure towards meeting carbon budgets, in the context of total government expenditure and UK GDP.
- **Section 6: Recommendations** summarises our recommendations, including those discussed in Chapters 1-7.

The remainder of the report then addresses progress and priorities across the sectors of the economy and in the devolved administrations.

- Chapter 1 - Progress decarbonising the power sector
- Chapter 2 - Progress reducing emissions from buildings
- Chapter 3 - Progress reducing emissions from industry
- Chapter 4 - Progress reducing transport emissions
- Chapter 5 - Progress reducing emissions from agriculture
- Chapter 6 - Progress reducing emissions from waste and F-gases
- Chapter 7 - Devolved administrations

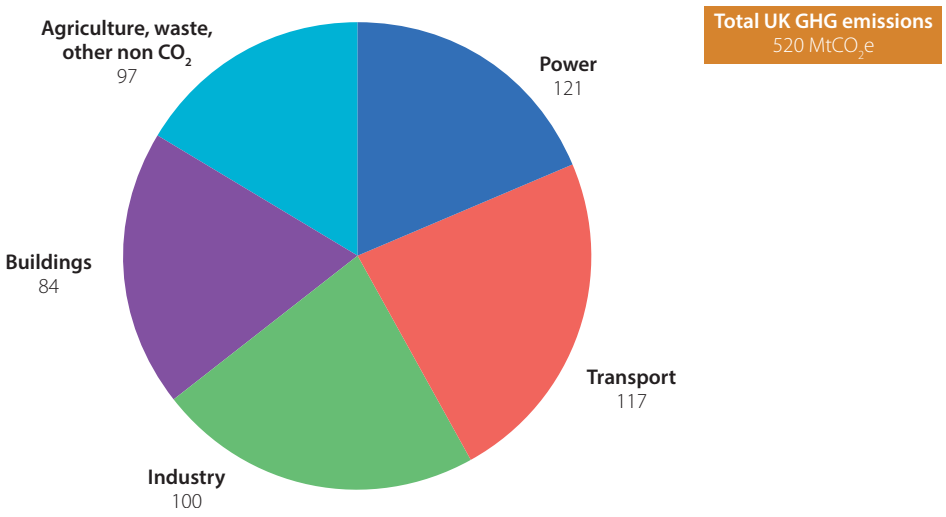
1. Overview of greenhouse gas emissions

As required under the Climate Change Act, we report on UK domestic emissions of six greenhouse gases: carbon dioxide, methane, nitrous oxide and three fluorinated-gases. Although not currently included in the carbon budgets, international aviation and shipping emissions are an important part of the 2050 target, and we consider them in Chapter 4 - Transport.

Provisional emissions statistics indicate that UK domestic greenhouse gas emissions were 520 $MtCO_2e$ in 2014. Emissions from the power sector made up the greatest share (23%), followed by emissions from transport (22%), industry (19%) and buildings (16%). Sector specific estimates for agriculture and waste emissions are not yet available, but total emissions from agriculture, waste and other non-CO_2 are estimated to account for 19% of total emissions (Figure 1).

The 2014 statistics suggest an 8% decrease in emissions compared to the previous year, resulting in emissions that are 36% below 1990 levels. This means that emissions are below the average annual level of the second carbon budget and close to the level of the third budget, but with deep reductions still required to meet the fourth carbon budget (Figure 2).

Figure 1. Total UK domestic GHG emissions by sector in 2014 ($MtCO_2e$)



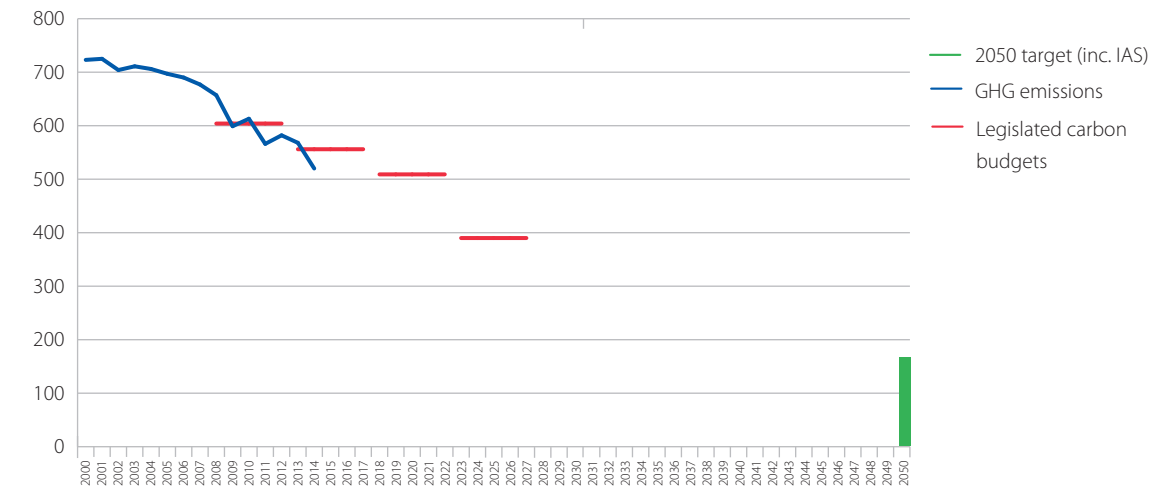
Source: Provisional emissions statistics for CO_2 are based on energy use data, as published in Energy Trends, where available. Where data on energy use is not available, emissions for CO_2 are assumed to remain unchanged from the previous year, while for other GHGs, provisional emissions estimates are based on the assumption that the trend in emissions will be halfway between "no change" on the latest year and a repeat of the trend over recent years. The total emissions exclude the emissions from international aviation and shipping. Emissions from electricity generation are allocated to the power sector rather than to the sectors where the electricity is used.

The reduction in emissions in 2014 is far higher than other reductions achieved since the financial crisis. Emissions fell at an annual average rate of about 1% over the period 2009-2013 (Figure 2). The larger fall in 2014 reflects, in part, a milder winter that depressed demand for heating. However, even without the higher average winter temperatures, the reduction in emissions (i.e. the temperature adjusted change) would have been around 6%[2]. If that could be sustained in future years, it would achieve the 2050 target in the Climate Change Act 15 years early. This raises the question of whether the drop reflects significant progress in reducing underlying sources of emissions, or whether it reflects one-off events.

The large drop in emissions in 2014 was driven by an 18% reduction in emissions from the power sector, alongside reduced emissions from industry (Figure 3).

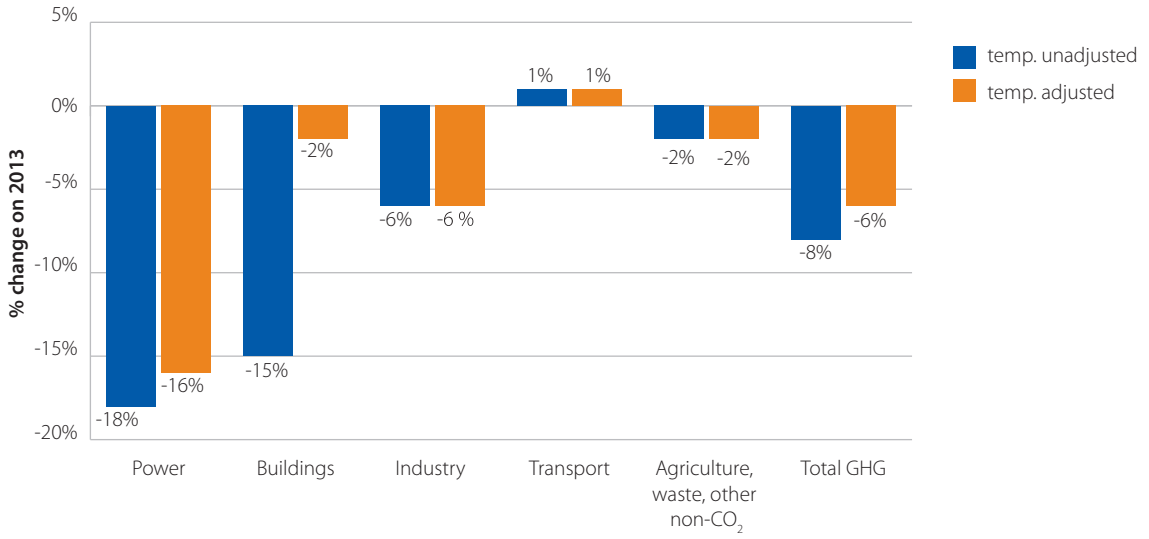
2 Our approach to adjusting for temperature is set out in Technical Annex 1 - Overview

Figure 2. UK GHG emissions against legislated budgets and 2050 target ($MtCO_2e$)



Source: DECC Provisional UK greenhouse gas emissions national statistics 2014, CCC calculations
Note: GHG emissions are presented on a total (gross) basis, while carbon budgets relate to the net carbon account. IAS = international aviation and shipping.

Figure 3. Change in UK domestic GHG emissions between 2013 and 2014



Source: DECC (2014): 2014 UK Greenhouse Gas Emissions, Provisional Figures
Note: Provisional emissions statistics for CO_2 are based on energy use data, as published in Energy Trends, where available. Where data on energy use is not available, emissions for CO_2 are assumed to remain unchanged from the previous year, while for non-CO_2 GHGs, provisional emissions estimates are based on the assumption that the trend in emissions will be halfway between "no change" on the latest year and a repeat of the trend over recent years.

The large reduction in emissions from the power sector reflects a combination of underlying progress that can be expected to continue and changes that are not replicable in the long term:

- Electricity demand fell 4%. This was partly, though not wholly, as a result of the mild winter and as consumers installed embedded generation (i.e. rooftop solar). There was also a 2.2 percentage point increase in the share of electricity imports; the emissions of imports are not counted in the UK's carbon account though they are covered by the EU Emissions Trading System.
- The share of generation met by low-carbon sources increased by 4 percentage points to 35% as more renewable capacity was installed.

- The impact of these changes on emissions was exaggerated as it was all reflected in reduced generation from coal, the most carbon-intensive fuel source, which decreased by 23%. Half of this is permanent as some plant (1.2 GW) closed due to EU air quality directives, and some (0.65 GW) converted to biomass generation. The other half reflected reduced use of the 20 GW of coal plants that remain on the system.
- By 2050 almost all generation will need to be provided from low-carbon sources. In that context, the 4% increase in the low-carbon share, which itself represents good progress, is more representative of progress towards the long-term target than the headline emissions figure.

The other significant emissions reduction in 2014 was in the industrial sector (down 6%). However, there is limited information available on what has driven this change. The provisional statistics for industry have been subject to substantial revisions in previous years.

Emissions in the other sectors, which together account for 56% of UK emissions, did not demonstrate significant reductions:

- Without the higher average winter temperatures, we estimate that buildings emissions would have fallen only slightly.
- CO_2 emissions from transport rose slightly.
- Emissions estimates for agriculture, waste and other non-CO_2 gases are based on past trends and highly uncertain.

We conclude that whilst the large drop in emissions in 2014 is welcome, it cannot be taken as a sign that the UK has shifted permanently to a lower emissions path. The headline figures are dominated by the power sector and uncertain reductions in industry, whereas progress will be needed across all sectors to meet carbon budgets and the 2050 target.

Meeting carbon budgets and preparing for the 2050 target

The UK is on track to meet the second and third carbon budgets (2013-2017 and 2018-2022). However, this partly reflects accounting changes and does not imply that the UK is progressing as required to the fourth carbon budget (2023-2027) or the 2050 target, which require genuine progress in reducing emissions (Box 1):

- Under the Climate Change Act, performance against carbon budgets is measured by the **net UK carbon account**. For those sectors of the economy (i.e. the power sector and energy-intensive industry) covered by the EU Emissions Trading System (EU ETS), this is based on the UK's share of the ETS cap rather than actual emissions. We estimate that the net carbon account was 497 $MtCO_2e$ in 2014. This is 11% below the level required to meet the second carbon budget, which imposes an annual average limit of 556 $MtCO_2e$ for the years 2013-2017. It is also 2% below the level required to meet the third carbon budget, which imposes an annual average limit of 509 $MtCO_2e$ for the years 2018-2022.
- However, this low level of the UK's net carbon account reflects changes in the UK's share of the ETS cap for 2013-2020, rather than progress reducing emissions in the rest of the economy. Meeting the second and third carbon budgets is therefore no longer a reliable indicator of whether the UK is suitably on track to the fourth carbon budget or the 2050 target, since these require that actual UK emissions are significantly reduced in sectors not covered by the EU ETS.

Earlier this year, the Committee provided advice to the Secretary of State for Energy and Climate Change on this issue.[3] We concluded that it should be addressed in order to maintain the integrity of the carbon budgets:

- Ideally, the second and third carbon budgets would be tightened to reflect the change to the UK share of the EU ETS cap;
- If this is not possible, the Government should commit not to carry forward to future carbon budget periods any surplus emission allowances arising from the difference between the expected and outturn UK's share of the ETS cap.

This approach would make it clear that emissions in the non-traded sector need to reduce at the rate of 3% per year, consistent with meeting the 2050 target in the most cost-effective manner, and meeting the fourth carbon budget.

While the net carbon account determines whether a budget is met, it is important also to focus on actual (gross) emissions in the traded sector, given the need to reduce these in the context of meeting longer-term carbon targets.

In section 2 we set out UK progress as compared to our best estimate of the cost-effective path in both the traded and non-traded sectors. In section 4, we assess whether current policies put the UK on track to meet the fourth carbon budget and prepare for the 2050 target. Both those assessments show some good progress, but with more to be done – we set out our recommendations in section 6.

3 Available at: http//www.theccc.org.uk/publication/letter-preserving-the-integrity-of-the-uks-climate-change-regime/

Box 1. The Net Carbon Account and Second and Third Carbon Budgets

The net carbon account can be calculated as:

- The UK share of the European Union Emissions Trading System (EU ETS) cap; plus
- Actual emissions from sources not covered by the EU ETS (the "non-traded sector").

The net carbon account is different from the actual level of UK emissions because for those sources covered by the EU ETS (the "traded sector") actual emissions will generally differ from the UK's share of the EU ETS cap.

The UK's share of the EU ETS cap is the total number of emissions allowances allocated directly to UK installations, including to any new market entrants, and allocated to the UK Government to auction.

We estimate that the net carbon account was 497 $MtCO_2e$ in 2014:

- Non-traded sector emissions were 322 $MtCO_2e$.
- We estimate that the UK share of the EU ETS cap was 175 $MtCO_2e$, which was lower than the actual emissions from UK sources covered by the EU ETS (198 $MtCO_2e$).
- The net carbon account (497 $MtCO_2e$) is therefore lower than the UK's actual emissions (520 $MtCO_2e$) in 2014.

When we recommended the level of the first three carbon budgets we expected that the UK share of the EU ETS cap would be an annual average of 223 $MtCO_2e$ over the second carbon budget period (2013-2017). Our current estimate is substantially lower. There have been changes to the total number of allowances at the EU level, as well as the share of those allowances across member states, the net effect of which has reduced the UK share of the ETS cap. The introduction of backloading in the EU ETS (temporary removal of allowances from the ETS, to be introduced later) is also likely to further reduce the UK share of the cap.

The impact of these changes is that the second and third carbon budgets, legislated in 2009, can now be met with a higher level of emissions from the non-traded sector. In fact, the second and third budgets no longer require a reduction in actual UK emissions (Table B1). This is in contrast to the lowest cost way of progressing towards the 2050 target, which requires steady ongoing reductions year-on-year.

Therefore, while the UK is on track to meet the second and third carbon budgets, the changes to the EU ETS mean that this is no longer a reliable indicator of whether the UK is on track to meet the fourth carbon budget or the 2050 target cost effectively.

Table B1. Required effort in the non-traded sector under the second carbon budget

	Original expectation ($MtCO_2e$)	**2014 estimate ($MtCO_2e$)**
Second carbon budget	2,782	
Annual average allowance	556	
UK share of ETS cap (estimated)	223	175
Non-traded sector allowance	333	381
Required annual average change versus first carbon budget in the non-traded sector	1.4% reduction	1.3% increase

Source: DECC provisional statistics (2015), EEA ETS data viewer, CCC calculations.

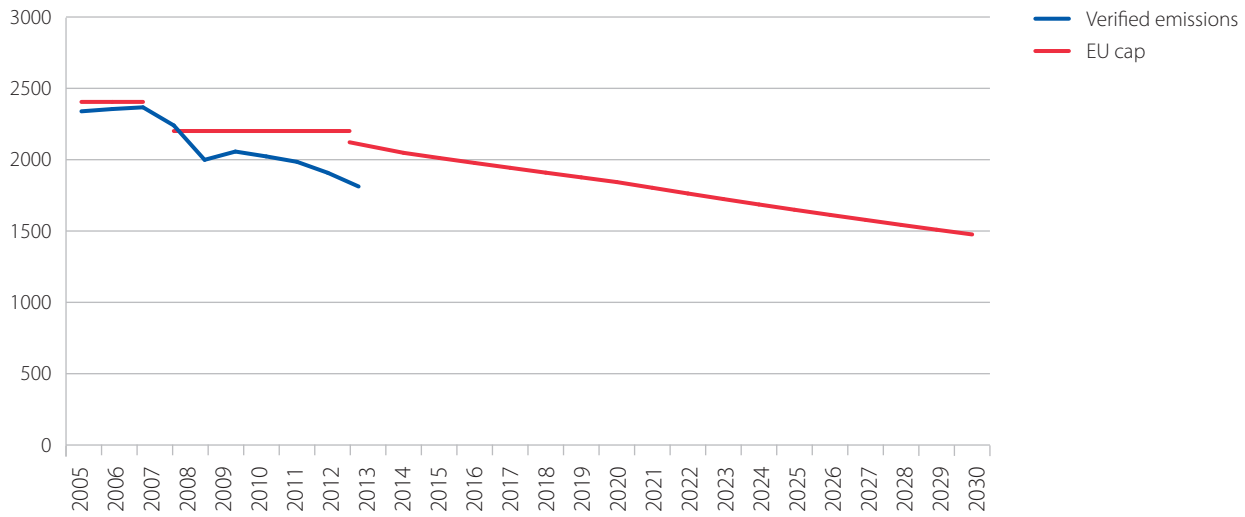
The operation of the EU ETS

The purpose of the EU ETS is to set a sufficiently ambitious overall cap so that European traded sector emissions decrease in line with the EU's 2050 target while allowing for differences in the relative cost-effectiveness of reducing emissions across member states.

However, since the financial crisis, emissions across Europe in sectors covered by the EU ETS have been consistently below the level of the cap, suggesting that the cap has been met without any effort required to reduce GHG emissions (Figure 4). The market value of European Union Allowances (EUAs) is therefore very low, and does not currently provide a significant incentive to reduce GHG emissions:

- The EU ETS, currently in Phase 3 (2013-2020), sets total EU allowances at 2,084 $MtCO_2e$ in 2013, followed by 1.74% annual reductions until 2020.
- In 2014, verified EU traded sector emissions decreased by 5% to 1,812 $MtCO_2e$, 11% below the level of the ETS cap.
- Cumulatively, there has been an excess of allowances of around 2 $GtCO_2e$, roughly equivalent to the entire 2014 cap.
- The persistent excess of EUAs has kept their price very low, at an average of €6.2 per tonne in 2014.

Figure 4. Total EU traded sector emissions relative to cap ($MtCO_2e$)



Source: European Commission, EEA ETS data viewer
Note: For years 2005-2012, the red line represents total allocated allowances over the first and second trading period (freely allocated allowances, correction of freely allocated allowances and allowances auctioned or sold) corrected for scope adjustments. In 2013, the value is set to 2,084 MtCO2e and then reduced each year by 1.74% until 2020, followed by 2.2% annual reduction to 2030. The verified emissions are also corrected for scope adjustment to provide comparable time series.

In order to restore the value of the EU ETS as a policy instrument (and the credibility of EU climate policy more broadly), the cap to 2030 must constrain GHG emissions sufficiently to ensure adequate progress to 2050.

In October 2014 the European Council agreed a 2030 policy framework for climate and energy. Its key provisions were:

- A target of at least a 40% reduction in total EU emissions below 1990 levels, met through domestic measures alone (i.e. without the purchase of international carbon credits from outside the EU).
- An increase in the annual reduction in the EU ETS cap from 2020 to 2.2%, from the currently legislated 1.74%. This would mean that the EU ETS cap in 2030 would be 43% below the 2005 level.

These proposals were supplemented by plans for structural reform of the EU ETS, largely involving a 'Market Stability Reserve' to address the surplus of emission allowances that has built up and to improve the resilience of the system to major shocks. Negotiations around the Market Stability Reserve

are continuing and will require approval by the European Parliament and Council. This is currently expected by summer 2015. The UK Government has supported commencement of the Market Stability Reserve as soon as possible (i.e. 2017). It should continue to do so.[4]

There is also the possibility that the EU will increase its proposed effort for 2030 after the UN negotiations in Paris at the end of this year. A successful agreement in Paris would include a process for parties to increase ambition and require transparent reporting of efforts. The UK Government has supported a higher EU ambition: a 50% reduction in total emissions by 2030 relative to 1990. We will return to this issue as part of our advice on the fifth carbon budget.

Whilst the EU carbon price may remain low for some time, it could have to increase rapidly in future if the EU commits to significant action to reduce emissions as part of a wider international effort. It is important therefore that the the UK develops policies and makes investments that prepare for a higher carbon price, rather than assuming that the current low price will persist in the long term.

The UK carbon price support

UK power plants pay a higher price for their carbon emissions than the price in the EU ETS. This is due to the UK's carbon price support, which was introduced in 2013 at a price of £4.94/tonne (on top of the £4/tonne in the EU ETS), and with a target trajectory to top up the EU ETS price to reach a total "Carbon Price Floor" of £33/tonne in 2020 and £78/tonne by 2030 (2014 prices). The carbon price support was increased to £9.55/tonne in 2014 and £18.08/tonne in 2015.

The rising cost of carbon in the UK power sector has contributed to the large reduction in coal generation and the closing of several coal plants in 2014.

However, as we reported last year, the carbon price support will be frozen at £18 until 2019. The combined price is therefore likely to be well below the original Carbon Price Floor until the EU ETS is significantly strengthened. The new Government should recognise this when setting other policy approaches to support low-carbon investment in the power sector.

- The Government has committed to the removal of new public subsidy for onshore wind. In judging the level of subsidy paid to low-carbon generators (e.g. onshore wind), the Government should consider the full costs of the low-carbon option and the alternative:
  - This should include any system integration costs, for example reflecting that intermittent renewable capacity will generally need to be backed up by flexible capacity that can operate on demand. We will explore these costs further as part of the analysis for our advice on the fifth carbon budget.
  - The appropriate comparator is not the wholesale electricity price, but the alternative means of providing generation. Where this is unabated gas generation, its costs should be judged across its lifetime, assuming that it would face the full costs of its emissions.
  - We also note that a long-term contract for low-carbon generators is not itself a subsidy.
  - This implies for example, that under the Government's central scenarios for carbon and gas prices, onshore wind at a cost of £80/MWh should be considered subsidy free from around 2020.

4 Since any tightening of the EU ETS makes UK carbon budgets easier to meet (see Box 1) but does not reduce effort required on the path to the 2050 target, it follows that any tightening of the EU ETS should be accompanied by a tightening of existing carbon budgets.

- We have recommended extension of the funding commitment for low-carbon power generation. This is the cost of funding low-carbon investments over and above the market price of carbon. If the Government sets this funding based on an assumed future carbon price which does not transpire in the market, the presumption should be that the funding will be increased, rather than the ambition reduced.

We set out these policy recommendations in more detail in Chapter 1 - Power.

2. Underlying progress towards reducing greenhouse gas emissions

Our approach to monitoring progress

The carbon budgets were set to reflect our best estimate of the most cost effective path to the statutory 2050 target. Monitoring progress against the actions required on that cost-effective path provides an indication of whether the UK is likely to meet the carbon budgets and the 2050 target at lowest cost.

We use indicators to monitor progress towards meeting the legislated carbon budgets:

- **Headline indicators** that directly measure reductions in GHG emissions: economy- and sector-wide GHG emissions, GHG emissions intensity and energy demand.
- **Implementation indicators** that measure actions designed to reduce GHG emissions, for example: additional low-carbon power generation capacity, roll-out of loft, cavity wall and solid wall insulation, take up of electric vehicles, tree planting.
- **Policy milestones** which track measures needed to enable future action to reduce GHG emissions: commitments to funding such as the Levy Control Framework and support for electric vehicles, as well as non-funding commitments such as building standards and publication of relevant strategies and action plans.

There is inevitable uncertainty over the rates at which technologies will become available and their future costs, the type and speed of behaviour change and a large number of other factors. Our indicators represent our best assessment of the technologies and behaviours required to meet emissions targets at lowest cost, based on the latest evidence. We will continue to reassess the cost-effective path and the associated indicators.

The indicators are not intended to be prescriptive or exhaustive:

- It may be possible to meet carbon budgets while underperforming in some indicators provided that is offset by outperformance of other indicators.
- It is possible that some technologies or behaviours that are not currently included in our indicator framework become more cost-effective than current evidence suggests.

The requirement on Government, in response to this report, is to be clear about how it will meet the carbon budgets and the 2050 target. Where it decides alternative routes are better it must set out how they are consistent with the cost-effective path to the 2050 target.

Performance adopting low-carbon technologies and behaviours

Table 1 summarises the underlying progress against our indicator framework, with further detail set out in each sector chapter. Overall we find evidence that good progress has been made in some areas, but not in others:

- **Power (23% of UK emissions):** Near-term progress in installing new low-carbon capacity is on track, but longer-term development of projects is at risk. Low-carbon capacity should provide the bulk of generation by 2030 such that the sector's carbon intensity is reduced by 80-90% to 50-100 gCO_2/kWh.
  - Average carbon intensity fell 12% in 2014 to 443 gCO_2/kWh, and if gas plants had always been used ahead of coal plants (which was technically possible throughout the year) then carbon intensity would have been 263 gCO_2/kWh. That represents an improvement in achievable emissions intensity of 11% on 2013, 43% on 2007.
  - Investment in renewable capacity is in line with our indicators, taking renewable generation to 20% of total UK generation, up from 5% in 2007.
  - Progress is set to continue to 2020. Deployment of renewables continues to make good progress, particularly for onshore wind, offshore wind and solar power. There is sufficient volume in project pipelines to maintain this momentum - projects already under construction or contracted under Electricity Market Reform are sufficient to increase the renewables share to over 30% in 2020.
  - The pipeline beyond 2020 is less developed and is at risk given the high degree of uncertainty about the contracts that will be available to investors beyond 2020. These risks are increased by delays in previous years to carbon capture and storage and further delays this year for the new nuclear programme.
- **Buildings (16% of UK emissions):** Progress is currently falling short against our indicators for improving the efficiency of UK buildings and appliances and for the take-up of low-carbon heat towards 12% of UK demand by 2020.
  - Recent policy changes have resulted in a slow-down in the rate of installation of insulation measures in homes. This follows a period of good progress since 2008 when emissions from homes have decreased due to more efficient boilers and higher levels of insulation, as well as more efficient appliances and lighting. The slow-down is also having a detrimental impact on the UK's ability to meet targets to alleviate fuel poverty.
  - Non-residential buildings emissions have stayed flat, with limited information available on actual installations of insulation or other improvements in thermal efficiency.
  - In 2013, low-carbon heat accounted for only 1.6% of buildings' heat demand. Current heat policies are expected to result in deployment that falls well short of our indicator trajectory, which would cause a large emissions gap in the fourth carbon budget period (see section 4).
- **Transport (22% of UK emissions):** Progress is broadly on track to our indicators for improving the efficiency of new vehicles towards 50 g/km for cars and 60 g/km for vans by 2030 whilst increasing the penetration of ultra-low emission vehicles (e.g. electric cars) towards 60% of sales by 2030.
  - New car and van CO_2 intensity has continued to improve and is broadly in line with our indicators. For cars, CO_2 intensity in 2014 is 125 g/km. This is 2.8% below the previous year and 24% lower than 2007.
  - There has been strong growth in UK electric vehicle (EV) sales which more than quadrupled in 2014 to 0.3% of new car and van sales, significantly outperforming our indicator. Qualitative signs are also encouraging, with a wide range of models now available across car classes and some improvements in national charging infrastructure.

- **Industry (19% of emissions) and agriculture (9.5% of 2013 emissions):** Underlying progress is harder to track in industry and agriculture where there is limited data available on low-carbon investments and practices.
- **Waste sector (4% of emissions in 2013):** Waste is broadly meeting our indicators, with the amount of biodegradable municipal waste sent to landfill down by 45% in 2014 relative to 2007.

This picture demonstrates that planned emissions reductions are possible and can be delivered through a variety of means. There has been success with EU regulation (new vehicles), UK regulation (boilers), taxation (waste) and public subsidy (renewable power). Extending this success will require that the right mix of instruments is used to overcome specific barriers to action, as we set out in section 6.

Table 1. Underlying progress in 2014

Measure	Indicator	Outturn (UK)	Outturn (Devolved Administrations)
Power			
Total renewable generation	58TWh	62TWh	Scotland: 19.0 TWh Wales: 3.4 TWh Northern Ireland: 1.7TWh 2014 numbers are provisional
Renewable capacity: onshore wind	8.1GW	8.5GW	Scotland: 5.0GW Wales: 0.6GW Northern Ireland: 0.7GW
Renewable capacity: offshore wind	4.7GW	4.5GW	Scotland: 0.2GW Wales: 0.6GW Northern Ireland: 0GW
Buildings			
A-rated boilers	6.8m	9.3m	
Loft insulation	4.15m (cumulative)	5.9m (cumulative)	Scotland: 1.1m (cumulative) (2013)
Cavity wall insulation	3.5m (cumulative)	3.2m (cumulative)	Scotland: 1.2m (cumulative) (2013)
Solid wall insulation	0.7m (cumulative)	0.2m (cumulative)	Scotland: 71,000 (cumulative) (2013)
Low-carbon heat	2.2% of total heat demand	1.6% of total heat demand	
A++ rated cold appliances	6% of stock	1%	
A+ rated wet appliances	21% of stock	14%	

Table 1. Underlying progress in 2014			
Measure	**Indicator**	**Outturn (UK)**	**Outturn (Devolved Administrations)**
Industry			
Low-carbon heat	1.3% additional since 2007 (2.7% total)	3.3% additional since 2007 (4.7% total)	
Transport			
New car CO_2	122.8g/km	124.7g/km	Scotland: 124.4g/km Wales: 123.5g/km Northern Ireland: 122.7g/km
New van CO_2	180.2g/km	181.9g/km	Scotland: 183.4g/km Wales: 186.2g/km Northern Ireland: 180.7g/km
Electric vehicles (total)	11,257	15,277	
Waste & other non-CO_2			
Biodegradable waste sent to landfill	-34% to -48%	-45%	
Percentage of methane captured at landfill sites	59%	61%	
Source: Multiple sources: see Technical Annexes 1-8.			

3. The contribution of infrastructure to carbon budgets

Infrastructure plays a key role in supporting economic activity in a modern well-connected society. It also has an important role in meeting the legislated carbon budgets and the 2050 target. Investment in infrastructure provides an opportunity to support economic growth and a low-carbon economy as the UK emerges from the financial crisis.

In this section we describe the infrastructure required to meet carbon budgets and compare this to current plans for infrastructure development at the national level and across the devolved administrations. We also consider the increase in emissions arising from these plans, concluding that any increase is likely to be small and manageable.

Infrastructure needed to meet carbon budgets

New infrastructure has a key role to play in decarbonising the power sector, transport and buildings. This includes:

- **Low-carbon electricity generation capacity** sufficient to meet UK demand of a very low carbon-intensity of generation (e.g. reducing carbon intensity from the current level around 450 gCO_2/kWh to 50-100 gCO_2/kWh in 2030).
- **Electricity transmission and distribution infrastructure** to accommodate increased renewables capacity and additional demand from heat pumps and electric vehicles.
- **Smart grid infrastructure** capable of supporting an increase in demand-side response and maximising the efficiency of the transmission and distribution networks.

- **CO_2 pipes and storage infrastructure** to support a significant roll-out of carbon capture and storage (CCS) in both electricity generation and industry.
- **Electric vehicle charging infrastructure** sufficient to facilitate full roll-out of electric vehicles, including a nationwide network of charge points in public places, and across the strategic road network.
- **District heating infrastructure** that can support low-carbon heat delivered to industry, commerce and homes.

A wider definition of infrastructure would also include measures to decarbonise buildings (i.e. insulation, low-carbon heat, etc). These measures are discussed in Chapter 2 – Buildings. Improved flood defences, resilience of existing infrastructure and infrastructure investment to address regional water scarcity and other impacts of ongoing climate change are also needed, and discussed in our accompanying report on adapting to a changing climate.

It is clear that there are opportunities for targeted infrastructure spending to play a significant role – including in CO_2 transport and storage for CCS (Chapter 1 – Power), low-carbon heat networks (Chapter 2 – Buildings) and charging for electric vehicles (Chapter 4 – Transport).

The National Infrastructure Plan

The National Infrastructure Plan sets out the Government's vision and approach for how the infrastructure needs of the economy are expected to be met across transport, energy, flood defences, water, waste, communications and science. First published in 2010, the National Infrastructure Plan was most recently updated in December 2014.

The National Infrastructure Plan is underpinned by the National Infrastructure Pipeline, which sets out details of £460 billion of planned infrastructure investment to 2020 and beyond (Table 2).

Table 2. National Infrastructure Pipeline

Sector	No. of projects & programmes	Total spend to 2020 and beyond (£m)
Communications	6	£10,954
Energy	147	£274,931
Flood	26	£3,654
Science and Research	22	£1,375
Transport	270	£142,273
Waste	20	£1,984
Water	60	£30,861
Grand Total	551	£466,031

Source: HM Treasury (2014): National Infrastructure Pipeline December 2014

The National Infrastructure Plan includes spending on a number of areas relevant to carbon budgets and adaptation to climate change:

- **Electricity generation.** The National Infrastructure Pipeline provides for £78 billion of expenditure between 2021 and 2030 on an illustrative investment profile, consistent with overall deployment under the EMR Delivery Plan 100 gCO_2/kWh scenario. Further funding is required to be on track to around 50g/kWh as set out in Chapter 1 - Power.

- **Electricity transmission infrastructure.** The National Infrastructure Pipeline has provision for £14.9 billion investment in onshore transmission, and a further £3.1 billion in offshore transmission.
- **Electricity distribution infrastructure.** The National Infrastructure Pipeline has provision for £20.8 billion investment in distribution infrastructure.
- **Smart grid infrastructure.** The National Infrastructure Pipeline includes a total £2.1 billion investment to 2020, and a further £4.3 billion post-2020 for rollout of smart meters to domestic and small non-domestic customers. The investment covers dedicated communications infrastructure, IT systems upgrades across the energy industry and end-user smart meter equipment.
- **CCS infrastructure.** The National Infrastructure Pipeline includes the CCS Commercialisation Programme covering both demonstration projects, with provision for around £0.9 billion investment.
- **Electric vehicle charging infrastructure.** The National Infrastructure Pipeline includes the Roads Investment Strategy, which sets aside £15 million between 2015-16 and 2020-21 for a national network of electric vehicle charge points ensuring access to a charge point every 20 miles on 95% of the Strategic Road Network.
- **Flood defences.** Flood defences will be very important in adapting to the impacts of climate change. Flood defences, and other key infrastructure investment for adaptation are covered in Chapter 2 on the built environment in the Adaptation Sub-Committee's Progress Report on the National Adaptation Programme.

District heating infrastructure is not currently included in the Plan, but additional capital funding and regulation for heat networks should be considered as part of a plan to address the significant shortfall in low-carbon heat. Developing the approach to the CO_2 transport and storage infrastructure for CCS will also be an important priority this Parliament (see Chapter 1 – Power).

We conclude that current plans for infrastructure spend appear broadly compatible with meeting carbon budgets. Total planned expenditure is generally of the level required, and where available we assess details on where this is being spent in Chapters 1-7. However, outside the power sector, without more detail about the precise nature of spending in each of the above categories it is not possible to say whether the private and public sector are delivering what is needed. Inclusion of District Heating in the National Infrastructure Plan would confirm that Government intends to develop this important option. We will seek to understand the nature of infrastructure spending in more detail ahead of our next Progress Report.

Infrastructure in the devolved administrations

In Northern Ireland, Scotland and Wales, the split between the responsibility of the UK Government and each of the devolved administrations for infrastructure policy and funding varies according to the distinct devolution settlement in place for each administration.

In devolved areas, for example funding for flood defences, the devolved administrations are responsible for prioritising and delivering infrastructure investment using the funding they receive from the UK Government through their 'block grant' allocations. For non-devolved areas the devolved administrations work closely with the UK Government to ensure the right infrastructure is delivered. They have each published infrastructure plans which include programmes that could contribute towards meeting UK carbon budgets:

- **The Scottish Government** is responsible for rail specification, roads, local transport, policy and funding for flood defences, water and waste disposal. The Scottish Infrastructure Investment Plan

2011 sets out a pipeline of public investment in both economic and social infrastructure through to 2030, with investment of £21-26 billion. The plan aims to continue to work with the UK Government to maximise the synergy of investment plans, particularly in terms of cross border investments as well as sharing best practice. Scotland's plan encourages initiatives to promote emission reductions within the transport sector, including electric vehicle charging infrastructure. It also prioritises investments for renewables infrastructure and prioritises consents for electricity generation and transmission infrastructure. This also includes carbon capture technologies and the plan states that Scotland wants to lead the world in CCS development.

- **The Welsh Government** is responsible for roads, local transport, policy and funding for flood defences, water and waste disposal. One of the priorities of the Welsh Government in its Infrastructure and Investment plan is to update the energy transmission and distribution network to ensure that the new network is up to the challenges of the changing relationship between demand and supply. The plan considers the need to increase the capacity of nationally and internationally significant Welsh ports. Between 2015 and 2023, distribution network operators across Wales are expected to invest £1.5 billion in their networks. Wales' plan has climate change as a key component (Box 2).
- **The Northern Ireland Executive** is responsible for rail specification, roads, local transport, policy and funding for flood defences, water and waste disposal. Northern Ireland's Investment Strategy states that the Executive will support significant investment in the electricity grid and interconnections to ensure that consumers benefit from the Single Electricity Market[5], and in wind energy. The plan also sets out that the Executive will work with utility companies to increase renewable energy, and support major programmes for home insulation and smart metering to reduce energy demands.

Box 2. Wales Infrastructure Investment Plan 2012

Wales' Infrastructure Investment Plan 2012 sets out how Wales should consider the need to be resilient to future pressures and avoid the worst impacts of climate change by cutting emissions.

The plan aims to ensure that proposals consider sustainable development and climate change knowledge. The plan highlights the challenges of being sustainable in the construction sector and states that the Welsh Government and industry will work together to ensure that they deliver environmental and low-carbon solutions when building homes and other buildings.

Emissions from buildings in the domestic and public sectors alone account for over a quarter of Welsh greenhouse gas emissions and the plan aims to drive improvements in the energy performance of buildings and processes to tackle fuel poverty and deliver a low-carbon future. The plan also considers the impact of future climate change when planning and investing in flood resilience.

Source: Welsh Government (2012): Wales Infrastructure Investment Plan for Growth and Jobs 2012

Impacts of the planned infrastructure spend on meeting carbon budgets

Concerns have been raised over the possible impacts of the planned infrastructure spend on meeting carbon budgets, including:

- **Embodied emissions:** greenhouse gases emitted at each stage in the value chain of the infrastructure provision, from extraction of raw materials, through transport and processing of products and materials, to construction.
- **Demand for fossil fuels:** planned infrastructure, such as road building, could encourage particular types of demand (e.g. for cars) that result in higher emissions than would otherwise occur.

5 The Single Electricity Market is the wholesale electricity market covering both Northern Ireland and the Republic of Ireland.

- **Supply of fossil fuels:** infrastructure spending includes specific expenditure on the extraction of fossil fuels that contribute to greenhouse gas emissions.

We have considered the increase in emissions arising from these plans. We conclude that any increase is likely to be small and manageable based on current evidence (Box 3). Under the Infrastructure Act 2015 we have a new duty to advise the Secretary of State about whether the exploitation of onshore petroleum (including shale gas) is consistent with carbon budgets. We will undertake more detailed research of this particular question ahead of that advice, due by 1 April 2016.

Box 3. Impact of the National Infrastructure Plan on GHG emissions

Impacts of infrastructure on GHG emissions include embodied emissions, increasing demand for fossil fuels, and increasing supply of fossil fuels.

Embodied emissions

Embodied emissions are GHGs emitted at each stage in the value chain of the infrastructure provision, from extraction of raw materials, through transport and processing of products and materials, to construction. These GHG emissions would have an impact on achievement of carbon budgets if the investments:

- are additional to expected investments in the economy; or
- displace less carbon-intensive investments elsewhere in the economy.

Our advice on carbon budgets is underpinned by Government projections of energy demand and emissions. It is difficult to assess whether the investments in those areas covered in the National Infrastructure Plan are consistent with these projections.

This is an important question given the scale of construction required to develop the projects in the National Infrastructure Pipeline. The Pipeline provides for an average annual expenditure of £45 billion between 2014 and 2020, which is equivalent to 37% of construction sector output in 2014. This is significantly higher than historical expenditure on infrastructure of around £30 billion per annum, suggesting that the lifecycle GHG emissions resulting from deployment of the infrastructure could also be greater than historical levels.

The Centre for Industrial Energy, Materials and Products (CIE-MAP) at the University of Leeds has estimated the embodied greenhouse gas emissions of the UK's National Infrastructure Pipeline. The analysis estimates that the National Infrastructure Pipeline contains around 174 $MtCO_2e$ of embodied emissions over the period to 2020/21, or 29 $MtCO_2e$ per year:

- Embodied emissions are the full supply chain emissions associated with the initial creation of an asset, including emissions from raw material acquisition; transport, processing and manufacturing of building materials; distribution of materials to site; and energy used on-site in assembly.
- This study estimates the emissions intensity for the emissions embodied in infrastructure per pound spent ($kgCO_2e/£$), based on the emissions intensity of the construction sector, with future intensity adjusted to account for past trends. This relates to all the physical goods and services required along the construction sector's supply chains, whether produced in the UK or abroad, and accounts for different carbon intensities of production abroad.
- Overall, 244 $MtCO_2e$ are estimated to be embodied in UK infrastructure from 2014/15 if the desired level of spending is met, or 174 $MtCO_2e$ over the period to 2020/21, with Energy and Transport projects responsible for the bulk of embodied emissions.

Embodied emissions include emissions from overseas sources, and relate to greenhouse gases emitted through the lifecycle of the infrastructure, rather than in a specific year. Therefore, 29 $MtCO_2e$ per year is the worst case scenario for the impact on annual domestic GHG emissions. It is therefore likely that the scale of any impact of these embodied emissions on carbon budgets will be small and manageable. As we develop our advice on the fifth carbon budget, we will work with DECC to establish how far planned infrastructure investment is reflected in emissions projections.

Box 3. Impact of the National Infrastructure Plan on GHG emissions

There are likely to be actions that could be taken to reduce the scale of any impact – for example, techniques to minimise the need to repair, maintain and replace road surfaces and so reduce future carbon emissions associated with that activity. This has been recognised in HM Treasury's Infrastructure Carbon Review, which sets out advice for developers and operators of infrastructure assets. The Infrastructure Carbon Review calls for Government and industry to work together to incorporate carbon reduction objectives within all their infrastructure projects and programmes by 2016.

Any infrastructure project should consider how to minimise carbon emissions during its planning phase. This should form part of the relevant formal requirements, for example included in the Environmental Impact Assessment. Where public sector funding is involved, formal requirements should include explicit consideration of the level and social cost of carbon emissions in assessing bids and choosing the winning approach to a particular project. The Committee welcomes views for future reports about how best to deliver this requirement.

Demand for fossil fuels

As well as investing in measures to reduce demand for car travel, DfT has recently announced a series of investments in the road network that are likely to slightly increase overall travel demand.

The National Infrastructure Pipeline includes the Road Investment Strategy, comprising around £15bn of expenditure on 100 projects to improve the strategic road network between 2015 and 2021. Around £9bn of this is allocated to road widening, smart motorways and junction improvements, with the remaining £6bn being used for resurfacing. The investment is weighted towards improving existing roads, rather than building new roads – DfT estimates that the investment will result in a less than 1% increase in additional lane miles on the network.

In its impact assessment, DfT estimate the additional traffic and associated CO_2 emissions caused by these projects. These investments are modelled as increases in capacity at specific points on the network which, they estimate, lead to a 0.2% increase in vehicle-km and a 0.1-0.2% increase in CO_2 emissions by 2040.

It should be noted that the National Transport Model is not designed to model the detail of small scale investments, so it does not fully capture the impact of the Road Investment Strategy and is likely to underestimate the impact on emissions. However, the impact appears small. DfT models would have to underestimate the additional traffic by an order of magnitude for the Roads Investment Strategy to increase CO_2 emissions by even as much as 1-2%.

Supply of fossil fuels

The National Infrastructure Pipeline includes £53 billion expenditure on capital costs relating to oil and gas fields and associated infrastructure on the UK continental shelf for the years 2014-18. This figure excludes costs of exploration, appraisal and decommissioning. This level of expenditure is consistent with historical levels (Figure B3):

While the National Infrastructure Plan summarises private investment in oil and gas infrastructure, this investment responds in part to Government policy, such as taxation levels.

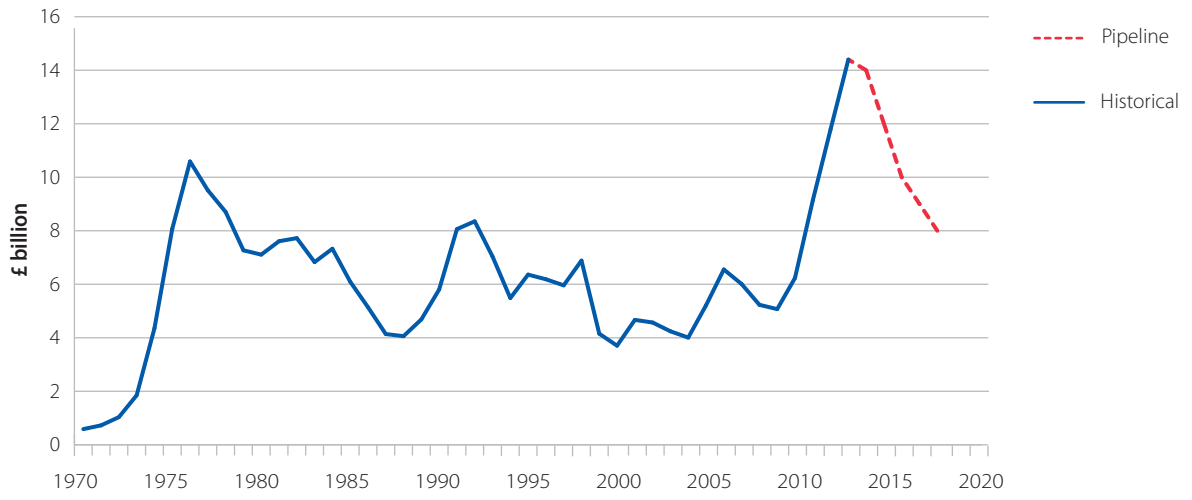
The question of what level of oil and gas extraction is consistent with carbon budgets and the climate objective is complex. It requires careful consideration of various factors, including:

- The extraction rates consistent with meeting the climate objective at the global level, and the expected oil prices consistent with these extraction rates.
- Costs of UK extraction relative to global oil prices.
- The degree to which domestic production of oil and gas might affect domestic consumption (in the case of carbon budgets) and global consumption (in the case of the climate objective).
- Geopolitical and energy security considerations.

This question is particularly important given the objective set out in the Infrastructure Act 2015 of "maximising the economic recovery of UK petroleum". The Infrastructure Act also requires the Secretary of State to request the Committee on Climate Change to provide advice on the impact of onshore petroleum (e.g. shale gas) on carbon budgets and the 2050 target. We will therefore consider the impact of both onshore and offshore petroleum in a report to be published in March 2016.

Box 3. Impact of the National Infrastructure Plan on GHG emissions

Figure B3. Expenditure on oil and gas fields and associated infrastructure, 1970-2018



Source: DECC (2014): Income from and expenditure on UKCS exploration, development and operating activities: annually 1970-2013; HM Treasury (2014): National Infrastructure Plan Pipeline Spreadsheet: December 2014 Update
Note: Values exclude costs of exploration, appraisal and decommissioning

Source: Scott et al. (2015): Embodied greenhouse gas emissions of the UK National Infrastructure Pipeline; DECC (2013): Roads Reform Impact Assessment

4. Meeting the fourth carbon budget and preparing for the 2050 target

We set out in Section 1 that the UK was on track to meet the second and third budgets due to accounting changes. In this section we focus on whether the UK is on track to the fourth carbon budget and 2050 target, which have not been affected by these changes.

Emissions reductions expected from current policies

Our assessment is based on an update of analysis from our 2014 Progress Report to Parliament. In that report we identified a large 'policy gap' between current policy ambition and the cost-effective path that would meet the fourth carbon budget and prepare for the 2050 target:

- In 2014 we evaluated Government policies intended to reduce emissions against a set of criteria (Box 4). This allowed us to identify those policies which are expected to deliver (classified as "lower risk") and those at risk of failing to deliver, either due to design and delivery problems, or because they are currently unfunded. We also identified where policy is needed but currently there is none.
- Our assessment was that a significant amount of current ambition was at risk and that some parts of the cost-effective path, particularly after 2020, had no policy to drive delivery. Even if at-risk policies delivered in full, there would be a policy gap of 45 $MtCO_2e$ to the fourth carbon budget in the non-traded sector.

Our 'cost-effective path' was designed to include realistic take-up of those changes which can reduce emissions at relatively low cost (e.g. improved energy efficiency of homes and vehicles) and/or are required to prepare effectively for meeting the 2050 target (e.g. increasing uptake of electric vehicles and heat pumps). Our updated assessment is that a similar amount of current ambition remains at risk and policy remains to be developed for significant parts of our scenario for the cost-effective path.

The estimated gap to the fourth carbon budget appears to be smaller (i.e. 10-31 $MtCO_2e$ in a central case). This reflects changes in the Government's baseline projections, which are subject to significant uncertainty (Box 5), rather than policy development.

Box 4. Criteria to evaluate level of risk in current policies

The criteria that we have used to assess policies are:

- **Design and Implementation.** We assess whether the design and implementation of the policy tackles the right barriers; whether the policy has established a track record or there is evidence of similar policies working before; and whether there are risks to the policy due to various factors such as lobbying, lack of coherence, or lack of political support. We also assess whether the original impact assessment makes a prudent assessment of the level of abatement delivered by the policy.
- **Incentives.** We assess whether the right incentives – monetary or regulatory – are in place for the policy to deliver the necessary abatement.
- **Funding.** We assess whether, if required, there is adequate funding in place for the policy, both now and in the future.

If policies meet all three criteria we would expect them to deliver and we have classified them as "lower risk", whereas if they fail any one of the criteria we classify them as "at risk".

Box 5. DECC's emissions projections and related uncertainty

Revised projections

Since our last report, DECC have significantly revised down their projection of emissions expected in the absence of any policy to reduce them (i.e. the 'baseline projection'). This means that the gap to the fourth carbon budget is smaller than we estimated in 2014. It also means that implementation of the set of measures (e.g. insulation of homes, starting to shift to low-carbon heating systems) identified by the Committee as being on the cost-effective path to 2050 may result in emissions that are lower than required under the legislated budget.

The reduction in the DECC baseline projection of emissions reflects changes in the non-traded and traded sectors:

- Non-traded sector: residential and LULUCF emissions have been revised downward due to lower household projections, incorporation of Met Office predictions of warmer winters (reducing winter heating demand), and inclusion of the impact of unmanaged forest in the projections.
- Traded sector: power sector emissions have been revised downward in the fourth carbon budget period as coal-fired power stations are now assumed to allocate relatively more of their allowed operating hours under the Industrial Emissions Directive in the second and third carbon budget periods, and less in the fourth carbon budget period.

We will be working closely with DECC to fully understand these changes to the baseline.

Uncertainty in projections

DECC also report the impact of uncertainty in key model inputs (e.g. GDP, population, temperature) based on the 95% confidence interval from a Monte Carlo analysis. Inevitably this analysis does not capture all possible uncertainties, suggesting the full range of uncertainty is likely to be wider. For example, last year's central projection falls outside of the uncertainty range estimated this year (Figure B5).

For the non-traded sector, DECC estimate that emissions could be 6% higher or 8% lower than in their central case over the fourth carbon budget period (Figure B5). For the traded sector, DECC estimate that emissions could be 13% higher or lower than in their central case.

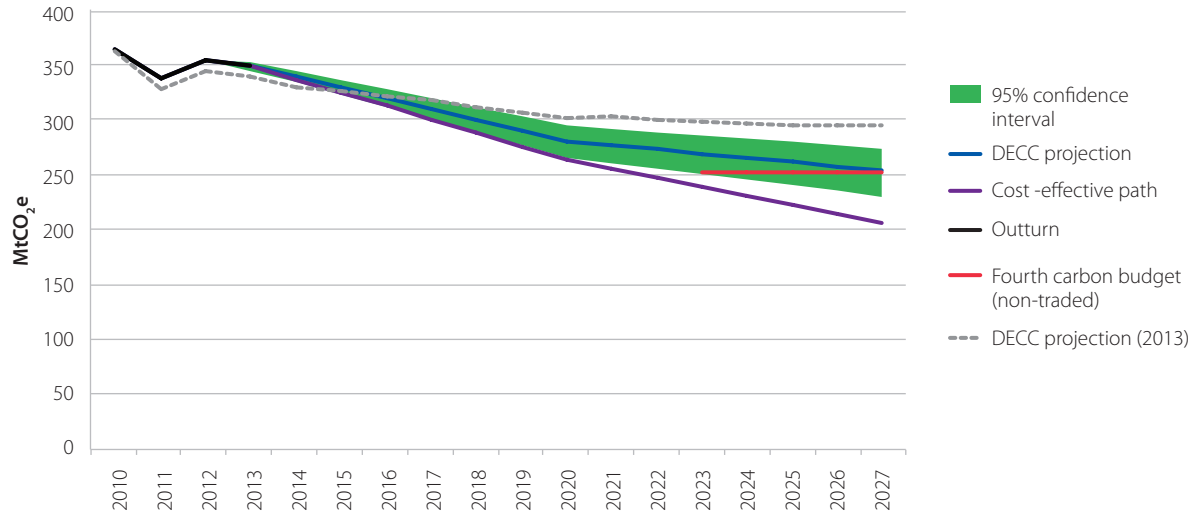
This uncertainty poses risks: that emissions will be higher than anticipated, such that the fourth carbon budget is not met or greater effort is required to meet it; or that emissions will be lower than anticipated, such that carbon budgets can be met through a level of effort that is insufficient to make adequate progress towards the 2050 target.

Box 5. DECC's emissions projections and related uncertainty

Monitoring progress

It is important therefore not only to assess the estimated gap to future carbon budgets, but also whether effective policies are in place to deliver the measures included in the cost-effective path, which was designed in the face of these uncertainties.

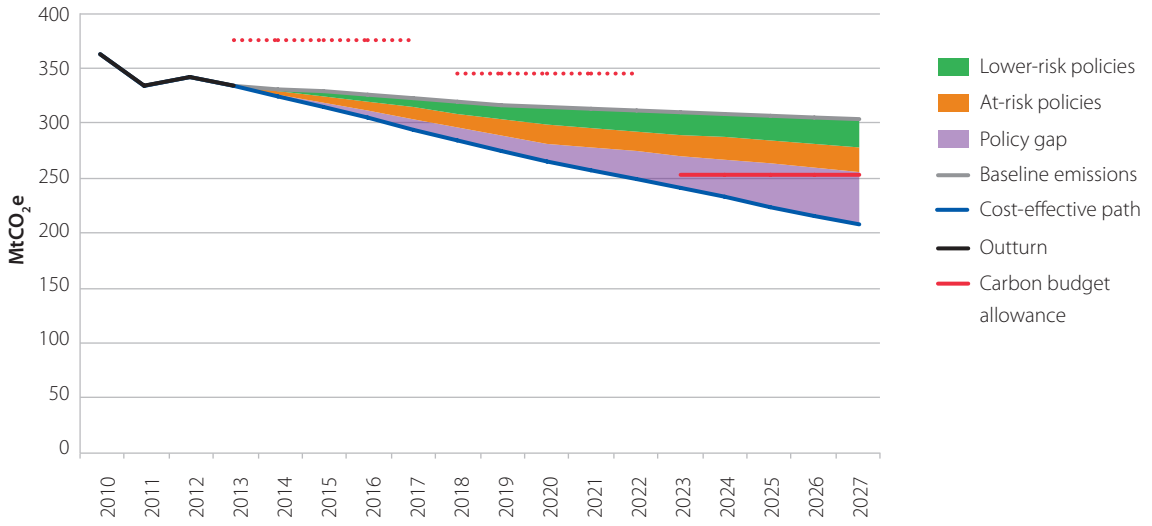
Figure B5. DECC's estimated uncertainty range for non-traded sector emissions



Note: DECC (2014): Updated Emissions Projections 2014. These projections include the assumed impact of Government policies currently in place to reduce emissions, assuming they all deliver in full.

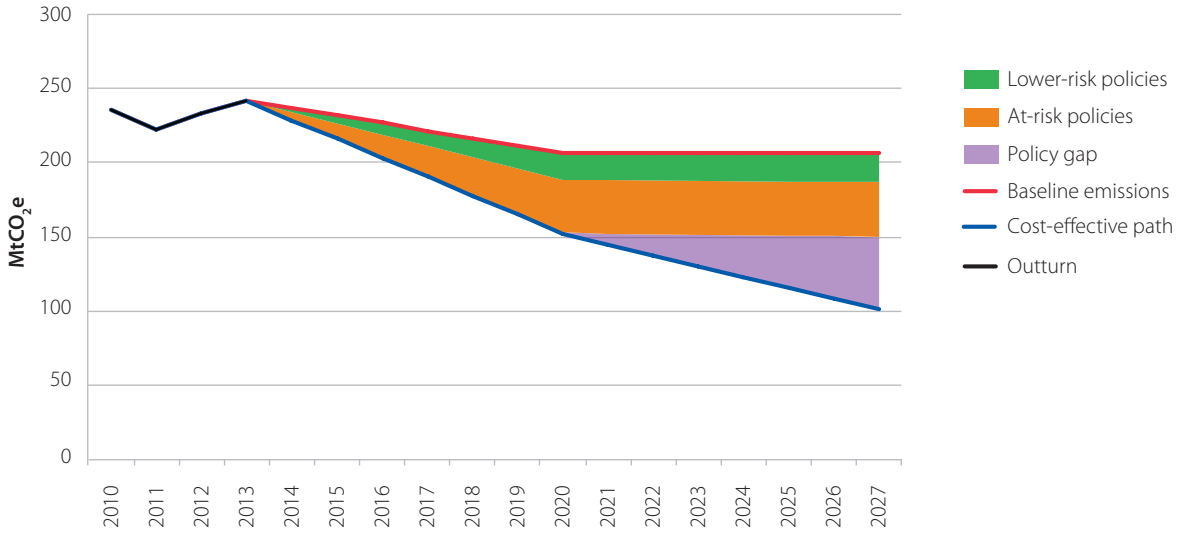
Figures 5 and 6 set out the expected impact of policies against the cost-effective path to the 2050 target and the legislated carbon budgets, for the non-traded and traded sectors. A detailed assessment of policies is set out in Technical Annex 1 – Overview.

Figure 5. Assessment of current and planned policies against future targets (non-traded sector)



Source: DECC (2014): Updated energy and emissions projections: 2014; CCC analysis
Note: Allowed non-traded sector emissions are estimated; dotted line for second and third carbon budgets (2013-22) reflects that these are not consistent with meeting the 2050 target, as set out in Section 1.

Figure 6. Assessment of current and planned policies against future targets (traded sector)



Note: Traded sector portion of carbon budgets not shown as these do not limit actual emissions in the traded sector

We estimate that roughly half of the abatement targeted by existing policies in the non-traded sector is at risk, whilst no policies exist for a significant part of the cost-effective abatement that is available during the fourth carbon budget period:

- **Lower-risk policies** are expected to deliver around 23 $MtCO_2e$ of abatement in 2025. These include policies to improve the fuel efficiency of cars and vans, building regulations to improve the efficiency of new build homes, and smart metering in the residential and commercial buildings sectors.
- **At-risk policies** are responsible for delivering an additional 22 $MtCO_2e$. These have design and delivery problems or are currently unfunded. At-risk policies include the Agricultural Action Plan, policies to improve the fuel efficiency of HGVs, the Renewable Heat Incentive post-2016, Zero Carbon Homes and the Renewable Transport Fuels Obligation. It is critical that these policies are strengthened to ensure that they deliver at their full potential.
- **Policy gap.** A further 28 $MtCO_2e$ of abatement is available in 2025 through opportunities to reduce emissions at low cost or actions required to prepare for meeting the 2050 target that are not targeted by current policies, but which ought to be pursued as part of good budget management. These largely reflect that policies have not yet been developed for the 2020s.
- This compares to a total of 54 $MtCO_2e$ of abatement required across the non-traded sector in 2025 to meet the fourth carbon budget, or 92 $MtCO_2e$ to meet the cost-effective path.

In the traded sector, lower-risk policies (e.g. the Renewables Obligation and Contracts for Difference that have already been signed) are expected to deliver around 94 $MtCO_2e$ of abatement across the fourth carbon budget period. Policies we have assessed as at risk (e.g. the contract offered to new nuclear but not yet funded, fuel switching away from coal) are targeting an additional 184 $MtCO_2e$. Current policy is not sufficient to meet the cost-effective path to the 2050 target; in this case the total policy gap is 175 $MtCO_2e$, reflecting that the Government has not yet stated its carbon objective for the power sector in the 2020s or committed funding to achieve this.

The need for policy continuity

In summary, while carbon budgets have been legislated to 2027, in other respects the policy framework for the 2020s is far from clear. Many current policies, or associated funding commitments, are set to expire in the next few years (Table 3)[6].

In order to close the policy gap and meet the cost-effective path the Government needs to extend policies into the 2020s, to ensure that there is sufficient lead time for investors and consumers to respond. The following new policies are required:

- **Power:** policies to deliver deployment beyond 2020, moving the power sector from 200 gCO_2/kWh in 2020 to 50-100 g/kWh by 2030.
- **Buildings:** policies to drive low-carbon heat beyond 2020 and residential energy efficiency beyond 2017 (e.g. insulation measures for cavity walls and solid walls).
- **Industry:** policies to drive low-carbon heat beyond 2020; to deliver further options in energy-intensive sectors; and an approach to deploying initial industrial CCS projects, compatible with widespread deployment from the second half of the 2020s.
- **Transport:** policy to address the upfront cost barrier of electric vehicles post-2020; to drive passenger demand reduction beyond 2015-2016; and to reduce emissions from HGVs through demand side measures beyond 2015.
- **Agriculture:** Policy to address emissions beyond 2022.

Many low-carbon investments have long lead times and payback periods. Efficient investment planning requires that the policy framework within which decisions will be made is known well in advance.

To enable appropriate investments, and in order to allow consumers and business to prepare, it is necessary that the Government should extend existing policy approaches and funding commitments as soon as possible.

A number of changes are also needed to deal with the risks to delivery for existing policies. We set out our recommendations for strengthening existing policies and extending policies into the 2020s in section 6.

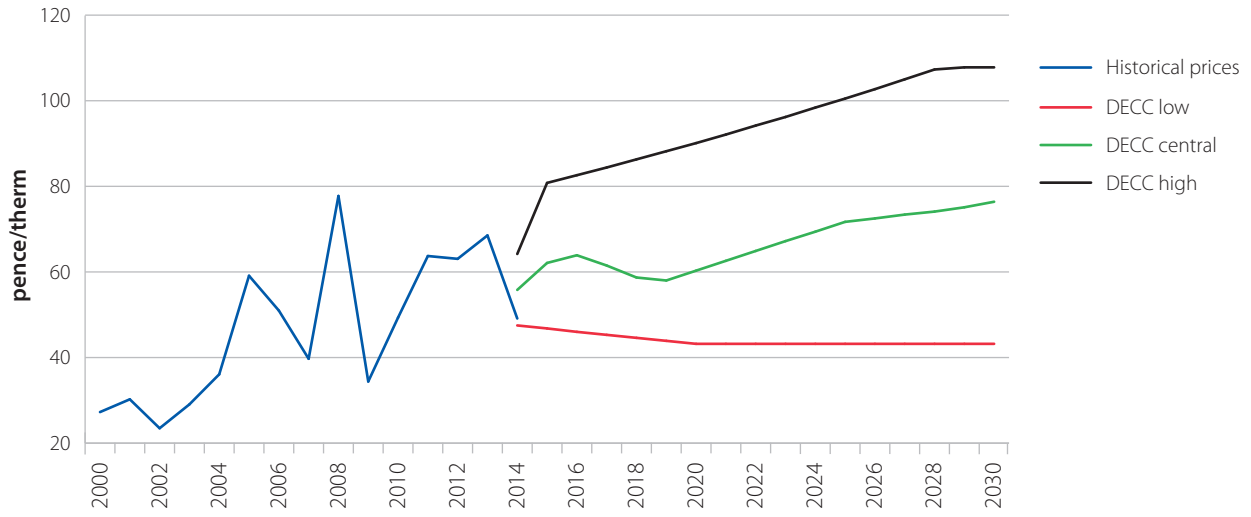
6 Further details are set out in Technical Annex 1 – Overview and Chapters 1-7.

Table 3. Policy visibility in 2020s	
Programme	**End date**
Power	
Levy Control Framework	April 2021
Buildings	
Energy Company Obligation	April 2017
Green Deal	No certainty over funding beyond 2015
Funding for Renewable Heat Incentive	April 2016
Industry	
Climate Change Agreements	2020
Compensation for or exemption from climate change policies	2019/2020
Transport	
EU CO_2 targets for cars and vans	2020
Electric vehicle support package to tackle financial and non-financial barriers	2020
Local Sustainable Transport Fund	2015/16
Agriculture	
Greenhouse Gas Action Plan (England only)	2022
Source: CCC assessment	

Low fossil fuel prices

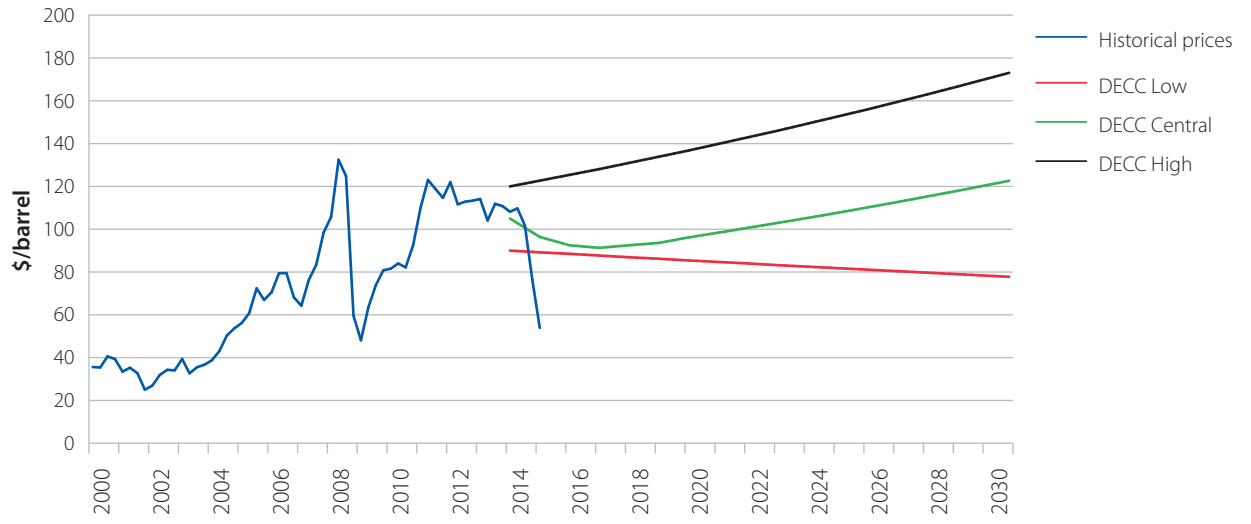
Gas and oil prices fell significantly in 2014, and low prices have persisted into 2015, with average Q1 prices of 46 pence per therm for gas and $54 per barrel for oil.[7] Gas prices are now consistent with DECC's low gas price projection, while oil prices are significantly below DECC's low oil price projection (Figures 7 and 8). The low prices have raised questions regarding the potential impact of fuel prices in meeting carbon budgets.

Figure 7. Historical UK gas prices and DECC projections



Source: ICE UK natural gas contract; DECC (2014) Fossil Fuel Price Projections.
Note: Historical prices have been adjusted to 2014 prices using the GDP deflator.

Figure 8. Historical oil prices and DECC projections



Source: Europe Brent Spot Price (BP Statistical Review, 2014); DECC (2014) Fossil Fuel Price Projections.
Note: Historical prices have been adjusted to 2014 prices using the GDP deflator.

7 These are the units used by DECC in its standard reporting; 1 therm = 29.3 kWh, 1 barrel of oil = 1,700 kWh.

Lower fuel prices confer a significant economic benefit, but will tend to make carbon budgets more difficult and relatively more costly to achieve:

- Consumers may increase their fuel use in response to lower prices. That would lead to higher emissions and require more effort to meet the carbon budgets.
- The economic case for changes that reduce emissions may be weakened (e.g. insulation to save heating costs may look less attractive if heating bills fall).
- The cost of low-carbon technologies relative to high-carbon alternatives will generally be higher when fossil fuel prices are low.[8]

However, there are other reasons to suggest that the overall impacts may be limited:

- Fuel prices are highly variable, reflecting trends in demand, supply, and political circumstances, and may return to higher levels. Since the relative cost of low-carbon investments are determined across their lifetimes, future prices are also relevant.
- It is not clear how households/businesses respond to changes in fuel prices, which are only one factor in decision making on energy use. For example, most estimates suggest consumers' travel demand is relatively unresponsive to price.[9]
- The tax regime will tend to mute the impact of fossil fuel prices on consumer prices. For example, on average, oil costs make up roughly 50% of petrol and diesel pump prices faced by consumers.
- As well as fossil fuel costs falling, some low-carbon technologies appear to be delivering at lower costs than expected. For example, in auctions earlier this year wind power was contracted at a cost 16-18% lower than expected (Chapter 1 – Power).

We have assessed the impact of low fuel prices on the overall costs of carbon budgets and on the required funding for low-carbon power generation:

- **UK costs.** We assessed the overall impact of different fuel price scenarios on the costs of meeting carbon budgets in our advice on the fourth carbon budget. Our assessment was that the overall cost of meeting the budget would be under 1% of GDP. This covered both central fuel prices (an estimated cost of 0.6% of GDP) and 'low' fuel prices (which increased cost by around 0.1% of GDP for the measures required to meet the budget).
- **Global costs.** While a "business as usual" path of increasing energy consumption is usually associated with rising oil and gas prices, worldwide action to reduce GHG emissions would be expected to significantly depress prices. While there is no evidence that the current decline in oil and gas prices is due to such action, it is critical that governments recognise that future reductions in prices will be the natural outcome of action to reduce emissions, and do not undermine the economic case for doing so. If governments were to reassess the economic case for reducing emissions as oil and gas prices decrease, such a shift would be self-defeating and impossible to maintain, putting the climate objective at significant risk.

8 There are exceptions to this, for example the cost of carbon capture and storage is reduced by lower fuel prices, since much of the cost is in the extra input required to fuel the capture process.

9 The Department for Transport estimates that a 1% decrease in fuel costs would increase the volume of car traffic by only around 0.3%, decreasing to around 0.17% by 2035 as demand for road transport moves further towards saturation. See *DfT (2013): Road Transport Forecasts 2013 – Results from the Department for Transport's National Transport Model.*

- **UK policy.** Lower gas prices could also raise a question as to how much low-carbon generation can be supported under the Levy Control Framework, which caps the total support paid to low-carbon generators. However, our analysis suggests that even under low gas and electricity prices, there would be enough funding to meet our indicator trajectories, provided the budget is well managed (Chapter 1 – Power).

The carbon budgets have been designed to be robust across a range of uncertainties, including for fossil fuel prices. It is not clear that current low fuel prices will persist, but even if they do, the carbon budgets remain achievable at costs accepted when they were legislated, and the conclusions in relation to policy set out in this report still apply. We will continue to monitor fuel prices and incorporate the full range of projections in our advice on the fifth carbon budget, due at the end of this year.

5. Public sector expenditure on meeting carbon budgets

In giving advice on carbon budgets we are required under the Climate Change Act to take account of fiscal circumstances, and the impact of carbon budgets on taxation, public spending and public borrowing.

The Spending Review 2010, published by HM Treasury, set out departmental spending plans for the four years until 2014-15. Government will now need to consider expenditure on meeting carbon budgets alongside other priorities for the new spending review period.

This section sets out estimates of public sector expenditure on meeting carbon budgets over the financial years 2013/14 and 2014/15, specifically:

- Public sector expenditure on research, development and demonstration (Table 4)
- Current government support for roll-out, which is necessary to reduce emissions in the near-term, and secure the innovation required in the medium- to long-term (Table 5)
- A detailed breakdown of these estimates is set out in Technical Annex 1 – Overview.

Table 4. Public sector expenditure on research and development (£m)

Sector	**2013/14**
Power	£195m
Buildings	£20m
Industry	£6m
Transport	£82m
Agriculture	£4m
Waste and other non-CO_2	£1m
Cross-cutting	£53m
Total	**£360m**

Source: See Technical Annex: Overview

Table 5. Current government support for roll-out (£m)		
Sector	**2013/14**	**2014/15**
Levy-funded spending policies		
Power	£3,700m	£4,400m
Buildings	£930m	£500m
Sub-total	**£4,600m**	**£4,900m**
General taxation funded policies		
Power	-	£3m
Buildings	£100m	£420m
Transport	£230m	£280m
Waste and other non-CO_2	£770m	£800m
Cross-cutting	£50m	£50m
Sub-total	**£1,200m**	**£1,500m**
Green Investment Bank	**[£660m]**	**[£790m]**
Total	**£5,800m**	**£6,400m**

Source: See Technical Annex: Overview
Note: The UK Government is the sole shareholder in the GIB and has committed an initial £3.8 billion of public funds. However, the GIB expects the invested funds to generate a positive return over the lifespan of projects. Also, GIB expenditure on power projects is included in our estimate of levy-funded spending on power. We therefore exclude GIB spending from our total.

Overall, we estimate that:

- Public sector expenditure on research and development related to climate change mitigation measures was around £360 million in 2013/14 – around 0.02% of GDP and 0.05% of total Government expenditure (good data are not available for 2014/15).
- Current public support for the roll-out of particular technologies and associated innovation related to climate change mitigation measures was around £5.8 billion in 2013/14, and around £6.4 billion in 2015/16, around 0.4% of GDP in each year:
  - Support funded through energy bills was around £4.6 billion in 2013/14, and around £4.9 billion in 2014/15 – around 0.3% of GDP in each year.
  - Support funded through general taxation was around £1.2 billion in 2013/14, and around £1.5 billion in 2014/15 – around 0.1% of GDP and 0.2% of Government expenditure in each year.

This level of expenditure is consistent with what is required to meet carbon budgets in the near-term. In order to meet the fourth carbon budget and achieve the cost-effective path to the 2050 target, spending will need to increase. The increase helps to deliver the direct benefits of a reduction in emissions, as well as indirect benefits in areas such as improved air quality. For example, Chapter 1 sets out our recommendation for the level of the Levy Control Framework to 2025.

6. Recommendations

Given the overall picture of progress set out above, we identify priorities for Government leadership in the transition to a low-carbon economy. These cover the three key issues in climate policy: investment to support growth in low-carbon sectors, developing future options and enabling low-carbon choices:

- **Low-carbon investment:** Many low-carbon policies and funding streams have no certainty beyond the next few years. That prevents efficient investment in low-carbon technologies and their supply chains, which often have long lead-times and payback periods and in many cases are not yet economic without Government intervention. To enable those investments, Government will need to extend existing policy approaches and funding commitments into the 2020s. Specific examples covered in this report include funding for low-carbon electricity, the approach to low-carbon heat and energy efficiency in buildings and emissions regulations for vehicles.
- **Developing future options and innovation:** Many of the technologies that could contribute to meeting the 2050 target are still developing in terms of their cost and performance, the ability of suppliers and financiers to deliver them and the willingness of consumers to adopt them. Public support in these areas should be targeted to areas that the market will not or cannot provide, including some elements of R&D and infrastructure spending. To support private innovation, Government must ensure that there is a clear future market for low-carbon products through credible policy commitments that "price in" a rising cost of carbon. There is scope for substantial benefits for UK industry which is well placed to compete in many areas of green innovation. Specific examples include offshore wind, carbon capture and storage (CCS), low-carbon heat, electric vehicles, and earlier-stage technologies that still need research, development and demonstration.
- **Low-carbon choices:** How lifestyles – which have changed considerably over the past 35 years – continue to change and the decisions people make in response to new products will increasingly determine whether we continue to reduce emissions. Government has a role to address barriers to change, through effective policy design and evaluation to build the evidence base for "what works". Specific examples include setting incentives and information provision to increase take-up, for new products such electric and low-emission vehicles, home insulation measures, and heat pumps, and behavioural choices such as travel behaviour and food consumption.

This assessment leads to four main recommendations on mitigation for this Parliament:

1. Electricity: Ensure the power sector can invest with a 10-year lead time. As soon as possible, set the Government's carbon objective for the power sector in the 2020s and extend funding under the Levy Control Framework to match project timelines (e.g. to 2025 with rolling annual updates).

2. Buildings: Develop plans and policies that deliver low-carbon heat and energy efficiency.

a. Develop an action plan to address the significant shortfall in low-carbon heat, ensuring a better integration with energy efficiency and fuel poverty. Commit to the Renewable Heat Incentive to 2020, or until a suitable replacement is found.

b. Set out the future of the Energy Company Obligation beyond 2017, ensuring it delivers energy efficiency while also meeting fuel poverty targets.

c. Implement the zero carbon homes standard without further weakening, ensuring investment in low-carbon heat.

3. Transport: Maintain support for the up-front costs of electric vehicles, while they remain more expensive than conventional alternatives, and push for stretching 2030 EU CO_2 targets for new cars and vans.

4. Infrastructure: Make decisions that help reduce emissions. A range of infrastructure decisions to be made this Parliament could have significant impacts. Foremost amongst these is the need for carbon capture and storage (CCS). Others include requirements for infrastructure support for heat networks and electric vehicles. Decisions taken now need to avoid 'lock-in' to high carbon pathways.

Our full set of recommendations is set out in Tables 6 and 7. We have designed them to be specific and measurable. We will monitor them closely, including the Government's statutory response to this report (due by 15 October 2015). In our 2016 Progress Report, we will review progress against each recommendation and broader progress in closing the policy shortfall to the fourth carbon budget.

Table 6. Summary of recommendations – central Government

#	Recommendation	Owner	Deadline
Power			
1	Ensure power sector can plan on a 10-year cycle: as soon as possible, set the Government's carbon objective for the power sector in the 2020s and extend funding under the Levy Control Framework to match project timelines (e.g. to 2025 with rolling annual updates)	DECC with HMT	Ahead of 2016 Progress Report
2	Continue with auctions under Electricity Market Reform, maintaining momentum by adhering to the proposed timings and working with industry to learn lessons from the first auctions	DECC	Next low-carbon auction by end-2015
3	Set out approach to commercialise CCS through the planned clusters: including a strategic approach to transport and storage infrastructure, completing the two proposed projects and contracting for at least two further 'capture' projects this Parliament	DECC	Ahead of 2017 Progress Report
4	Support offshore wind until subsidies can be removed in the 2020s: set out intention to contract 1-2 GW per year and wider innovation support provided costs fall with view to removing subsidies in the 2020s	DECC	Ahead of 2016 Progress Report
5	Be transparent over the cost implications of technology choices: including the cost of alternatives if low-cost options are constrained, system integration costs and the full carbon cost of fossil-fired generation	DECC	Ongoing, CCC to review in 2016 Progress Report
Buildings			
6	Develop an action plan to address the significant shortfall in low-carbon heat: short term this should commit to extend the Renewable Heat Incentive to 2020, or until a suitable replacement is found; long term it should link support for low-carbon heat with energy efficiency, support for heat networks and wider decisions about infrastructure for heat.	DECC	Ahead of 2016 Progress Report
7	Energy efficiency: set out the future of the Energy Company Obligation beyond 2017, ensuring it delivers energy efficiency while also meeting fuel poverty targets	DECC and DAs	Ahead of 2017 Progress Report
8	Implement commitments on Zero Carbon Homes for 2016: implement zero carbon standards without further weakening and ensure incentives are in place to encourage low-carbon heat sources.	DCLG	Ahead of 2016 Progress Report

Table 6. Summary of recommendations – central Government			
#	**Recommendation**	**Owner**	**Deadline**
9	Simplify policies for commercial energy efficiency: simplify and rationalise wide range of existing policies for commercial energy efficiency to strengthen incentives	DECC	Ahead of 2016 Progress Report
Industry			
10	Develop joint work with industry into action plans: publish plans setting out specific actions and clear milestones to move abatement efforts forward along the paths developed with industry in the "Roadmaps"	DECC	Ahead of 2016 Progress Report
11	Complete roll-out of "Roadmaps" to other industrial sectors: taking account of lessons learned, roll-out roadmaps to industrial sectors not covered in first wave	DECC	Ahead of 2017 Progress Report
12	Join-up industrial CCS with power sector projects: set an approach to commercialisation of industrial CCS alongside the approach adopted for the power sector, including ensuring industry can link into planned infrastructure.	BIS with DECC	Ahead of 2017 Progress Report
13	Evaluate effectiveness of compensation to at-risk industries for low-carbon policies: independent evaluation of industries that are at-risk and effectiveness of the compensation framework	BIS	Ahead of 2017 Progress Report
Transport			
14	Provide motor industry with greater certainty to 2030: push for clear, stretching 2030 EU targets for new cars and vans that take account of the need for ultra-low emission vehicles and use realistic testing procedures.	DfT	Ahead of 2018 Progress Report
15	Tackle barriers to EV uptake: maintain support for upfront costs while they remain more expensive than conventional vehicles; provide a national network of charge points and roll-out local incentives such as access to parking.	DfT with Local Authorities	Ahead of 2017 Progress Report
16	Ensure the tax regime keeps pace with technological change: align existing fiscal levers (e.g. Vehicle Excise Duty) to ongoing improvements in new vehicle CO_2, including a greater differentiation between rates for high and low emission vehicles.	DfT with HMT	Ahead of 2017 Progress Report
17	Extend successful emissions-reduction schemes for freight operations: larger freight operators have pioneered schemes to reduce fuel costs and emissions that should be rolled out across the industry, including small operators.	DfT with BIS and industry	Ahead of 2016 Progress Report
18	Ensure lessons from schemes to reduce travel demand are applied: sustainable travel schemes should be properly evaluated and extended if they provide cost-effective emissions reductions.	DfT	Ahead of 2017 Progress Report
19	Publish an effective policy framework for aviation emissions: plan for UK 2050 emissions at 2005 levels (implying around a 60% increase in demand) and push for strong international and EU policies	DfT	Ahead of 2016 Progress Report

Table 6. Summary of recommendations – central Government			
#	**Recommendation**	**Owner**	**Deadline**
Agriculture and Land-Use			
20	Deliver the Smart inventory to current timeline: the Smart inventory is essential for effective measurement of emissions from agriculture and should be delivered in 2016, without further delays.	Defra	Ahead of 2016 Progress Report
21	Strengthen the current voluntary approach to reduce agricultural emissions: farming industry to develop robust indicators to properly evaluate the GHG Action Plan. Government to consider stronger measures as part of its 2016 review if these cannot assess the effectiveness of the existing scheme.	Defra	Ahead of 2016 Progress Report
22	Co-ordinate effort to reduce emissions from agriculture and forestry: ensure measures being implemented across the four nations are feasible, cost-effective and consistent with UK carbon budgets.	DECC with Devolved Administrations	Ahead of 2016 Progress Report
Waste and Non-CO_2			
23	Scotland, England, Wales and Northern Ireland to set out approaches to increase methane capture rates: as a devolved matter, each nation should set out specific actions and clear milestones	Defra and DAs	Ahead of 2017 Progress Report
24	Reduce biodegradable waste to landfill: each nation should set out specific actions and clear milestones – including England – to further reduce biodegradable waste to landfill.	Defra and DAs	Ahead of 2017 Progress Report
25	Find opportunities to exceed regulatory minimums on F-gas abatement: including clearly assessing and addressing barriers where evidence suggests cost-effective abatement above minimum standards	Defra	Ahead of 2016 Progress Report

Table 7. Summary of recommendations – devolved administrations			
#	**Recommendation**	**Owner**	**Deadline**
Scotland			
26	Consider further action to facilitate heat networks: for example, obliging local authorities to connect to existing local networks and requiring consideration of network heat in new developments.	Scottish Government	Ahead of 2017 Scottish Progress Report
27	Evaluate current energy efficiency schemes: focus particularly on area-based schemes to better understand the most effective way to implement supplier obligations once they become devolved	Scottish Government	Ahead of 2017 Scottish Progress Report
28	Improve evidence on agricultural abatement: to include what has worked under "Farming for a Better Climate" and whether its measures have been taken-up beyond the focus farms	Scottish Government	Ahead of 2016 Scottish Progress Report
Wales			
29	Develop a heat strategy: build on UK evidence and approach to develop clear heat strategy for Wales including a renewable heat target	Welsh Government	2017
30	Prepare for higher ambition required of industry: plan ways to reduce industry emissions, including consideration of voluntary partnership agreements with industry and encouraging innovative solutions	Welsh Government	2018
31	Address non-financial barriers for electric vehicles: including further measures which could be implemented such as parking, use of priority lanes, raising awareness and public procurement	Welsh Government	2016
32	Meet tree planting targets: consider whether further measures are needed to ensure tree planting targets are met, and develop approach jointly with stakeholders and other DAs	Welsh Government	2016
Northern Ireland			
33	Consider further action to facilitate heat networks: for example, obliging local authorities to connect to existing local networks and requiring consideration of network heat in new developments	N.I. Executive	2017
34	Improve monitoring of agricultural emissions: following Defra's delivery of the Smart inventory, put in place local monitoring and process for acting on its findings	N.I. Executive	2017
35	Address non-financial barriers for electric vehicles: including further measures which could be implemented such as parking, use of priority lanes, raising awareness and public procurement	N.I. Executive	2016

Chapter 1: Progress decarbonising the power sector

1. Overview of emissions
2. Performance against the Committee's progress indicators
3. Supporting infrastructure for low-carbon generation
4. Forward look and policy gap
5. Recommendations

Key messages and recommendations

In this chapter we consider emissions from the electricity system and progress investing in new low-carbon power generation and associated infrastructure in 2014. We outline priorities for taking forward the policy framework to ensure we build on this progress and meet future carbon budgets. The chapter includes new analysis on cost reduction potential for emerging technologies (offshore wind, carbon capture and storage) and the Government's role in supporting these.

Deep decarbonisation of the power sector by 2030 is central to emissions reduction across the economy and meeting the UK's legislated commitments at lowest cost, whilst ensuring that security of supply is maintained. This reflects that:

- Power is a major source of emissions (around one quarter of total UK emissions).
- Low-carbon technologies are available for power generation which are or are likely to become cost effective (i.e. cheaper than fossil fuel generation facing a rising carbon price).
- In the period to 2030 there will be significant capital stock turnover in the UK's power system as assets retire, creating an opportunity to replace this with low-carbon capacity.
- Low-carbon power can be used as a route to decarbonisation in other sectors (buildings, transport and industry).

Through the Energy Act 2013, Parliament has recognised the need for rapid decarbonisation of the power sector as a priority in moving to a low-carbon economy. The Act provides for long-term contracts that encourage low-carbon investment. This policy framework lays the foundations for delivering decarbonisation of the power sector, whilst maintaining security of supply and affordability for UK consumers.

Our key messages for the power sector are:

- **There was strong progress in 2014.** Power sector emissions fell by 18% between 2013 and 2014, the largest reduction in emissions in the power sector since reporting began in 1990. This resulted from a fall in coal capacity on the system, strong renewables deployment and output, decreased consumption and increased imports of electricity. In 2014, the emissions intensity of UK electricity fell 12% to 442 gCO_2/kWh, and the achievable emissions intensity (which represents underlying structural progress in decarbonising power generation) fell 11% to 263 gCO_2/kWh.
- **Progress is set to continue to 2020.** Deployment of renewables continues to make good progress, particularly for onshore wind, offshore wind and solar power. There is sufficient volume in project pipelines to maintain this momentum – projects already under construction or contracted under Electricity Market Reform are sufficient to increase the renewables share from 20% in 2014 to over 30% in 2020.
- **There are significant risks beyond 2020.** There remains a high degree of uncertainty about the contracts that will be available to investors beyond 2020. This risks undermining further progress as decisions are being made now over investments beyond 2020 and the supply chain to support them. These risks are increased by delays in previous years to carbon capture and storage and further delays this year to the new nuclear programme.

Key messages and recommendations

- **Evidence on cost reduction is promising.** Contracts awarded under the first auction for low-carbon power were significantly cheaper than budgeted for (i.e. around 17-18% lower than reserve prices for wind). The lower contract prices for offshore wind are consistent with the latest evidence from industry on cost reductions. This evidence, alongside new analysis we present in this report, confirms that in the 2020s multiple low-carbon technologies could become cost-competitive with unabated coal or gas generation facing the full costs of their emissions. Cost reductions in low-carbon technologies will only be achieved if there is sufficient confidence in their future markets to allow private sector innovation to proceed.
- **The Government should provide more confidence on power sector decarbonisation beyond 2020.** An unambiguous commitment to decarbonising the power sector is needed to provide investors with confidence that there will be a market for low-carbon technologies in the 2020s (e.g. to support supply-chain investment, development of new projects and create the conditions for a competitive pipeline to drive cost reductions).

Our recommendations are:

- **Ensure the power sector can invest with a 10-year lead time:** As soon as possible, set the Government's carbon objective for the power sector in the 2020s and extend funding under the Levy Control Framework to match project timelines (e.g. to 2025 with rolling annual updates).
- **Continue with auctions under Electricity Market Reform,** maintaining momentum by adhering to the proposed timings and working with industry to learn lessons from the first auctions.
- **Set out an approach to commercialise CCS through the planned clusters:** including a strategic approach to transport and storage infrastructure, completing the two proposed projects and contracting for at least two further 'capture' projects this Parliament.
- **Support offshore wind until subsidies can be removed in the 2020s:** set out intention to contract 1-2 GW per year and wider innovation support provided costs fall with view to removing subsidies in the 2020s.
- **Be transparent over the full cost of technology choices:** including the cost of alternatives if low-cost options are constrained, system integration costs and the full carbon cost of fossil-fired generation.

1. Overview of emissions

Emissions in the power sector were 121 $MtCO_2$ in 2014, 26 $MtCO_2$ (18%) lower than in 2013, the largest single annual reduction in the power sector since reporting began in 1990. Between 2009 and 2014 power sector emissions declined on average by 4% per annum (Figure 1.1).

The large reduction was due to reduced UK generation as demand fell and imports rose, and a large improvement in carbon intensity as generation shifted toward a lower carbon mix:

- There was a 7% fall in UK electricity generation in 2014, reflecting falling demand and increased imports:
  - Electricity demand fell by 13 TWh (4%) to 304 TWh. Relatively high temperatures drove a quarter of this fall and there is evidence to suggest improved energy efficiency (and/or changes in consumer behaviour) and changes in industrial energy use accounted for most of the remainder, with a smaller contribution from increased embedded generation (i.e. rooftop solar).
  - Net imports increased to 20.5 TWh in 2014 (up 42%) due to higher imports from France, making up 6% of electricity supplied in 2014. Emissions from imported electricity are not counted in the UK's carbon account, but are covered by the EU Emissions Trading System (EU ETS).
- Emissions intensity fell by 12% to 442 gCO_2/kWh as coal use went down and renewables generation increased:
  - Coal generation decreased by 23% to 95 TWh. Some coal plant closed permanently due to EU air quality directives, and some converted to biomass generation, suggesting at least part of this reduction may be permanent. It was supported by relatively low gas prices, which discouraged switching from gas to coal generation.
    - In 2014 1.2 GW of coal capacity closed and an additional 0.65 GW converted to biomass – these units had generated 19 TWh in 2013.
    - For the 20.2 GW of coal capacity that remained on the system, generation fell by 18 TWh as load factors declined from 64% in 2013 to 52% in 2014.
  - Renewable generation increased by 10 TWh to 60 TWh, mainly due to increased capacity, particularly for onshore wind, offshore wind and solar power. Load factors for onshore wind and offshore wind were 25% and 34% respectively, compared to an average of 24% and 28% during the period 2009-2013[1].
  - Although there were two significant nuclear outages in 2014, total nuclear generation over the year was similar to the level in 2013 at 58 TWh (19% of UK generation).

Over half of the emissions reduction in the power sector in 2014 was due to reduced coal burn and increased imports, while increased generation from low-carbon sources only accounted for a 4% reduction in emissions. Towards 2030 almost all generation will need to be provided from low-carbon sources in order to meet future carbon budgets. The rest of this chapter sets out the extent to which this progress is likely to continue or whether additional actions are required to be on track to meeting carbon budgets towards 2030 (Figure 1.2).

1 Adjusting for capacity entering operation during the year, load factors could be as high as 28% and 41% for onshore wind and offshore wind respectively in 2014, compared to an average of 29% and 40% between 2009 and 2013.

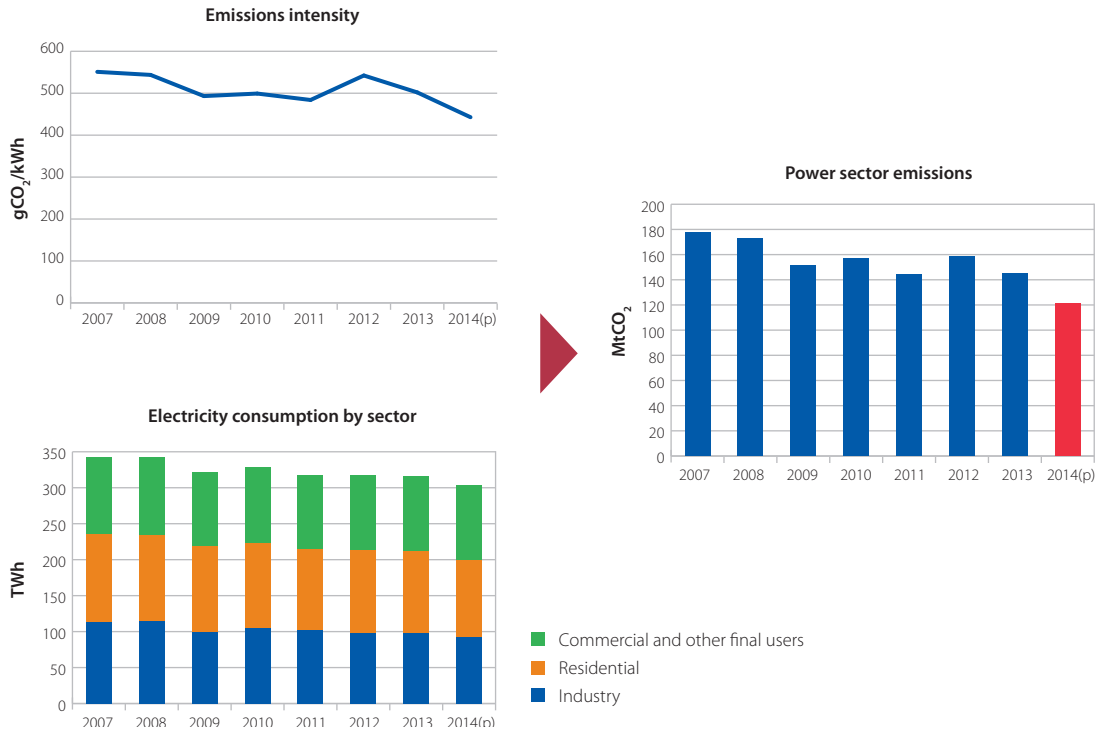
Achievable emissions intensity

In order to identify underlying progress we also track Achievable Emissions Intensity – the emissions intensity of the grid if it were operated to minimise emissions by first dispatching renewables and nuclear, followed by gas and finally coal. This reduced from 297 gCO_2/kWh in 2013 to 263 gCO_2/kWh in 2014 due to increased deployment of wind, biomass and solar capacity, and a reduction in electricity demand. This compares to an achievable emissions intensity of 462 gCO_2/kWh in 2007 (Figure 1.3).

There is sufficient low-carbon capacity to meet almost half of demand in a typical year, and sufficient gas capacity to meet the remainder except for a small number of peak hours during the winter when a small amount of coal capacity would still be needed. If the grid had been dispatched in this way in 2014 then UK emissions would have been 48 $MtCO_2$ (40%) lower.

Actual UK Emissions have been far higher than achievable emissions in recent years. However, we would expect these to converge over time as the low-carbon share increases, as coal comes off the system and as the carbon price faced by generators rises. The UK party leaders' joint climate pledge[2] confirms the direction of travel is to end the use of unabated coal for power generation. However it remains unclear at this stage on what timeline this goal can be achieved, and whether through existing EU air quality directives and/or other economic drivers.

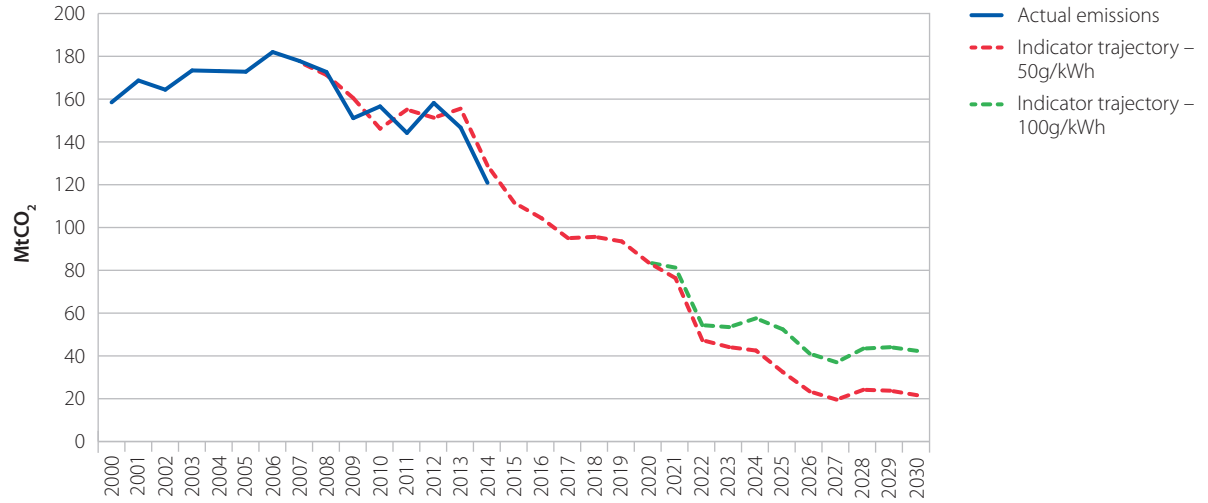
Figure 1.1. Emissions intensity of electricity supply, electricity demand and CO_2 emissions from the power sector (2007-2014)



Source: DECC (2015) *Energy Trends*; DECC (2015) *UK Greenhouse Gas Emissions* 2007-2014 (provisional); CCC calculations.
Note: Emissions intensity is UK based usable generation, i.e. excluding losses. Electricity consumption includes imported power. 2014 data are provisional.

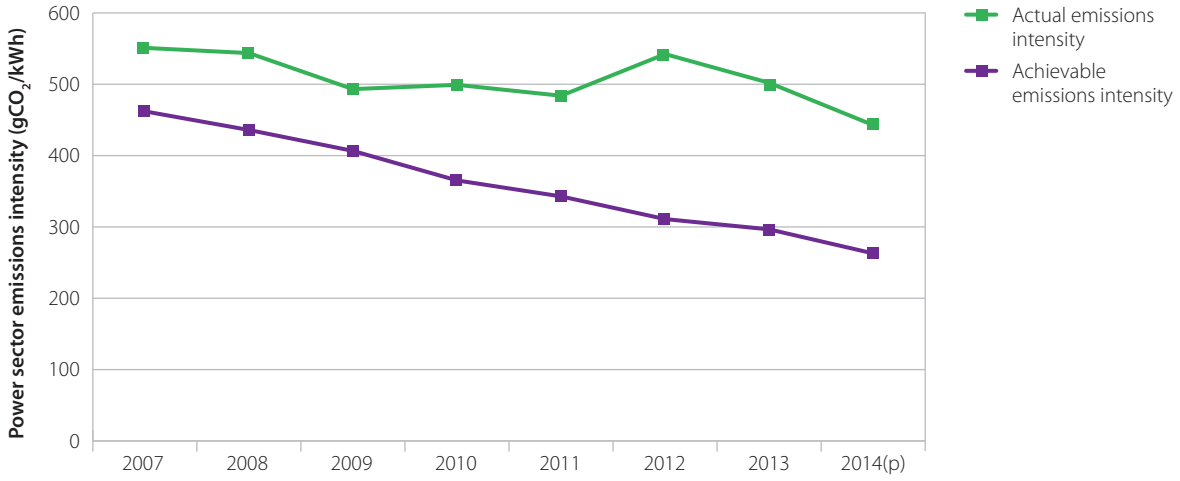
2 Green Alliance (2015) *Leaders Joint Climate Change Agreement*. Available at: www.green-alliance.org.uk

Figure 1.2. Actual power sector emissions compared with our indicator trajectory (2000-2030)



Source: DECC (March 2015) *Energy Trends*; DECC (March 2015) *Provisional 2014 results for UK greenhouse gas emissions and progress towards targets*; CCC calculations.
Note: 2014 data are provisional. See section 2 for an explanation of our indicator trajectory.

Figure 1.3. Achievable emissions intensity (2007-2014)



Source: CCC calculations based on DECC *Energy Trends* (March 2015).
Note: Achievable emissions intensity is the minimum average emissions intensity that could be achieved in a year, given the installed capacity of power sector technologies, electricity demand and the demand profile of that demand. Emissions intensity is UK based useable generation, i.e. excluding losses. In 2015 we revised the Achievable Emissions Intensity methodology to include emissions of 200 gCO_2/kWh for electricity generation from biomass to reflect sustainability concerns, which changes values in all previous years (this is not included in actual emissions intensity).

2. Performance against the Committee's progress indicators

The Committee's approach to tracking progress

We track progress in the power sector against our detailed indicator framework, which we set out in our first Progress Report in 2009 and revised in our 2014 Progress Report. Our power sector indicators cover the overall policy approach, the deployment of low-carbon capacity that it supports (i.e. renewables, nuclear and carbon capture and storage) and broader infrastructure:

- **Policy:** We monitor Government's progress in implementing new market arrangements to incentivise low-carbon investment.
- **Renewables:** We monitor actual deployment of capacity and resulting generation as well as progression through the project development cycle, including planning.
- **Nuclear:** We monitor progress towards building a new generation of plants, including indicators on planning and regulation.
- **CCS:** Our indicators for the first three carbon budget periods focus on progress with the UK's programme of demonstration projects, together with preparation for wider rollout in the 2020s.
- **Infrastructure:** We monitor progress in developing the transmission network (required reinforcement, access to the network, investment in the onshore and offshore grid, interconnection), alongside progress with rolling out smart meters and developing/procuring Demand-Side Response (DSR) capabilities.

Taken together our indicators, if met, would put the UK on the path to a power sector that is largely decarbonised by 2030, based on a portfolio of options and with the potential to support decarbonisation of other sectors such as heat and transport.

Progress reforming the electricity market

The Energy Act 2013 provides for a system of long-term contracts for low-carbon generation, in line with our previous advice. These provide revenue certainty to low-carbon investors, thereby increasing confidence that investment will come forward at a lower cost to the consumer.

The implementing arrangements for the new market rules are now largely complete, culminating in the first auction for low-carbon contracts, which completed in early 2015.

Low-carbon auctions

The first auction received a large number of bids and resulted in prices which suggest success in driving down costs through competition:

- The total value of all bids into the auction was £1.2 billion, bidding for £0.3 billion of contracts.[3] If the remaining projects bid in to future rounds, these should also be competitive for at least the next two years, with a need for new entrants to ensure continuing competition from 2018.
- Onshore wind contracts were signed at £79-82.5/MWh and offshore wind at £114-120/MWh. These were 17% and 18% below the reserve prices for the auction. The results for onshore wind are comparable to the lifetime cost for a new unabated gas plant built around 2020, provided it faces the full cost of its emissions (e.g. as in the Government's carbon values, which rise to £76/tCO_2 by 2030). The results for offshore wind are consistent with the latest published estimated costs by industry[4].

3 DECC (2015). *Contracts for Difference (CFD) Allocation Round One Outcome.* Available at: www.gov.uk
4 Offshore Wind Programme Board (2015) *Cost Reduction Monitoring Framework.* Available at: www.ore.catapult.org.uk

- The lower prices allowed 14% more generation to be contracted from the available funding pot than if contracted at reserve prices.
- There were a small number of solar PV projects that were offered contracts but did not proceed, suggesting some lessons to be learned in bidding behaviour.

To ensure continued success in low-carbon auctions, new projects will need to be developed so that there continues to be more bidders than available contracts. However, there is a risk that development is restricted by the current high level of uncertainty over the direction for the sector beyond 2020. We make a number of recommendations to address this in section 5.

More broadly, as this was the first auction under a new regime, we would expect some learning in implementation. The Government should work with industry to identify this learning and ensure that it is reflected in the next set of auctions.

Capacity Market auctions

The first auctions in the UK's new Capacity Market, which aims to ensure security of supply for the UK electricity system, also proceeded recently. The first auction took place in early 2015 and secured its target capacity:

- 49 GW of capacity was contracted for the period beginning 2018/19, as targeted by DECC[5] from a pool of 62.5 GW of prequalified bidders.
- The auction cleared at a price of £19.40/kW, compared to an auction cap of £75/kW.
- Only a small amount of the contracted capacity is new build capacity (5%). However the high level of liquidity in the auction (e.g. number of bidders) suggests that more capacity would be available if required.
- 2 GW of small-scale generation plant (mostly diesel- or gas-fuelled) was contracted that is not subject to emissions constraints under the EU ETS. If running at low load factors we would expect these generators to have limited emissions impacts. We will continue to monitor the participation of carbon-intensive small-scale generators in the capacity market, and in other markets, and any emission implications they may have.
- Capacity market auctions will continue on an annual basis in order to secure capacity for delivery four years later. Alongside these 'four year ahead' auctions, capacity auctions for delivery one year after the auction will take place, the first of which will be in 2017/18.

We will continue to closely monitor the implementation and development of the new market arrangements.

Deployment of renewable generation

In 2014, around 20% of electricity generated was from renewables (60 TWh), up from 16% in 2013 (50 TWh) and 5% in 2007 (19 TWh). Total installed capacity for renewable generation reached 25 GW. Contracts have been signed for around 6.5 GW of renewable capacity to come online by 2020, indicating that the UK should be on track to meet a goal of at least 30% of electricity generated by renewable energy sources in 2020[6]. Investment in low-carbon generation in the UK is comparable to other European countries (see Box 1.1).

5 DECC (2014) *Update to the target capacity for the Capacity Market Auction*. Available at: www.gov.uk

6 The EU's Renewable Energy Directive requires that 15% of the UK's primary energy demand comes from renewable energy sources in 2020. Estimates suggest that this translates to at least 30% of electricity generated that year by renewables. DECC (2009) *National Renewable Energy Action Plan for the United Kingdom*. Available at: www.gov.uk

In this section we consider progress and delivery risks for the following renewable technologies – onshore wind, offshore wind, biomass, solar. Additional detail on each of these technologies, and on wave and tidal technologies is provided in the technical annex.

Box 1.1. International/European investment in renewable generation

Global clean energy investment was $310 billion in 2014, a 16% increase on 2013, and included investment in hydropower, solar, biomass, biofuels, wind power, and wave and tidal power.

- The Asia Pacific region accounted for 50% of this investment (of which China was just over half), with the EMEA (Europe, Middle East and Africa) and the Americas each accounting for 25%.
- The UK invested $15.2 billion (£10 billion) in clean energy, a similar level to Germany and twice that of France, and represented 5.1% of total global investment. In our 2013 *Fourth Carbon Budget Review* we suggested that power sector investment in the UK should average around £10-15 billion per annum to 2020 in order to decarbonise the power sector.

In capacity terms, the UK installed 2.5 GW of solar, 0.8 GW of onshore wind and 0.8 GW of offshore wind in 2014, bringing total renewable energy capacity to 24.2 GW. Other European countries are also active in these markets, whilst China is rapidly developing its offshore wind market.

- **Onshore Wind:** France and Germany added 1 GW and 5 GW of onshore wind capacity respectively.
- **Solar PV:** With 2.5 GW added in 2014, the UK was Europe's largest market for solar PV. Germany installed 1.9 GW (bringing its total installed capacity to 38.5 GW) and France installed 0.9 GW (bringing its total installed capacity to 5.7 GW) as part of a European market of 7 GW.
- **Offshore Wind:** Germany added 0.5 GW of offshore wind last year and announced plans to install 6.5 GW of offshore wind by 2020; it is expected to install 2 GW in 2015. Additionally China, which has 0.7 GW of operational offshore wind, is expected to add 0.8 GW of capacity in 2015 as part of a target to add 30 GW of offshore wind by 2020. The expected global offshore wind market in 2015 is 3.9 GW per annum, of which the UK will account for about 25%.

Source: Enerdata (2015) *Wind Regains Momentum in 2014 and Industry Outlook Improves;* Available at: www.energy.globaldata.com; BNEF (2015) *Global Trends in Clean Energy Investment.* Available at: www.bnef.com; IEA (2015) *Photovoltaic Power Systems Programme Statistic Reports.* Available at: www.iea-pvps.org.

The combination of capacity that has already been installed, contracted or is in construction suggests that our indicators for renewables in 2020, specifically onshore and offshore wind, can be met with only a small addition from projects that have already been consented (Table 1.1, Figures 1.4-1.5). To the extent that more capacity is needed, this could come from projects in the planning pipeline (see Technical Annex).

Table 1.1. Overview of renewable deployment in 2014

Technology	% of UK Generation in 2014	Average Load Factor (%)[1]	Installed Capacity (2014)	Of which, capacity added in 2014	Further capacity in Pipeline[2]	CCC Indicator capacity in 2020	Current[3] cost estimates (£/MWh)
Onshore wind	6%	26%	8.3 GW	0.8 GW	2 GW	13 GW	£80/MWh
Offshore wind	4%	37%	4.5 GW	0.8 GW	5.4 GW	11 GW	£115/MWh
Biomass	7%	83%	3.4 GW	0.4 GW	2.1 GW	-	£100/MWh
Solar	1%	10%	5.2 GW	2.4 GW	0.8 GW	-	£80/MWh
Tidal Stream	<1 %	31%	<0.1 GW	-	-	-	*£100-200/MWh*
Wave	<1 %	31%	<0.1 GW	-	-	-	*£200-300/MWh*
Tidal lagoons	0%	-	0 GW	0	-	-	*£115/MWh*

[1] The Average Load Factor is defined as the total generation of a technology during the year as a proportion of the generation that would be provided if capacity was generating 100% of the time. We estimate average load factors based on end year capacity, which may under estimate true technology load factors, if capacity is added during the year. Load factors for onshore and offshore wind are for CCC indicators, load factors for other technologies are from DECC (2013) *National Grid EMR Analytical Report*. Available at: www.gov.uk.

[2] Awarded a CfD, or under construction. There are also many projects at an earlier stage of development, including 0.3 GW of tidal lagoons in discussion with the Government over a possible contract.

[3] Generating in 2016-8 for wind, biomass, solar; 2020 for tidal stream & wave; early 2020's for tidal lagoons. Italics are cost estimates, non-italics are auction results.

In the specific case of onshore wind there is a large pool of projects (5.2 GW with planning permission and 7.3 GW seeking approval) that could add to the 10.5 GW already constructed, under construction or contracted. Alongside large-scale solar PV, onshore wind appears to be one of the lowest cost low-carbon options available for electricity production.

The Government has announced its intention to close the Renewables Obligation (RO) for new onshore wind projects from April 2016. Given the relatively short lead time, the Government must ensure this is not perceived as a retrospective change by investors. Plans to apply a grace period for projects already underway could achieve this, provided it sufficiently covers projects that have already incurred significant expense.

The Government should also clarify its intentions for treatment of onshore wind in the competitive low-carbon auctions. The long-term contracts themselves are not subsidies, and contracts awarded to onshore wind in the first auction were significantly cheaper than projects supported by the RO and close to subsidy free. In section 5 we recommend that subsidy is judged against the full cost of high-carbon alternatives and that the Government is transparent over the cost to consumers if low-cost options like onshore wind are constrained.

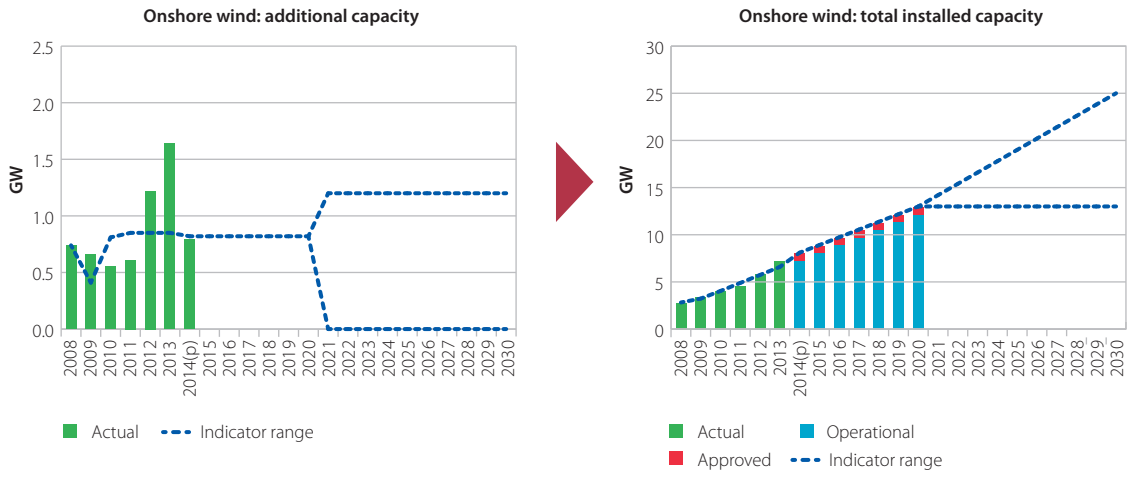
In our 2014 Progress Report we suggested a cautious approach be taken to biomass and solar generation, given questions relating to the sustainability of biomass feedstocks and the seasonality of solar generation (and any associated costs to the electricity system). These remain unresolved, whilst there has been strong progress developing capacity in both areas:

- **Biomass sustainability.**
  - Electricity generated from biomass feedstocks has increased from 9.6 TWh in 2009 to 20.1 TWh in 2014, mostly due to coal stations converting to biomass. Biomass offers a relatively low cost route towards meeting the EU Renewable Energy Target for 2020 and is likely to increase further over the next five years. For biomass to offer genuine emissions savings, the feedstock must come from sustainable sources.
  - In our 2014 Progress Report to Parliament we recommended that the Government should add to the UK's criteria for biomass sustainability, in its 2016/17 UK Bioenergy Strategy Review, a requirement that all biomass (i.e. both new and existing capacity) is sourced from forests that can demonstrate constant or increasing carbon stocks, and push for this to be reflected in standards at the EU level. Some progress has been made. The Government issued new sustainability criteria last year (Timber Standard and Woodfuel guidance) including the implicit requirement that generators receiving incentives under the Renewables Obligation, Renewable Heat Incentive (RHI) and Contracts for Difference (CfDs) must demonstrate that biomass is sourced from forests that are being managed in a way to maintain/enhance carbon stocks. We will monitor the impact of the new criteria, which will come into effect in Autumn 2015.
- **Solar seasonality.**
  - Solar costs have fallen quickly and capacity has expanded. Solar accounted for 4 TWh (1%) of generation in 2014[7] following rapid expansion in the last two years. This is split between large-scale ground-mounted installations, which are relatively cheap with costs similar to those for onshore wind (i.e. new installations could be deployed at around £80/MWh), and smaller rooftop installations, which despite falling costs remain relatively expensive (e.g. in 2014 these received feed-in tariffs up to £140/MWh, not including export tariffs)[8].
  - DECC closed the RO to solar projects larger than 5 MW in April 2015. Under the RO, solar projects could earn up to around £100/MWh, significantly more than their costs required. Projects of this size are still eligible for contracts under EMR if they are able to out-compete other low-carbon technologies. DECC should work with the industry to ensure that this route to market is genuinely open for solar projects, which are often smaller than those of competing technologies.
  - Given the high price paid to solar PV projects funded by Feed-in Tariffs (FiTs), committed projects accounted for around 15% of the funding available for low-carbon technologies in 2014, but less than 5% of the generation under the Levy Control Framework. The Government should continue to closely monitor FiTs spend to ensure that it does not crowd out other, cheaper technologies which compete for available funding.
  - As we raised in last year's report, there is a question as to how much solar can be efficiently accommodated in the UK grid given solar output is poorly matched to UK demand (i.e. solar output is high in summer but demand is high in winter). Alongside the rapid reductions being observed in costs, this raises a question over how much capacity should be installed now and on rooftops rather than later when costs could be lower. That must be balanced against the value in maintaining the existing industry and enabling cost reductions in installation. We will consider these aspects further, including the potential contribution of seasonal storage, when designing scenarios for our advice on the fifth carbon budget later this year.

7 Of which we estimate about 70% was exported to the electricity grid in 2014.
8 Ofgem (2014) *Feed-in Tariff Scheme: Tariff Tables*. Available at: www.ofgem.gov.uk

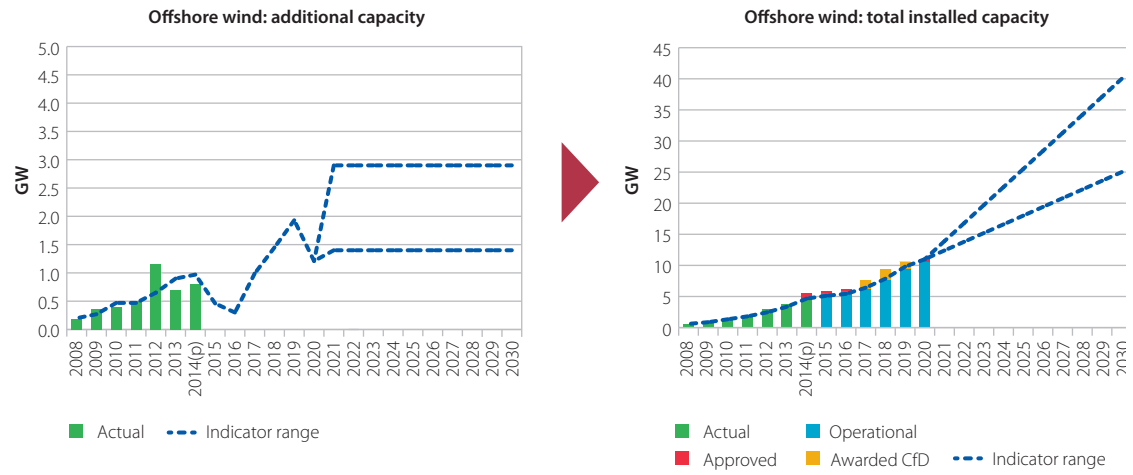
Overall, renewables deployment appears on track to 2020. However, there is a risk that the value of this progress will be lost if more confidence is not provided beyond 2020. We return to this issue and how to resolve it in section 5.

Figure 1.4. Onshore wind: annual additional and cumulative capacity against our indicators (2008-2030)



Source: DECC (March 2015) *Energy Trends*; Pöyry (2013) *Technology Supply Curves for Low-Carbon Power Generation*; CCC estimates.
Note: 2014 data are provisional. Other indicators begin from 2007, however for renewables a consistent data set is only available from 2008.

Figure 1.5. Offshore wind: annual additional and cumulative capacity against our indicators (2008-2030)



Source: DECC (March 2015) *Energy Trends*; Pöyry (2013) *Technology Supply Curves for Low-Carbon Power Generation*; CCC estimates.
Note: 2014 data are provisional. Other indicators begin from 2007, however for renewables a consistent data set is only available from 2008. Volatility in offshore wind additional capacity indicator to 2020 reflects expected dates that specific projects in pipeline commence operation.

Deployment of new nuclear generation

New nuclear power may play an important role in decarbonising the power sector through cost-effective baseload low-carbon generation. Of the existing 9 GW nuclear capacity on the system (which provided 19% of UK generation in 2014), 8 GW is set to come offline over the next 15 years. A continued contribution of nuclear power to low-carbon electricity generation therefore relies on a programme of nuclear new build. Last year we noted ongoing delays in the new nuclear programme.

While important milestones for new nuclear projects were passed in 2014, a Final Investment Decision on the first new build nuclear plant is still pending:

- The UK's first new build nuclear power station since 1995, Hinkley Point C, received State Aid clearance from the European Commission in 2014. However a Final Investment Decision on this project has been pushed back to later in 2015 due to legal challenges and ongoing contractual negotiations.
- Other new build nuclear projects passed important milestones in 2014:
  - Horizon's Advanced Boiling Water Reactor (AWBR) received parliamentary justification, the first step in the regulatory process.
  - The Government extended its infrastructure guarantee scheme to NuGen's Moorside project, with the aim of providing financial security to investors in the project.
  - The Generic Design Assessment (GDA) process continues for reactors for both of these developers, with decisions expected in 2018 and 2019 respectively; plant operation is expected to commence in the mid-2020s.

In order for a successful programme of new nuclear plant to be deployed, projects need to deliver to time and budget. If costs rise and the benefits of a programme do not translate into lower costs than for the first plant (i.e. £92.50/MWh, which has been agreed for Hinkley Point C) then the value of a nuclear programme could be called into question, particularly if other low-carbon options are making good progress.

There may be some scope for life extensions to existing plants to provide nuclear generation over the fourth carbon budget period. In 2014, EdF announced an extension to its Dungeness B power station that will be able to provide low-carbon generation to 2028. EdF suggests that an average lifetime extension of seven years across its fleet is achievable[9], which could allow 4-5 GW of existing nuclear power to stay online until the late 2020s, subject to regulatory approval.

Any further delays to new nuclear build may reduce the contribution it can make towards sector decarbonisation. We will reflect this possibility in developing scenarios for our advice on the fifth carbon budget (2028-2032), due by the end of 2015.

Commercialisation of CCS

Carbon Capture and Storage (CCS) is likely to be a crucial part of a least-cost path to decarbonisation in the UK, and globally. As a low-carbon and potentially flexible form of generating capacity, CCS can provide a back-up role for variable renewables and help to manage swings in demand. CCS also has a crucial role in decarbonising heavy industry where there are limited options, and in the longer term would help to maximise the emissions reduction obtained from scarce supplies of sustainable bioenergy as well as opening up other decarbonisation pathways (e.g. based on hydrogen). Estimates by the Energy Technologies Institute (ETI) and the Committee[10] suggest that the cost of meeting the UK's 2050 emissions target would approximately double in the absence of CCS deployment.

CCS has taken positive steps towards being proven globally, with the first "at scale" CCS power demonstration project (a 110 MW post-combustion coal plant retrofit) commencing operation at Boundary Dam in Canada in 2014. There has also been an increase in the number of active projects, with 22 CCS projects now in construction or operation, a 50% increase since 2010[11], although questions remain over whether the flow of projects is sufficient.

9 EdF (2012) *EdF Press Release.* Available at: www.press.edf.com.
10 ETI (2015) *Carbon Capture and Storage, CCS could clear a path to the UK's carbon reduction targets.* Available at: www.eti.co.uk; CCC (2014) *Fourth Carbon Budget Review – Part 2.* Available at: www.theccc.org.uk.
11 GCCSI (2014) *The Global Status of CCS: 2014.* Available at: www.globalccsinstitute.com

Cost estimates for CCS have increased in recent years. In 2011 costs for early plants were estimated to be £60-150/MWh, more recent estimates put the cost at around £150-200/MWh (Boundary Dam was at the higher end of this range).[12] An updated assessment by ETI suggests that there remains potential for CCS to compete with other low-carbon electricity generation technologies during the 2020s. However, these cost reductions are reliant on Government measures to encourage sharing of infrastructure and developing appropriate risk-sharing arrangements around storage and other liabilities (see section 5).

In our first report in 2008 we set out that CCS urgently needs to be proven and commercialised in the UK, and our original indicators reflected this with the first plant coming online in 2014 and multiple plants by 2020. Progress has been slow with the first projects now aiming to commence operation by 2020:

- Government support has been provided for two plants to conduct Front End Engineering and Design (FEED) studies: White Rose in Yorkshire (a 304 MW oxy-fuel coal project) and Peterhead in Aberdeenshire (a 340 MW post-combustion CCGT retrofit). FEED studies are aiming to conclude and take positive investment decisions in 2015 (alongside capital funding from Government). These plants could then commence operation by the end of the decade.
- A 570 MW pre-combustion coal facility at Caledonia Clean Energy project in Grangemouth (formerly known as the Captain Clean Energy project – one of the reserve projects from the DECC Commercialisation Programme), has recently been awarded £4.2 million funding for research and feasibility studies.

CCS spans different fuels and technology types (e.g. gas or coal; pre- or post-combustion and oxy-fuel). The aim of the CCS programme should be to develop more of the lowest-cost fuel/technology combinations, while taking into account strategic considerations such as the development of clusters to share infrastructure and enable extension of the network to industrial CCS projects.

The UK's initial project mix appears broadly sensible. White Rose is a coal project that includes a large CO_2 transport pipeline that allows for follow-on projects and Peterhead is a gas project re-using existing infrastructure. Both are well placed to connect future sites from industry. It will be important for these projects to proceed in order to provide momentum and a platform for a wider UK CCS industry to develop.

The urgent need to develop CCS, together with the significant delays in deployment to date, suggest that follow-on projects need to be developed alongside initial deployment (e.g. decisions on a second phase of projects should be made over this parliament). DECC's recent Phase II scoping document considers this at a high level, but further work is required to translate this into implementation (see section 5).

12 CCC (2011) *The Renewable Energy Review.* Available at: www.theccc.org.uk; Pöyry (2015) *Potential CCS Cost Reduction Mechanisms.* Available at www.theccc.org.uk.

3. Supporting infrastructure for low-carbon generation

The transition to a low-carbon electricity system places new demands on electricity infrastructure and system security. This is due to both higher levels of variable renewables and inflexible generation (e.g. nuclear) as well as increased demand during peak periods as low-carbon electricity is extended to new markets (e.g. via the electrification of vehicles and heat in buildings).

Transmission infrastructure – investment and access

Our indicators for transmission investment are based on the major network upgrades identified by the Electricity Network Strategy Group (ENSG) in 2009. Our transmission indicators are also in line with a more recent assessment commissioned by the Committee on the upgrades to both transmission and distribution infrastructure required to accommodate low-carbon generation towards 2030.[13]

Of the six 'Stage 1' assets identified by the ENSG in 2009,[14] just one has been installed in 2014, although delays in the development of the remaining assets are largely down to shifting demand for these assets. Increased microgeneration across the UK, alongside the deployment of distribution connected solar and wind farms are already creating grid integration issues. A more integrated approach to planning across the transmission and distribution system could be required in order to avoid unnecessary costs to the electricity system:

- In North Wales, the first part of the Stage 1 transmission upgrade was completed in 2014. Upgrade completion dates for the three remaining parts of these upgrades were pushed back due to revised generation connection dates of renewables, and the connection date of Horizon's Wylfa nuclear power station.
- The West coast 'bootstrap' (a large transmission link off the West coast of the UK) is on track to be completed by 2017.
- Completion dates for other stage 1 assets have been pushed back towards 2020 and beyond, primarily due to changes in the dates when generation assets are expected to come online.

Ofgem's Integrated Transmission and Planning Regime project concluded in early 2015, with important implications for the transmission network. The remit of the System Operator, National Grid, has been expanded to include publishing plans for the electricity transmission system covering England, Wales, Scotland, interconnection and the offshore transmission regime. Meanwhile, recent experience suggests that grid integration issues of low-carbon technologies may be causing problems on the electricity distribution networks of the UK (e.g. distributed solar in South West England). Whilst a wider system outlook is certainly desirable, Ofgem and National Grid should continue to monitor the need to address planning challenges encompassing both the transmission and distribution networks.

Infrastructure to support increased system flexibility

Flexibility over the timing of electricity generation and demand is important for security of supply in an electricity system with high levels of variable renewable generation and inflexible generation such as nuclear. Flexibility is needed to maintain security of supply by ensuring power is always available when needed and to ensure that electricity generated (e.g. wind and solar) can be accommodated, for instance, during periods of low demand.

As more low-carbon generation is added, more flexibility will be needed to balance the system and run it efficiently. Policy and market design must therefore ensure that flexibility services, including demand-side options, can enter the market and compete effectively, while having net emissions benefits.

13 Imperial College and Element Energy (2014). *Infrastructure in a low-carbon energy system to 2030: Transmission and distribution.* Available at: www.theccc.org.uk.
14 ENSG (2009) *Our Electricity Transmission Network: A Vision for 2020.* Available at: webarchive.nationalarchives.gov.uk

We therefore monitor progress in the installation of smart meters (which can support increased flexibility through demand-side response), participation of demand-side response in various markets, and interconnection with Europe, which can effectively share sources of flexibility:

- **Smart meters:** Smart meters provide more accurate information to energy users and utilities about their consumption and enable consumers to change the time at which they use electricity. At the end of 2014, just over 400,000 smart electricity meters were operating in residential homes, representing less than 2% of domestic properties. Delays in setting up the data infrastructure around the smart meter programme mean that the mass rollout of smart meters is now expected to commence in the second half of 2016, however the rollout is still expected to complete by the end of 2020. The meters being installed have sufficient functionality to reflect real-time prices and allow either direct consumer responses or automated services via third parties.
- **Demand-side response:** The concept of shifting electricity demand (e.g. away from 'peak' time periods such as 4-7pm on a winter evening) is known as Demand-Side Response (DSR). DSR – both direct demand shifting and use of small-scale diesel or gas generators at peak times – can help manage large volumes of variable renewable generation and can significantly reduce the overall cost of a decarbonised system (e.g. by shifting demand to off-peak periods with higher renewable output). It is already participating in several UK markets:
  - 320 MW of DSR flexibility was contracted during the winter of 2014/15 under the Demand Side Balancing Reserve, of which an estimated 40% was demand shifting (versus fossil-fuel generation). To ensure net emissions benefits, it is important that DSR flexibility is increasingly provided by demand shifting and not fossil-fuel based generators. We will monitor this over time.
  - 174 MW of DSR flexibility was contracted in the first Capacity Market auction (covering the period 2018/19), with the role of DSR expected to increase in subsequent auctions.
  - Other schemes, such as the Transitional Arrangements, exist to look at the participation of demand-side response in UK electricity markets.
- **Interconnection:** Interconnection to other electricity markets can help manage variability of demand and supply and reduce system costs by taking advantage of differences between linked jurisdictions. The UK has 4 GW of interconnection capacity. There has been progress in 2014 towards a significant expansion in interconnector capacity between the UK and other markets, suggesting up to around 7 GW of additional interconnection capacity (to Norway, Denmark, France and Holland) could be developed in the period to 2020, with potential to go further (e.g. to a total of around 18 GW) by 2030.

As part of our work later this year on the fifth carbon budget, we will update our detailed assessment of the security of supply challenges of managing a decarbonising electricity system and the importance and potential of flexibility options. We will also consider the extent to which the value of flexibility (e.g. for demand-side response and energy storage) is reflected by current market mechanisms and can be captured in the value chain.

4. Forward look and policy gap

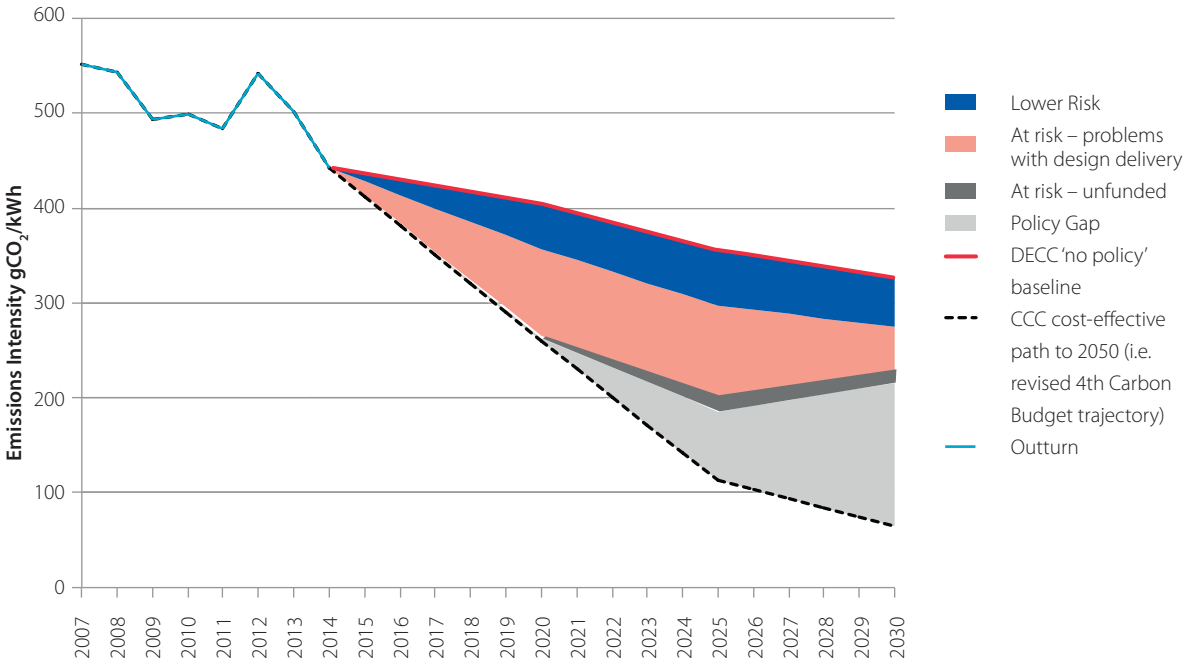
In our 2014 Progress Report we highlighted the 'policy gap' between what current policies can be expected to deliver, and the cost-effective path to meeting the UK's overall 2050 emissions target (i.e. to reduce greenhouse gas emissions by at least 80% compared to 1990). While there has been some progress in closing the policy gap over the past year, a significant gap remains beyond 2020.

- We have updated our analysis (Table 1.2 and Figure 1.6) since last year to reflect actual 2014 grid intensity, changes to the DECC 'no policy' baseline and the recent CfD auctions:
  - The baseline has changed to reflect electricity capacity changes in 2014 and DECC's latest *Updated Emissions Projections*.[15]
  - Successful auctions for low-carbon generation secured more than 2 GW of low-carbon capacity for installation pre-2020. We have revised our classification of this capacity from 'at risk' to 'lower risk'.
- However, significant risks remain for delivery of projects that have not yet secured low-carbon contracts, including the projects in the CCS demonstration, and for further fuel switching away from coal. Funding has been allocated for these projects to 2020 through the Levy Control Framework and CCS competition, and if they are delivered, this would broadly deliver against 2020 objectives.
- Beyond 2020, developer interest remains, but policies have largely not yet been set.
  - A contract has been offered for a new nuclear plant at Hinkley Point C, but no funding has been allocated through the Levy Control Framework and the project is yet to take a final investment decision.
  - No funding has been allocated for other new projects in the 2020s and the Government has not stated its intentions regarding new low-carbon investments in the 2020s. This creates a high degree of uncertainty for investors who need to take decisions now in preparation for investments that would come on line in the 2020s.
- Given this, our analysis suggests emissions intensity could be over 200 gCO_2/kWh in 2030 under current committed policy, whereas the aim should be to reduce emissions intensity to 50-100 gCO_2/kWh.

We conclude that a significant gap remains between what current policies are on track to achieve and what should be achieved on the path to the 2050 target. The next section sets out options to begin closing that gap.

15 DECC (2014) *Updated Emissions Projections*. Available at: www.gov.uk

Figure 1.6. Assessment of current and planned policies: power sector



Source: DECC (2014) *Updated Emissions Projections*; CCC analysis.

Table 1.2. Risk assessment of power sector policies

Policy	Comment
Lower risk policies	
Renewables Obligation, FiTs, FIDER and the first CfD allocation round.	Policies target the right technologies and have been effective in the past. Support is broadly matched to technology costs and funding is sufficient.
Policies with design/delivery problems	
CCS demonstration	Targets the right CCS applications; continuing risks to delivery of technology and reaching final investment decisions; £1 billion funding has been allocated.
Fuel switching	Some existing coal plant will close under the Large Combustion Plant Directive (LCPD) & the Industrial Emissions Directive (IED), however other plant may stay open for some time due to weakness of EU ETS and low coal prices. No new unabated coal plant due to the Emissions Performance Standard (EPS). Capacity mechanism is an incentive for new gas plant.
CfDs to 2020	Programme is in place and first auction has taken place, however lack of support beyond 2020 may increase uncertainty for bidders pre-2020. Support broadly appropriate.[16]
Unfunded policies	
Nuclear – first 2 reactors at Hinkley	Agreement on terms for proposed first contract, state aid approval granted, level of agreed strike price appropriate, contract terms have been agreed, however contract is not signed and funding has not yet been allocated.
Missing policies	
Power sector deployment beyond 2020	Moving the power sector from 200 gCO_2/kWh in 2020 to 50-100 gCO_2/kWh by 2030.

16 CCC (2013) *Next steps on Electricity Market Reform – securing the benefits of low-carbon investment.* Available at: www.theccc.org.uk.

5. Recommendations

Enabling efficient low-carbon investment

Continuing with low-carbon auctions

As set out in Section 2, the early auction results under the Electricity Market Reform indicate success in driving down costs. We recommend that auctions continue and proceed according to the timetable previously set out in order to maintain the positive momentum achieved by the first auction (i.e. the next auction round should open in late 2015).

In designing and running future auction rounds the Government should work with industry to ensure that any lessons are learnt from the first auctions earlier this year. This could include, for example, consideration of timings within the auction round, the length of the window from contract award to operation and the penalties for winning bids that do not proceed.

Setting a credible carbon objective for the power sector beyond 2020

The Government's threefold objectives for the power sector are security of supply, affordability for consumers and decarbonisation, in line with the targets in the Climate Change Act.

Translating these high-level objectives into policy requires the Government to clarify how it aims to balance them, given that there are important trade-offs (e.g. contracting low-carbon capacity currently adds to costs for consumers). If this is unclear then investors are exposed to policy risk, which can deter investment and add to costs, undermining all three objectives.

The framework to 2020 is apparent: the Government has set an objective for security of supply, has clear plans for renewable generation and CCS and has set a limit on funding under the Levy Control Framework consistent with delivering these. Beyond 2020, objectives and funding for decarbonisation have not yet been set.[17]

This is problematic as project planning cycles in the power sector go well beyond 2020 (Figure 1.7). Large offshore wind farms, CCS plants and nuclear plants have a project lead-time of up to 10 years or more, with supporting investments in the supply chain stretching even further.

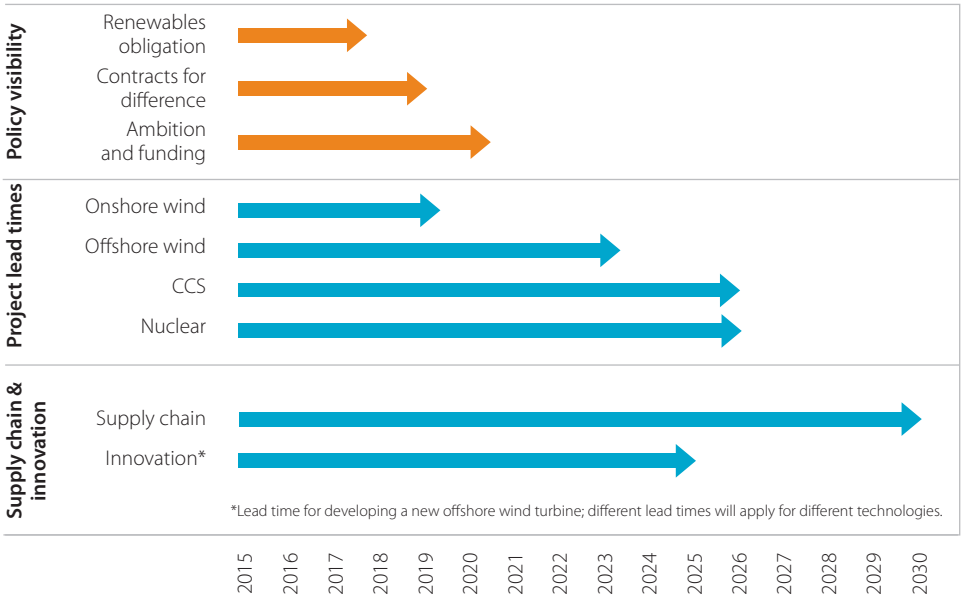
It is therefore an urgent priority to signal the Government's intentions for decarbonisation in the sector beyond 2020, such that the sector can invest with a 10-year lead time. This should involve a clear commitment to continuing decarbonisation through a portfolio of technologies, consistent with reaching a carbon intensity of generation of around 50-100 gCO_2/kWh by 2030, which the Committee have previously identified as being on the cost-effective path to the 2050 target.

To make a carbon objective credible (and bankable for investors and financiers) we recommend that the Government extends the funding limit under the Levy Control Framework. Confidence in a market beyond 2020 will drive competition and cost reduction, by supporting a strong pipeline of projects, keeping auctions well-subscribed, incentivising innovation throughout the supply chain and reducing the cost of capital.

A suitable extension would be to 2025, with this subsequently updated on a rolling annual basis to continue the 10-year investment window. This should be taken forward as soon as possible and certainly within the next year.

17 The Government has a published trajectory for carbon prices, but this is not bankable for investors as the actual tax rate is subject to change every year. Carbon budgets are set to 2027, but are accounted on a net basis (see Box 1 in the Summary/Overview).

Figure 1.7. Lead times for low-carbon projects (development and construction) compared with policy visibility



Source: CCC estimates; BVG (2015) *Approaches to cost-reduction in offshore wind.* Available at: www.theccc.org.uk

Extending the Levy Control Framework

The Levy Control Framework (LCF) has been set at £7.8 billion for 2020.[18] This caps the amount of additional money that can be paid to low-carbon generators on top of the wholesale electricity price. This was designed to limit costs to consumers while achieving the Government's objectives for deployment of renewable capacity, consistent with reaching at least 30% renewables penetration in 2020, as required under the EU Renewable Energy Directive.

Whilst various factors have changed, the allocated funding for 2020 still appears broadly consistent with the objective (Box 1.2). The Government has given no indication of availability of funding for low-carbon generation projects beyond 2020/21.

Furthermore, as we have set out in previous reports, the LCF as currently calculated is likely to overstate the additional cost of low-carbon generation to consumers in the longer term. This is because contracts offered to generators as Contracts for Difference that are settled relative to the electricity wholesale price, which is expected to be lower than the cost of the alternative of unabated gas generation.[19] This reflects the so-called 'merit order' effect – that low-carbon generation with a low marginal cost will tend to depress the wholesale price, reducing costs for consumers. We therefore continue to recommend calculating the support for low-carbon generation against the alternative of providing electricity through a new unabated gas plant facing a carbon price.

Using this approach, we estimate that the required support would be around £9 billion in 2025 to support investment in an appropriate portfolio of low-carbon options and provide the conditions for a competitive pipeline driving cost reduction:

- This estimate is based on the central scenarios published by DECC for 2025:
  - Carbon price of £55/tCO_2 as in the Government's original published target trajectory for the carbon price floor.

18 On a £2014 price index. Originally published as £7.6 billion for 2020/21 (in £2011/12).
19 For example, see section 3 of CCC (2013) *Next steps on Electricity Market Reform.*

  - Wholesale gas price of 72 pence/therm (compared to 46 pence/therm currently). If gas prices were to fall further (e.g. to DECC's low case of 43 pence/therm), required funding would increase to £11 billion to support the same level of low-carbon generation, although overall consumers' energy bills would be lower.

- The resulting wholesale price of electricity in the Government's central projection[20] is £67/MWh (compared to £51/MWh in 2014). This is £9/MWh lower than the long-run marginal cost of a new unabated gas plant implied by the gas and carbon price assumptions. If support costs were compared to this wholesale price (£67/MWh), then the required budget under the LCF would be £10 billion.
- The bulk of the increase in funding would be to support continuing markets for less-established technologies (i.e. offshore wind and CCS) that are required to drive innovation and cost-reduction, as set out below. This is likely to be sufficient to drive these technologies to maturity such that they can then compete more openly and exert cost pressure on other mature options, such as nuclear.
- Some further funding would be required to deliver planned nuclear investment and potentially other mature options like solar and onshore wind, depending on local acceptability and ability to win contracts in competitive auctions.
- Under our central cost assumptions, this level of funding (i.e. £9 billion judged against the costs of the alternative of unabated gas generation, or £10 billion judged against the wholesale electricity price) would keep the power sector on track to 50-100 gCO_2/kWh in 2030.

Beyond 2025, funding requirements are expected to fall, given continuing increases in the carbon price and as some early projects under the Renewables Obligation reach the end of their support agreements.

Funding of high-cost technologies through the LCF should be conditional on them achieving steady cost reductions with a view to competing with alternative options in future. A competitive market for contracts, as under the current auctions, contributes to ensuring that the lowest cost projects are funded.

In setting the LCF the Government will have to make assumptions over future gas and carbon prices and how these translate to the electricity price. These should be made transparent along with the planned response should these assumptions turn out to be incorrect. In particular, the expectation should be that if carbon prices turn out lower than the Government assumes, or if electricity wholesale prices are dampened by low-carbon generation, then the available funding should be increased accordingly. These are policy-related risks that developers are not well-placed to manage.

It is worth noting that whilst lower carbon prices or lower wholesale electricity prices will tend to increase the flow of money through low-carbon contracts they will reduce total costs faced by consumers and improve affordability overall even if the LCF is adjusted upwards to compensate (see our 2014 Energy Prices and Bills Report)[21]

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20 DECC (2014) *Updated Emissions Projections*. Available at: www.gov.uk
21 CCC (2014) *Energy Prices and Bills - impacts of meeting carbon budgets*. Available at: www.theccc.org.uk

Box 1.2. Funding under the Levy Control Framework could be sufficient to 2020 if costs are monitored closely

In 2012, the Government announced funding for low-carbon policies (including the Renewables Obligation, the Feed in Tariff and Contracts for Difference) of up to £7.8 billion in 2020 (on a £2014 price base) with provision for a 20% 'headroom'.

This remains sufficient to fund low-carbon generation to 2020 envisaged in our indicator trajectories, provided costs and deployment of more expensive technologies is monitored closely:

- Gas prices have fallen. If these persist they would reduce expected wholesale electricity prices, leading to a higher funding requirement for low-carbon generation contracted at a given price. Together these increase the 2020 funding requirement by £0.5 billion if gas prices fall to DECC's "low" scenario (43 pence/therm).
- Offshore wind projects are running more of the year than was expected (i.e. over 40% rather than the 38% expected). This means fewer projects may be required to meet our indicators for generation, but does not change the cost of a given level of generation.
- Rapid uptake of solar rooftop PV, financed through FiTs, has the potential to crowd out other technologies under the LCF, given the higher current costs of rooftop PV (e.g. up to £140/MWh for domestic installations in 2014, not including export tariffs). Tariff reductions triggered by high installation rates could limit the impact on overall spend, and require close monitoring.

Together these imply the funding requirement to deliver our indicators would be £7.4 billion in 2020 (in 2014 prices) if gas prices return to DECC's central fuel price projections, and £7.9 billion if gas prices fall further as in DECC's low prices.

These estimates assume the Carbon Price Support remains frozen at £18/tCO_2 as announced in 2014 Budget to Parliament. Available at: www.gov.uk.

Transparency over the costs of technology choices

Alongside transparency over available funding through the LCF we recommend that the Government adopts a transparent approach to technology choices:

- If the Government chooses to constrain low-cost options (e.g. onshore wind, large scale ground-mounted solar), they should also set out which alternatives will be considered to replace them. This should include an assessment of the increase in overall costs to consumers and of any changes required to the support arrangements to maintain overall ambition (e.g. an increase in the LCF may be needed).
- In judging the level of subsidy paid to low-carbon generators (e.g. onshore wind), the Government should consider the full costs of the low-carbon option and the alternative:
  - This should include any system integration and security of supply costs, for example reflecting that variable renewable capacity will generally need to be backed up by flexible capacity that can operate on demand. We will explore these costs further as part of the analysis for our advice on the fifth carbon budget later this year.
  - The appropriate comparator is not the wholesale electricity price, but the alternative means of providing generation. Where this is unabated gas generation, its costs should be judged across its lifetime, assuming that it would face the full costs of its emissions.[22]

This implies for example, that under the Government's central scenarios for carbon and gas prices, onshore wind at a cost of £80/MWh is likely to be subsidy-free from the 2020s.

22 For example, in the Government's original published trajectory for the carbon price floor, prices reach £33/tCO_2 in 2020 and rise to £78/tCO_2 in 2030 (in 2014 prices). Long-term carbon appraisal values rise to over £220/tCO_2 in 2050. These prices reflect a central view of expected technology costs, energy demand, and fossil fuel prices and are representative of the value of carbon in a world that is committed to a 2°C climate objective.

Developing options and supporting innovation

Delivering the large amount of low-carbon electricity needed to meet the 2050 target is likely to entail deployment of technologies that are currently high cost relative to established options such as nuclear and onshore wind. This reflects that established options face risks and limits to their potential roll-out – for example relating to site restrictions for onshore wind and new nuclear.

An effective strategy needs to ensure that emerging technologies are developed. The focus should be on technologies with scope for costs to fall to a level where they can put cost pressure on established technologies and can provide a large amount of low-carbon generation when it is needed. To ensure best value for consumers, the near-term goal should be development of the option, rather than deployment *per se* – although as we set out below, in some cases deployment has an important role in driving innovation and cost reduction.

For this report we commissioned detailed analyses to consider what is required to drive cost reduction beyond 2020 for two key emerging technologies – offshore wind and CCS (Box 1.3). These technologies are currently more expensive than other alternatives but have potential to deploy at large scale, relatively low delivery risks and scope for costs to fall.[23]

There are of course other emerging options, which are currently high cost but could have a significant future role and would benefit from innovation support. In the power sector, these include rooftop and distributed solar, where there is potential for UK-based cost reduction in installation but where the panel technology is likely to develop globally (supported by UK research), and wave and tidal technologies, for which the UK has a strong resource and which currently requires early-stage innovation and demonstration support. Innovation will also be important in supporting areas such as energy storage and smart grids.

Given their high initial costs, emerging technologies are likely to be dependent on Government support. A common theme from our new work is that Government must provide clarity about the conditions under which support will be available while setting stretching expectations for technology development to enable innovation and cost reduction.

For both offshore wind and CCS, delivering a programme cost-effectively and that maximises any potential UK industry benefit requires confidence of a market beyond 2020. This will be unlikely to occur if these technologies are required to compete openly with other low-carbon options in the early 2020s.

Offshore wind

Our updated assessment (Box 1.3) finds that costs for offshore wind appear to be falling in line with industry goals and could continue to fall through the 2020s under a supportive policy environment. This would enable offshore wind to provide an additional option for low-carbon generation at costs that are comparable to those of nuclear and onshore wind. That would be a major step towards meeting the 2050 target in the Climate Change Act given the importance of providing low-cost, low-carbon electricity and the large potential offshore wind resource (i.e. over 400 TWh per year, more than total UK electricity demand in 2014).

The most important enabler for these cost reductions is providing confidence that there will be a continuing market for deployment provided costs continue to fall:

- A sufficient scale of market is required to drive private sector investment in innovation (e.g. to create bigger turbines), to support a competitive project pipeline and supply chain, and to encourage a falling cost of capital through mature financial sector involvement.

23 See, for example, CCC (2011) *The Renewable Energy Review.* Available at: www.theccc.org.uk

- An EU market size of around 3-4 GW per annum would be enough to support three or four major players in the turbine market and provide sufficient potential return to incentivise the very large investment required to develop and bring the next generation of turbines to market.
- A UK market of around 1-2 GW per annum through the 2020s would be consistent with an EU market of that size and would support multiple developers in the UK, ensuring that auctions remain competitive.

The cost of a 1-2 GW annual UK programme in the 2020s implies annual support of around £0.8 billion in 2025. This is in addition to continuing support for pre-2020 projects, which falls from £3 billion in 2020 to around £2.5 billion in 2025 in DECC's central scenario for wholesale electricity prices. Overall LCF funding should be allocated at a level that is consistent with this scenario for offshore wind.

In allocating funding, it should be made clear that offshore wind is not expected to compete with established low-carbon technologies in the early 2020s provided projects continue to demonstrate cost reduction. A larger market could be secured in the event of lower prices than alternative technologies, providing further incentives to reduce costs.

Deployment should be complemented by support for targeted R&D, including in ways that de-risk and encourage collaboration within the industry and look ahead to new needs (e.g. to novel concepts such as floating turbines). A clear conclusion of our new work however is that on its own, targeted R&D support cannot be an effective substitute for confidence in an ongoing market.

Box 1.3. Updated assessments of the potential and drivers of cost reduction for offshore wind and CCS

Offshore wind

We commissioned BVG Associates (BVGA) to extend the evidence base on cost reduction to 2030, and assess the potential role of the UK Government in unlocking any further cost reductions.[1] Their findings were:

- **Costs are falling broadly on track to £100/MWh by 2020.**[2] This is a result of earlier than anticipated uptake of larger turbines (i.e. 6MW and 8MW), which have offset delays in other areas (e.g. support structure manufacture). The results of the first low-carbon auctions appear to confirm these reductions.[3]
- **BVGA identified potential for further cost reductions in the 2020s to get below £100/MWh.** Opportunities include technological innovations (e.g. larger and more reliable turbines rated at 10 MW), improved competition and management of risk in the supply chain, and falling cost of capital as the finance community gains confidence and experience in offshore wind.
- **The international market is important in driving investment, within which the UK is expected to be a major player in the 2020s.** BVGA's analysis focused on the role of the UK within the North-Western European market, which currently accounts for almost 90% of global installed capacity and will be of particular importance in the 2020s. While disruptive innovations may occur elsewhere (e.g. floating turbines), their progress is uncertain and they are unlikely to play a significant role in cost of energy reduction on UK projects in the period to 2030.
- **A strong European market will support more cost reduction, with a critical mass of an average annual deployment rate of around 3-4GW a year required to support competition and cost-reduction.** For example, this would support three to four players in the turbine market that are large enough to invest in major innovation programmes.
- **A UK market with annual average deployment rates in the range 1-2 GW in the 2020s is consistent with a balanced approach to cost-reduction.** Although the UK market is insufficient to drive unilateral cost-reduction on its own, it is an important player internationally. A reduced UK market size could affect confidence internationally, potentially resulting in other markets reducing their ambitions. A 1-2 GW UK market would also support multiple project phases each year, allowing competitive CfD auctions and reducing programme risks for individual developers.
- **To unlock these opportunities, confidence in a future market is the most important driver.** This will enable large equipment suppliers to make the required investments in developing the next generation of technology and infrastructure. It will also build industry interest and expertise throughout the supply chain, including in finance, which are needed to integrate new technologies effectively. As a result, a programme of offshore wind with confidence over a future market is likely to be cheaper than a programme without visibility.
- **Confidence in market scale can be supplemented, but not replaced by, targeted R&D support.** Pure R&D support is not likely to deliver larger turbines, lower finance costs or reduced project management costs. However, it can reduce risks in the commercialisation of some components and prepare for future challenges (e.g. floating platforms).
- **Other strategic actions may also enable cost reductions.** For example, continued knowledge sharing within the industry, sharing of transmission infrastructure across multiple projects and taking a more active public role in site development

Carbon Capture and Storage (CCS)

We commissioned Pöyry and Element Energy to extend previous studies of cost reduction in CCS[4], suggesting that there remains potential for CCS to compete with other low-carbon electricity generation technologies during the 2020s:

- **There is potential for individual CCS power projects to have lifetime generation costs below £100/MWh by the mid-2020s.** While large cost reductions are identifiable, absolute cost figures remain particularly uncertain given the early stage of development and importance of future market prices for fossil fuels.
- **CO_2 transport and storage infrastructure offers large economies of scale and forms the largest single opportunity for cost reduction.** It is vital therefore that initial projects invest in over-sized infrastructure, but early projects will be expensive per unit of electricity generated as a result. Further opportunities include cost of capital reductions, which will be primarily supported by UK deployment, and innovation in capture technology, which is likely to follow mainly from global roll-out.

Box 1.3. Updated assessments of the potential and drivers of cost reduction for offshore wind and CCS

- **A minimum programme size of 4 to 7 GW by 2030 could unlock the majority of cost reductions.** A 4 GW programme may be sufficient if the focus is on a single technology and fuel (e.g. post combustion gas), while a 7 GW programme would allow risk to be spread over projects covering both coal and gas, potentially with different capture technologies. Higher deployment may be appropriate if CCS costs turn out lower than those of other low-carbon technology options.
- **There should be no significant gap prior to the second phase of projects, to avoid a hiatus in the industry and a potential loss of momentum and skills.** Government should aim for a steady roll-out and scale-up of projects to maintain a knowledge base while also allowing time for learning and risk reduction from previous generations of CCS to feed-through into future projects.

Advisory group findings

Given the inevitable judgements involved in these assessments we also convened an advisory group of independent industry experts, chaired by Dr. Robert Gross of Imperial College.[5] The group was asked to review the consultancy studies and give recommendations for required Government actions. This group supported the key conclusions of the consultancy studies and highlighted important aspects for the Government's approach:

- **A modest and stable UK market is essential to cost reduction.** Cost reduction and commercialisation for both offshore wind and CCS will only be possible if there is enough market opportunity to create a 'critical mass' for developers, the supply chain, installers and the investment community.
- **The Government needs to provide a clear signal of intent early in this Parliament.** A typical offshore wind farm is likely to require around five years and £50 million of site development work prior to final investment decision, with a further one to two years for construction. A typical full chain CCS project might take nine years to deliver and in the case of CO_2 storage the pre-FID investment could reach £100 million.
- **Public R&D funding is unlikely to be as effective as a market-led approach.** The scale of costs and skills involved in developing, for example, a new generation of offshore wind turbines, and other related infrastructure, is significant. Existing manufacturers are best placed to deliver this and will only invest if they see a strong commercial opportunity. Public R&D funding, if pursued as a substitute to a stable market, would introduce new risks to the supply chain and reduce the other benefits of competition.
- **Policy can create the conditions for cost reduction but cannot assure it.** The consultancy studies are contingent on assumptions regarding technology development and the impact of policy. It will be important for the Government to signal clearly that ongoing levels of support will be contingent on industries realising anticipated levels of cost reduction.
- **Policy has important qualitative and strategic dimensions.** For example, in CCS, developing a cluster of CCS power or industrial projects, which is unlikely to occur in the absence of strategic oversight. In offshore wind, carefully determining the points in the development process where competitive tendering processes are most effective, and whether there is a greater role for a strategic approach to site development.

[1] BVG Associates (2015) *Approaches to cost-reduction in offshore wind.* Available at: www.theccc.org.uk

[2] The £100/MWh goal was set out in The Crown Estate (2012) *Offshore Wind Cost Reduction Task Force Report,* available at: www.gov.uk. Latest cost estimates were published earlier this year by the Offshore Wind Programme Board: Deloitte (2015) *Cost Reduction Monitoring Framework: Quantitative assessment report* and DNV GL (2015) *Cost Reduction Monitoring Framework: Qualitative assessment report.* Both are available online at ore.catapult.org.uk. Costs are for Final Investment Decision i.e. with first generation in 2022/23.

[3] The two projects that secured CfDs had strike prices of approximately £120/MWh and £114/MWh and will reach FID this year (or early 2016). Allowing for the fact that CfD contracts are shorter than project lifetimes, these strike prices are broadly equivalent to a cost of energy of £110/MWh and £105/MWh respectively (2012 values).

[4] *Potential CCS Cost Reduction Mechanisms* (Pöyry 2015). Available at www.theccc.org.uk.

[5] Gross, R. (2015) *Approaches to cost reduction in carbon capture and storage and offshore wind.* Available at: www.theccc.gov.uk. Other group members were: the Energy Technologies Institute, the Crown Estate, Climate Change Capital and DECC's Office of CCS Expert Chair.

Carbon Capture and Storage (CCS)

As set out in section 2, CCS is a vitally important part of the low-cost path to 2050. Although initial projects are expensive, they are required to establish whether CCS could offer low-cost abatement (e.g. mid-merit power generation) and whether there is future potential for emissions reduction in sectors with limited alternatives (e.g. parts of industry).

Our updated assessment (Box 1.3) confirms earlier findings from the Cost Reduction Task Force that CCS may be able to compete on cost with other low-carbon options by the late 2020s. This would be particularly likely if fossil fuel prices turn out to be at the low end of expectations or if flexible low-carbon generation operating for only part of the year is required.

The key opportunity for delivering cost reduction is through economies of scale delivered by shared infrastructure for transporting and storing CO_2. This implies a minimum level of roll-out will be required in the UK which, if signalled in advance, can also support a competitive pool of projects and increase interest from the financial community.

If based in clusters around the two planned projects at White Rose and Peterhead, a programme of 4-7 GW by 2030 could unlock economies of scale and deliver cost reduction for CCS:

- The projects planned at White Rose and Peterhead are being designed with oversized infrastructure and are located in areas where other projects can connect (see section 2). These projects need to deliver and stick to the timelines that have been set out (i.e. final investment decisions should be taken by the end of this year).
- A programme of 4-7 GW by 2030, alongside industrial installations (see Chapter 3), would unlock the bulk of the economies of scale for transport and storage for two clusters developed around these two projects.
- A 4-7 GW programme would also allow a phased scale-up in plant size in the UK for one or two fuels and capture technologies. This would allow lessons to be learnt between projects while maintaining sufficient momentum to retain skills and expertise in the UK, to keep a pool of potential projects under development and to interest the financial community and therefore reduce costs of capital.
- Going beyond 4-7 GW would deliver limited further clear benefits in cost reduction but would be appropriate if CCS plants can deliver low-carbon power more cheaply than the alternatives.

This size of program implies at least two further capture plants need to be signed before the two projects are operational. As in the current competition, a technology neutral approach is appropriate given uncertainty over which technology will be most successful. International experience will mean points of comparison are available to signal a direction change if needed.

We therefore recommend that the Government:

- **Aims to deliver 4-7 GW of CCS capacity by 2030,** alongside CCS applications in industry, with potential to go beyond this if CCS can provide low-carbon electricity more cheaply than the alternatives.
- **Provides sufficient funding for this programme under the Levy Control Framework.** We estimate that an increase in annual support of around £0.8 billion in 2025 would be sufficient to fund 7 GW of CCS, allowing two fuels or technologies to be taken forward in the UK. Lower funding would be required for a 4 GW programme, but this would reduce the diversity of fuels and technologies that would be proven in the UK and could limit the number of projects prepared to compete for contracts.

- **Ensures that the first two plants at White Rose and Peterhead deliver as planned.**
- **Signs contracts for at least two follow-on projects this Parliament,** to connect into clusters based around the planned projects.
- **Develops a strategic approach to CO_2 transport and storage infrastructure.** This could involve working with industry to develop an effective business model for infrastructure sharing or could involve a more regulatory approach to infrastructure build-out and pricing. This should include consideration of the potential for Enhanced Oil Recovery.
- **Works with industry and international partners to ensure knowledge sharing and to remove barriers.** This should include resolving issues around storage liabilities, fuel price indexing in contracts and additional storage appraisal.

Success across these areas would be a major step towards the 2050 target, and more broadly towards global efforts to tackle climate change, given the vital importance of CCS in meeting carbon targets in the UK and internationally.

Chapter 2: Progress reducing emissions from buildings

1. Buildings emissions trends and drivers
2. The Committee's approach to tracking progress in buildings
3. Low-carbon heat
4. Residential buildings
5. Non-residential buildings
6. Forward look
7. Summary

Key messages and recommendations

In this chapter, we examine emissions from homes, commercial and public buildings, which account for 17% of the UK's direct GHG emissions. These emissions are primarily due to fossil fuel use in space heating. Indirectly, buildings also account for two-thirds of power sector emissions, mainly due to electricity demand from lighting and appliances. We focus on progress towards heat decarbonisation and improving energy efficiency, which are key areas for emission abatement in buildings.

Overall performance:

- Direct buildings emissions fell by 15% in 2014, mainly as a result of higher temperatures which reduced heating demand. For energy efficiency, we are currently meeting our emissions trajectory (i.e. the cost-effective path to achieve carbon budgets, although not when adjusting emissions for temperature. Furthermore, the delivery of key measures has slowed down since 2012, putting required further emission reductions at risk. Very little progress has been made in heat decarbonisation.

Low-carbon heat:

- Decarbonising space and water heating is one of the biggest challenges for carbon budgets. In 2013, low-carbon heat accounted for only 1.6% of buildings heat demand. Low-carbon heat policy constitutes most of the gap between what current policies are expected to deliver and what our cost-effective trajectory for meeting the fourth carbon budget requires.

Energy efficiency

- In recent years, emissions from homes have reduced due to improved energy performance from higher levels of insulation, as well as more efficient appliances and lighting. However, recent policy changes have resulted in a slow-down in the rate of installation of insulation measures in homes. This means that cost-effective emissions savings are being missed and there is a detrimental impact on the ability to meet targets to alleviate fuel poverty. Non-residential buildings emissions have stayed flat, with little evidence of any energy efficiency improvement.

Our key recommendations are:

- **Low-carbon heat:** Develop an action plan to address the significant shortfall in low-carbon heat. Short term, this should commit to extend the Renewable Heat Incentive to 2020, or until a suitable replacement is found; long term it should link support for low-carbon heat with energy efficiency, support for heat networks and wider decisions about infrastructure for heat.
- **Energy efficiency:** Set out the future of the Energy Company Obligation beyond 2017, ensuring it delivers energy efficiency while also meeting fuel poverty targets.
- **Zero Carbon Homes:** Implement zero carbon standards without further weakening and ensure incentives are in place to encourage low-carbon heat sources.
- **Commercial sector:** Simplify and rationalise existing policies for energy efficiency improvement, with a view to strengthening incentives, by the end of 2016.

We set out the analysis that underpins these conclusions in the following sections:

1. Buildings emissions trends and drivers

2. The Committee's approach to tracking progress in buildings

3. Low-carbon heat

4. Residential buildings

5. Non-residential buildings

6. Forward look

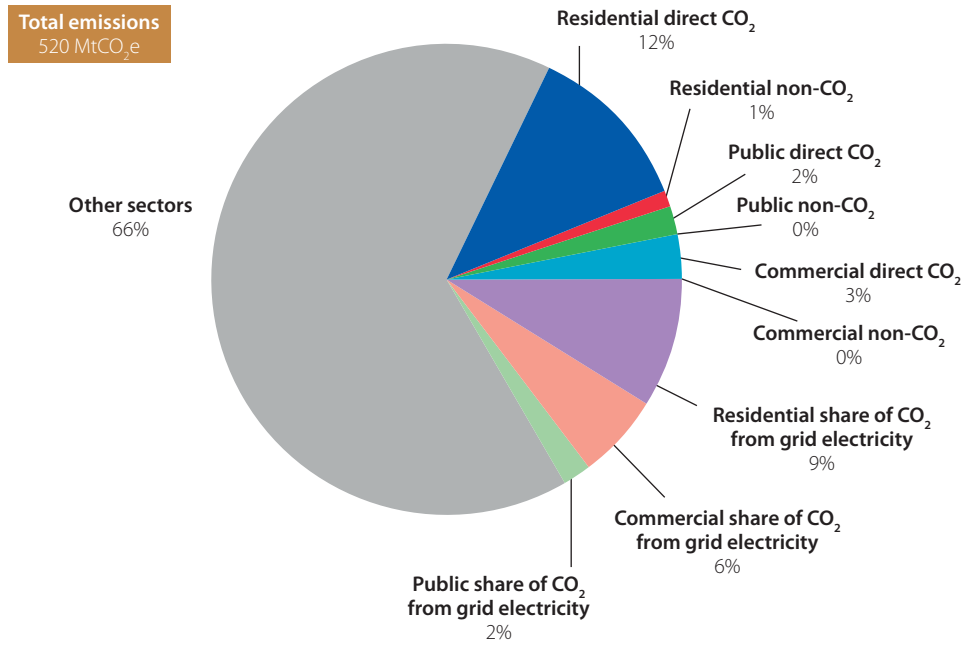
7. Summary

Our Adaptation Progress Report also includes chapters on the built environment, and healthy and resilient communities. These examine several topics that overlap with issues covered in this chapter. For example, reducing water demand will also have a positive impact in terms of emissions due to reduced energy consumption for water heating. Introducing passive cooling measures in new and existing homes as the climate warms will keep demand for energy-intensive air conditioning at a minimum. Passive cooling should be implemented alongside measures to increase the energy efficiency of the residential building stock, to avoid the latter increasing overheating risk. It is therefore important for the UK and devolved governments to manage climate change mitigation and adaption policies for buildings in an integrated way. A key measure for achieving this is the Building Regulations for both new build and existing homes. For example, the 2016 Zero Carbon Homes standard should seek to both minimise emissions and ensure passive cooling.

1. Buildings emissions trends and drivers

Direct buildings emissions fell 15% in 2014 to 84 $MtCO_2e$. They accounted for 17% of all UK GHG emissions. This fall was mostly due to the fact that 2014 was a warmer than average year. Temperature-adjusted emissions fell just 2% from the previous year, to 94 $MtCO_2e$. Electricity demand from buildings fell 5% in 2014, to 201 TWh. This is associated with 81 $MtCO_2$ of power sector emissions, or 67% of the total power sector emissions.[1] Direct building emissions are split between homes (74%), commercial buildings (16%) and the public sector (10%) (Figure 2.1).

Figure 2.1. GHG emissions from buildings in the context of total UK emissions (2014)



Source: NAEI (2015), DECC (2015) Energy Trends, March 2015, DECC (2014) DUKES; CCC calculations.
Note: 2014 emission estimates are provisional. Commerical sector and non-CO_2 are based on CCC estimates. The emissions from grid electricity are mainly power sector emissions, with a small contribution of 8 Mt from other sectors (mainly industry).

Emissions from buildings were more than 5$MtCO_2$ below our trajectory in 2014 (Table 2.1 and Figure 2.2). However, on a temperature-adjusted basis, they were 4$MtCO_2$ above the trajectory. It is also important to note that the trajectory does not include abatement from low-carbon heat technologies.[2] A lack of progress in public and commercial buildings is being masked by outperformance in homes. The slow-down in home insulation since 2012 (Section 3) suggests that some of the required further emission reductions are at risk if this trend continues.

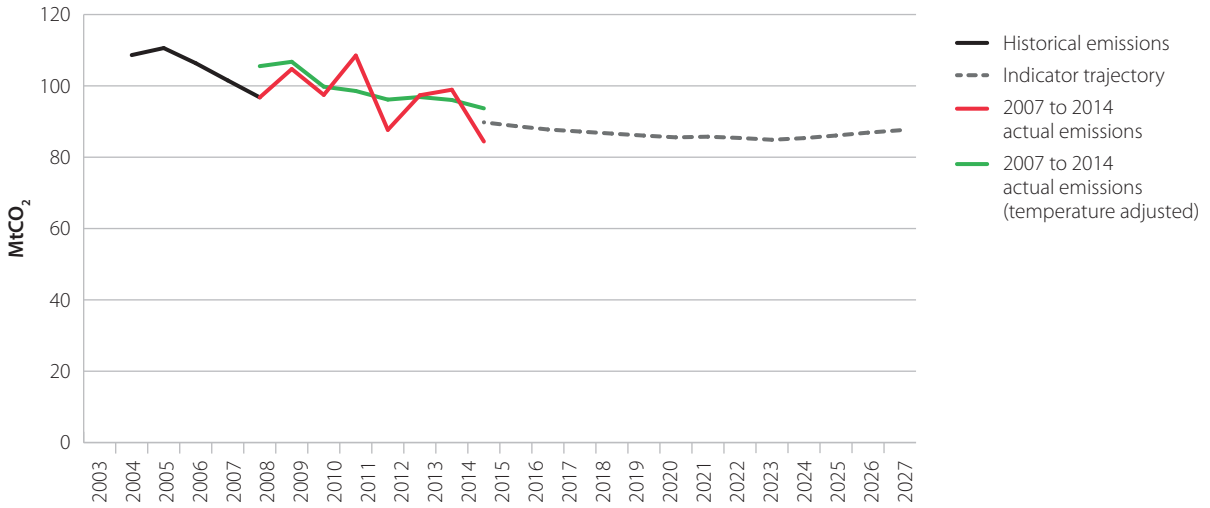
- **Residential buildings**: The drop in direct emissions in 2014 reflects a decline in fossil fuel consumption for space heating because of higher temperatures. The decline in electricity consumption is partially due to higher temperatures (with 7% of buildings heated by electricity) and partially due to continuing improvements in electrical appliance and lighting efficiency. For example, energy saving light bulbs accounted for just over 50% of the lighting stock in 2013 compared to 9% in 2007.
- **Commercial buildings**: Commercial buildings are the only element of the building stock which have not achieved a reduction in direct emissions since 2007. In 2014, there was less impact on energy use from higher temperatures than in homes.[3] There was better progress in reducing

1 It is also associated with a further 8 $MtCO_2$ of emissions associated with electricity consumed from the grid originally produced through autogeneration in industry and refineries.
2 Our trajectory currently only includes abatement potential from energy efficiency. We will include heat when we advise on the Fifth Carbon Budget later this year.
3 Consumption of heat in non-residential buildings is typically less sensitive to external temperatures. In 2014, DECC and CCC estimate that emissions from non-domestic buildings

electricity consumption, which fell by 5% in 2014. It is not possible to determine whether these changes are due to fuel-switching from electricity to gas due to lower gas prices. However, commercial energy intensity has remained flat over the carbon budgets period (Figure 2.5), which underlines the overall lack of progress in the sector.

- **Public sector**: On the surface, public sector buildings are making better progress than commercial sector buildings. However, one of the drivers could be downsizing of the public sector estate and falling public sector employment, which is currently at its lowest in 15 years. There is some evidence that this is being combined with some energy efficiency improvement, but progress is patchy. Electricity demand remained flat in public buildings.

Figure 2.2. All buildings direct emissions – historic vs trajectory



Source: NAEI (2015), DECC (2015), Energy Trends, March 2015, DECC (2014) DUKES; CCC calculations.
Note: 2014 emission estimates are provisional. Temperature adjustment is based on CCC calculations.

Table 2.1. Buildings emission trends – summary

	Direct emissions ($MtCO_2$) 2014		Temperature-adjusted change		% change from 2007	
	Actual	Temperature-adjusted	% change 2013-2014	% average change 2009-2013	CCC indicator trajectory	Outturn
Residential	62	71	-2%	-1%	-3%	-19%
Non-residential	22	23	-4%	1%	-14%	11%
of which commercial	14	14	-2%	2%	-	-
of which public	8	9	-7%	0%	-	-
All buildings	84	94	-2%	-1%	-5%	-13%

Source: CCC analysis based on National GHG Inventory.

would have been 4% higher under average temperature conditions, compared to 9% higher in the case of homes.

2. The Committee's approach to tracking progress in buildings

We track progress in the buildings sector against our detailed indicator framework, which we set out in our first Progress Report in 2009 and revised in our 2014 Progress Report. Apart from headline indicators on direct CO_2 emissions and electricity consumption, our buildings sector indicators cover low-carbon heat deployment, the installation of energy efficiency measures (insulation, boilers, LED lights and domestic appliances), and policies to deliver abatement.

- **Low-carbon heat:** We monitor overall deployment of low-carbon heat (as a percentage of heat demand), as well as delivery of installations under the main policy, the Renewable Heat Incentive. We examine low-carbon heat deployment in both the residential and non-residential sector in Section 3.
- **Energy efficiency:** We monitor actual installation numbers for key insulation measures (loft, cavity and solid wall insulation) and new boilers in homes, as well as the stock penetration for LED lighting and the most efficient wet and cold appliances (Section 4). While data for the residential sector is good, similar data is not available for the non-residential sector. We therefore only monitor the energy intensity of commercial and public sector buildings (measured as energy consumption per unit of output, Section 5).
- **Policies:** We monitor progress in implementing policies that drive low-carbon heat uptake and energy efficiency in homes, commercial and public sector buildings. This is a very complex policy landscape. Some policies (Renewable Heat Incentive, Building Regulations, appliance standards) apply to all buildings, while others cover only the residential (e.g. the Energy Company Obligation) or non-residential sector (e.g. CRC Energy Efficiency Scheme). Some policies are also devolved or partially devolved. Table 2.2 sets out the main policies. This list is not exhaustive – we refer to other supporting policies throughout the chapter. We examine low-carbon heat policy for all buildings in Section 3 and other policies separately for homes (Section 4) and non-residential buildings (Section 5).

Taken together, our indicators, if met, would put the UK on the path to a buildings sector that is much more energy efficient by 2030, and in which low-carbon heat plays an increasingly important role.

Table 2.2. Energy efficiency and emission reduction policies for buildings

Policy name	Sector	Description
Energy Company Obligation (ECO)	Residential	GB-wide obligation on energy suppliers to improve energy efficiency, reduce fuel poverty and save carbon in homes, legislated to run 2013-2017. Three sub-obligations: the Carbon Emissions Reduction Obligation (CERO), the Carbon Savings Community Obligation (CSCO) and the Home Heating Cost Reduction Obligation (HHCRO). Average annual ECO delivery costs by energy suppliers are around £0.8 billion, with costs recovered through customers' energy bills.
Green Deal	Residential	Financial mechanism for energy measures in able-to-pay households recommended in a Green Deal assessment. No upfront payment for measures as the costs are recovered over time through the electricity bill. Fixed interest rate finance through the Green Deal Finance Company. Green Deal assessments are available to businesses but no special finance is available.
Devolved energy efficiency schemes	Residential	Scotland and Wales have their own energy efficiency schemes (generally fuel poverty focused) to supplement the ECO. Northern Ireland has a supplier obligation scheme similar to the ECO, as well as an additional boiler replacement and fuel poor energy efficiency scheme (Chapter 7).

Green Deal Home Improvement Fund	Residential	Provides up to £1,250 subsidy for installing two out of a list of 11 energy efficiency measures. Previous phases have also subsidised solid wall insulation. England and Wales only.

Table 2.2. Energy efficiency and emission reduction policies for buildings

Policy name	Sector	Description
Renewable Heat Incentive (RHI)	All	Subsidy scheme available to businesses and public bodies (since 2011) and householders (since 2014). It pays a fixed tariff per unit of renewable heat produced for a range of technologies including heat pumps, biomass boilers and solar thermal.
Building Regulations part L	All	Sets out the energy efficiency requirements (the conservation of fuel and power) for new buildings and refurbishment to existing buildings. Devolved policy, called Part F in Northern Ireland.
Zero Carbon Buildings	All	From 2016, new homes built in England will have to be built to a zero carbon standard. This will require a high level of energy efficiency and will allow some offsetting of carbon emissions through off-site 'allowable solutions'. Public buildings will follow in 2018 and commercial ones in 2020. Scotland, Wales and Northern Ireland are planning similar standards.
Energy Performance Certificates (EPCs)	All	EPCs are required under the EU Energy Performance of Buildings Directive whenever a building is built, sold or leased and provide an energy rating based on the performance of the building itself and its services (such as heating and lighting).
Display Energy Certificates (DECs)	Public	Required for public buildings with a floor space over 500 m^2. This certificate shows the actual energy usage of a building and must be produced annually. Commercial buildings can adopt DECs on a voluntary basis.
Private-rented sector regulations	All	Legislation passed in early 2015 requires all properties in the private-rented sector in England and Wales to meet a minimum EPC standard of 'E' from 2018 when rented/leased.
Real time displays/Smart meters	All	Energy suppliers have an obligation to deliver smart meters (which provide near real time information on energy use) to all households and businesses by 2020.
EU Products Policy	All	Policy that regulates energy-related products in the EU. Includes minimum energy performance standards for appliances under the Ecodesign Directive and the Energy Labelling Directive.
CRC Energy Efficiency Scheme (previously the Carbon Reduction Commitment)	Non-residential	Mandatory carbon reduction and energy efficiency scheme for large non-energy intensive public and private organisations. It requires them to report on electricity and gas consumption and pay a carbon tax. It covers emissions not already covered by the EU Emissions Trading Scheme and Climate Change Agreements.
Climate Change Levy (CCL)	Non-residential	Tax on energy consumption which applies to all non-domestic consumers. In 2014/2015, the rates were 0.541 p/kWh for electricity and 0.188 p/kWh for gas.
Energy Savings Opportunities Scheme (ESOS)	Non-residential	Compulsory Energy Audits required under the EU Energy Efficiency directive for all 'large' enterprises (over 250 employees and/or above turnover and balance sheet thresholds). The first year of audits is 2015, to be repeated every three years.

3. Low-carbon heat

Low-carbon space and water heating is critical to cost-effective decarbonisation, but has not received the policy attention that its importance merits. The following section reviews the lack of progress to date in this area and the implications for meeting carbon budgets. An urgent policy response is required.

(a) Progress against indicators

Low-carbon heat made up 1.6% of all heat used in buildings in 2014, or 2.1% if agricultural buildings are included (Figure 2.3).

On this basis, the Government ambition of 12% of heat from low-carbon sources by 2020 no longer looks achievable:

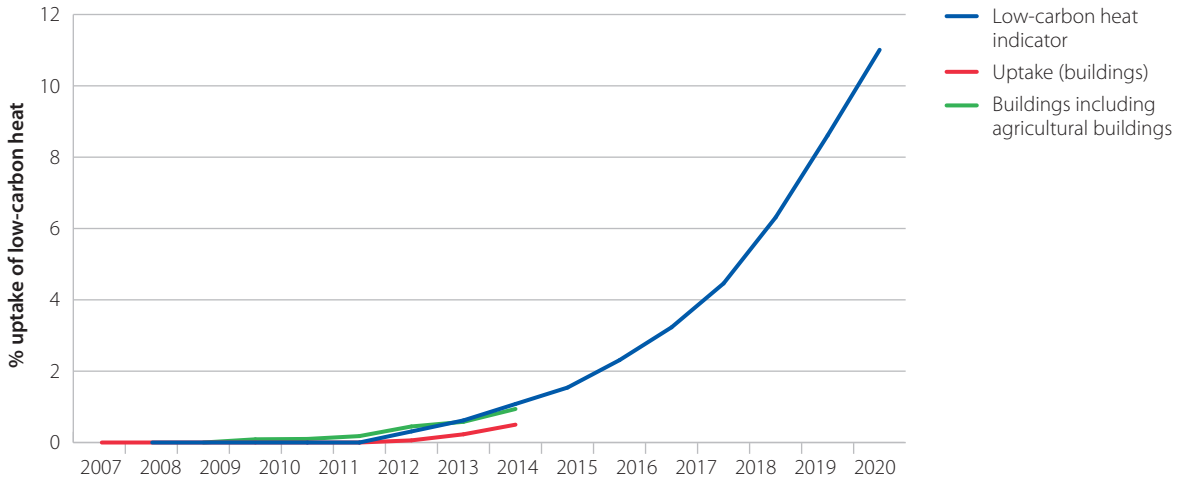
- Government's 12% ambition for 2020 has always looked difficult to achieve given the low starting base, particularly in the second half of the decade where uptake was set to increase from 4% to 12% within four years.
- This trajectory was informed by projections of uptake under the RHI, which have not been realised in initial years of the scheme. There is currently a mismatch between the ambition for the RHI and its role in driving low-carbon heat. In 2013, it supported only 0.6 TWh or 3% of the total low-carbon heat in the economy:
  - Industrial and domestic biomass makes up the largest part of low-carbon heat, at 5.9 and 5.2 TWh in 2013 respectively. In both cases, over 80% of the uptake precedes the RHI.
  - Of the additional low-carbon heat which has come online since, only a portion has been supported by the RHI. It is likely that for larger schemes, issues around the bankability of the RHI are one of the main issues.[4] The reasons for continued uptake of renewables without RHI subsidy in buildings are less clear, but may be due to lack of awareness of the scheme or delays in accreditation.
- The scale of the challenge is reinforced through comparison with progress in other EU countries. For example, although low-carbon heat is already delivering almost 10% of heat demand, the German Government has responded to concerns around the feasibility of meeting its 14% renewable heat target by 2020[5] with a new package of measures to drive uptake. The fact that it felt the need to take remedial action to mitigate the risk of achieving a four point increment in five years highlights the likely difficulty for the UK in achieving more than twice that ambition in the same period.

Our cost-effective trajectory for meeting the fourth carbon budget includes 24% of heat from low-carbon sources in 2025 across the economy. Falling behind on heat decarbonisation implies higher costs in other sectors for achieving the same level of effort.

4 For projects with long-lead in times, policy uncertainty around the future of the RHI, along with the uncertainty linked to the impact of any future tariff degression mean that RHI revenues may not be accepted by investors as part of the financial case. This issue could be remedied through the use of tariff guarantees. This solution has been considered by DECC in a paper *Non-Domestic Renewable Heat Incentive Tariff Guarantees* (DECC, 2014) which is available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/384316/RHI_Tariff_Guarantees_Position_Paper_-_9th_December_2014.pdf

5 Measures to address this include incentives totalling 300 million euros, bonuses for small and mid-size companies that invest in renewable sources of heating, as well as grants and loans for bigger companies.

Figure 2.3. Uptake of low-carbon heat in buildings



Source: DECC (2014) Digest of UK Energy Statistics 2014; DECC (2014) Energy Consumption in the UK; CCC calculations.

Uptake of heat pumps in homes continues to be slow, with 15,000 delivered in 2014 under the RHI, and a cumulative stock of around 120,000.[6] If sales remain at current levels, the cumulative total in 2020 will be around 250,000 – less than half our indicator of 600,000 on the cost-effective path.

(b) Policy

The following section reviews progress in building up low-carbon heat supply. Both the domestic and non-domestic RHI are also assessed in Sections 4 and 5, alongside other demand-side policies.

Building-scale technologies overview

Retrofit

The Renewable Heat Incentive (RHI) is the main mechanism in place for delivering low-carbon heat to 2020. It is a set of tariffs for domestic and non-domestic heating technologies. The tariffs pay a fixed price per unit of renewable heat generated.[7] They are designed to cover the additional costs relative to standard heating technologies.

The delivery of building-scale technologies under the RHI has picked up pace over the past year with both schemes forecast to be over budget for this year. However, there remain significant challenges to increasing heat pump uptake in non-residential buildings and continuing to build up the volume under the domestic RHI.

Recent analysis by the Energy Technologies Institute (ETI) has estimated a significant increase in abatement costs to 2050 of around 30%, if electric heating solutions are not deployed. This reinforces our assessment of the need to support the deployment of heat pumps in buildings.

The **non-domestic RHI** has successfully driven the uptake of bioenergy, but is failing as a mechanism for driving heat pump uptake.

- To date, 99% of the 3.0 TWh of heat generated[8] under the non-domestic scheme has been bioenergy – mainly small (45%) and medium-scale (34%) biomass boilers.

6 Calculated based on figures in Nowak, T., Jaganjacova, S. & Westring, P. (2014) *European Heat Pump Market and Statistics Report 2014.*
7 This is based on metered heat output in the case of the non-domestic scheme and on deemed heat for the domestic scheme (i.e. estimated).
8 DECC (2015) *RHI statistics release, April 2015.* If including equivalent heat generated by biomethane injected in to the gas grid, this would bring the total up to 3.2 TWh of heat generated to date.

- Discussions with industry stakeholders suggest that the returns offered by the current biomass tariffs may be higher than for heat pumps. This should regulate itself over time as the tariffs are adjusted down through the tariff degression mechanism, although this will not necessarily lead to the uptake of more heat pumps.

Targeted actions are required to address this issue and should be a focus for the new Government.

Uptake in the first year of the **domestic RHI** has seen a more balanced mix of technologies, but significant year-on-year growth in heat pump sales is required to meet the carbon budgets.

- Under the domestic RHI there were 19,000 heat pump accreditations out of a total of 33,000 accredited renewable heat installations – a volume of heat pump sales broadly in line with the average 18,000 heat pump sales observed between 2010 and 2013.[9]
- Even if the market were to grow 30% year-on-year to 2030, the cumulative number of heat pumps delivered would be around 3.2 million, falling short of our assessment of the cost-effective trajectory of 4 million heat pumps in homes by 2030.

Meeting carbon budgets will require maintaining incentives in place in the near-term for all buildings, combined with a targeted set of measures to address areas of shortfall. Two of the main non-financial barriers affecting uptake are low public awareness of the subsidies and the consumer risk premium attached to lesser known low-carbon technologies.[10] Addressing these barriers can help boost uptake and improve the overall scheme cost-effectiveness.

- Awareness of the support schemes is very low at 21% for the non-domestic scheme[11] and most likely lower for the domestic RHI.[12]
- Current RHI tariffs make allowance for additional costs,[13] designed to give a return of 16% to consumers and 12% to businesses. These are partly to overcome non-financial barriers to uptake, including lower confidence in new technologies. These barriers could be addressed through continued confidence building, including further training for installers, consumer training and follow-up support.

The priority for the new Government should be to produce a detailed delivery plan that sets out the role of heat in meeting the fourth carbon budget.

- In our 2014 Progress Report, we set out the need to commit funding to 2020 and to commit to the continued existence of the RHI until an adequate replacement is in place.
  - The non-domestic RHI is currently the main mechanism for delivering low-carbon heat uptake to 2020, due to the relative cost-effectiveness of large-scale renewable heat projects and lower risk premiums than for householders.
  - The domestic RHI scheme is intended to make a smaller contribution towards the 2020 renewables target and 12% low-carbon heat ambition (only around 10-30% of the total buildings uptake).[14] It is essential to build up supply chains to allow the sector to deliver at volume through the 2020s.

9 Nowak, T., Jaganjacova, S. & Westring, P. (2014) *European Heat Pump Market and Statistics Report 2014.*
10 Others include a poorly insulated housing stock which is less suitable for heat pump retrofit, hassle costs and the disamenity value attached to any loss of space.
11 DECC (2014) *Evaluation of the Renewable Heat Incentive. Interim report: The non-domestic scheme.*
12 Latest available figures from the DECC Wave Survey found that only 5% of people surveyed had heard of the RHI – see DECC (2014) *Green Deal Household Tracker survey. Research on awareness of the Green Deal and the Domestic Renewable Heat Incentive Wave 4 report, June 2014.*
13 This includes the cost of capital, hassle and a risk premium attached to new technology.
14 Range based on original 2010 RHI projected uptake of 51 TWh of low-carbon heat in buildings by 2020, on a heat output basis. The bottom of the range reflects the DECC (2013) *Domestic RHI Impact Assessment*; the top of the range is taken from CCC (2010) *The Fourth Carbon Budget.*

  - Financial incentives are currently required to drive uptake of low-carbon heat. Without incentives in place, the UK will struggle to meet the carbon budgets without incurring significant other costs.
  - There is a need for an immediate focus on large-scale heat pumps for non-domestic users to 2020, followed by a growing focus on the domestic market in the 2020s.
- Commitment to funding should be combined with actions to reduce funding costs by addressing non-financial barriers (through marketing campaigns and installer training) and by reducing the cost of capital factored in to the tariffs (through extending the Green Deal or low-cost finance options to cover low-carbon heat).
- Beyond 2020, long-term affordability concerns of the RHI imply the need to transition to alternative approaches. Options include regulation (for example, in the form of progressive standards), alternative forms of finance, a carbon tax and a greater role for local energy planning.

This should be part of a broader delivery plan which includes a policy framework for new build and heat network infrastructure, and is integrated where possible with fuel poverty and energy efficiency programmes.

New build

New homes are expected to make up around 20% of the building stock in 2050, but only 10% of heating demand. They are therefore less critical than retrofit to meeting carbon budgets. However, new build properties can play an important role in boosting supply-chains for low-carbon heat technologies and they present fewer barriers to heat pumps than retrofit:

- There is an opportunity cost of constructing new buildings without appropriate measures that then need to be retrofitted. In particular, heat pumps can be fitted at a lower cost in new homes and with optimal design conditions.
- There are spillover benefits to retrofitting existing homes if the supply chain and related expertise is boosted by the delivery of low-carbon heat to new build.

A delivery plan for low-carbon heat should cover both new build and existing buildings. Zero Carbon Homes and Zero Carbon non-domestic buildings policy (Sections 4 and 5) should therefore seek to encourage the deployment of low-carbon heat measures, unless heating requirements are very low. Alongside specific measures on existing buildings, this should be used to improve the uptake of low-carbon heat across all properties.

Networked low-carbon heat solutions

Heat networks

Heat networks are a key enabling technology for decarbonising heat in high density areas, where other options are limited.

Good progress has been made in supporting feasibility studies for heat networks, though it is currently unclear to what extent these will translate into a major expansion of district heating schemes.

- In 2014 there was strong demand from local authorities in England and Wales for funding from the Heat Networks Delivery Unit (HNDU) for feasibility studies, with £2 million awarded in early 2014 by DECC, followed by £7 million in 2014/15. A further £3 million is to be allocated by March 2016, which will bring the total up to £12 million by the end of this financial year.
- DECC has also targeted £7 million of innovation funding at heat networks (Box 2.1)

Challenges ahead include facilitating development funding, future-proofing networks and putting in place regulation for the sector (Box 2.2).

Government should extend the functions currently provided by HNDU, with an expanded focus on supporting network development.

- HNDU includes a number of industry experts and has provided valuable support to local authorities alongside funding.
- There is a risk that the current momentum and progress made in capacity-building will dissipate without Government commitment to heat network roll-out.

In the medium term, DECC will need to come to a view on the case for additional capital funding and an appropriate level of regulation for heat networks.

There is an opportunity to capitalise on heat network roll-out by developing local energy plans which take account of the building stock and supply-side options, and can take a wider approach to appraising network investment options. By pooling data, this could equally provide a springboard for a more integrated approach to heat and energy efficiency, and as a basis for targeting fuel poverty measures (Box 2.2). This route should be assessed within the context of a low-carbon heat delivery plan. We are undertaking further research in this area which will feed in to the Fifth Carbon Budget Advice later this year.

Biomethane

An alternative to new heat networks in some areas might be the use of bioenergy injected directly into the existing gas grid. Biomethane resources can also be deployed in other sectors long-term, including as a means of decarbonising high-grade industrial process heat. To 2030, our central decarbonisation pathway for meeting carbon budgets includes 27 TWh of biomethane, enough to heat around 2 million homes.

With support through the RHI, the theoretical maximum injection capacity of biomethane increased from 0.09 to 1.85 TWh in 2014.[15] Feedstocks are largely agricultural, with around half the contribution from food waste, and a smaller but growing share from sewage sludge. Further action to reduce food waste to landfill (Chapter 6) would help secure a sustainable feedstock stream for biomethane from anaerobic digestion.

15 This is according to figures from the Green Gas Certification Scheme, where a theoretical maximum generation is based on plant operating 24 hours a day throughout the year. It is therefore higher than current volumes (the RHI has supported around 0.2 TWh of biomethane injected into the grid to date). The increase was despite significant policy uncertainty due to the tariff and banding review of biomethane over the course of 2014.

Box 2.1. Innovation in low-carbon heat and buildings technologies

Low-carbon heat

Total public funding for low-carbon energy innovation delivered by members of the Low Carbon Innovation Coordination Group, which brings together the major public sector backed organisations working in this area, was forecast at around £800 million during the previous Spending Review period (2011-2013). While initially mainly focused on electricity and buildings energy efficiency, heat decarbonisation has seen a growing interest over the past year, with a stronger focus on demonstrator projects.

- Innovate UK and the Scottish Government under its CARES scheme and Local Energy Challenge Fund have set up two funding streams for feasibility studies and large-scale local low-carbon demonstrators, of £0.35 million and £20 million respectively. A number of the projects focus on integrating low-carbon heat with demand-side management and heat storage.
- DECC launched a smaller pot of £7 million for 16 low-carbon heat projects, of mixed feasibility and demonstration funding. The shortlisted projects range from a combined solar PV and heat pump project with interseasonal ground recharge, to a scheme trialling super insulated pipes, to industrial waste heat recovery.
- Innovate UK also launched the Energy Systems Catapult in 2015 which has a number of heat-related themes, including localised energy systems, integration of energy storage, advanced control solutions and heat network solutions.

In order to meet carbon budgets, key areas for future technology development include heat storage and system integration. New technologies, business models and financing mechanisms can open up new markets and guide investment.

- Phase change materials used for 'heat batteries' provide a means of smoothing heat demand peaks alongside conventional hot water storage tanks and solar ground recharge.
- Integrating heat with other energy supply and demand-side management can help optimise the overall system functioning and costs. A 2013 study found that the UK possesses poor scientific capabilities across the key decentralised energy research areas (i.e. district heating, heat pumps) but relatively strong capabilities in PV.
- New business models for delivering energy services are a key area of research, including a greater role for community energy, shared ownership models and smart systems.

Continued public support in these areas will be important, particularly in bridging the gap between research council-funded programmes and heat technology markets.

Sources: HMT (2011) *The Carbon Plan*. Skea, J., Hannon, M. and Rhodes, A. (2013) *Research Councils UK Energy Programme Strategy Fellowship Energy Research and Training Prospectus: Report no.3, Energy in the Home and Workplace.*

Box 2.2. Heat networks and locally-led delivery

Heat networks

A major expansion of low-carbon heat networks will require progress in a number of areas:

- Current HNDU funding is limited to feasibility studies, and it does not support local authorities in the development of local energy plans. Given the benefits of local coordination for energy and infrastructure planning, Government should consider supporting local authorities in this work and formalising their role.
- Sources for capital funding include the Green Investment Bank, the Public Works Loan Board, the District Heating Loan Fund in Scotland, as well as other European funding and grant schemes. Achieving roll-out of heat networks consistent with the 15% potential by 2030 highlighted in the DECC Heat Strategy will require further coordination and support.
- Most schemes currently under development use gas Combined Heat and Power (CHP) as the primary technology. A falling power sector emissions intensity means that gas CHP can only deliver carbon savings until the late 2020s.[16] Given that the network infrastructure is expected to last upwards of 50 years, there is a need for schemes to assess low-carbon transition options in order to future-proof the networks.

16 Based on modelling by LCP for DECC, LCP (2014) *Modelling the impacts of additional Gas CHP capacity in the GB electricity market*. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/389070/LCP_Modelling.pdf DECC based their analysis on a power sector decarbonisation scenario which achieves an average grid emissions intensity of 100g/kWh by 2030. This suggests that new gas CHP has the potential to save carbon until around 2032. The CCC central power sector decarbonisation scenario is more ambitious, aiming to achieve 50-100g/kWh by 2030.

Box 2.2. Heat networks and locally-led delivery

- Research undertaken by Which? has highlighted a number of issues linked to consumer protection and poorly designed schemes. Whilst a voluntary code of practice will provide a useful model, the industry may benefit from being set on a more equal footing with other regulated utilities.

Continued Government support is required in these areas.

Locally-led delivery: linking up heat decarbonisation with energy efficiency and fuel poverty

In our 2014 Progress Report, we set out the case for linking the Green Deal and the RHI as a means of reducing finance costs and thereby the overall funding costs of the RHI. This would build on existing links between the schemes (chiefly, the requirement for a Green Deal assessment to take place before the RHI can be obtained, along with the installation of loft and cavity wall insulation where this is identified in the assessment).

Local energy planning provides a means of taking a more integrated approach to buildings decarbonisation and energy infrastructure planning. This could help mitigate the risk of funding going towards competing building-scale and network solutions.

- The Energy Technologies Institute (ETI) has developed software to support local energy planning and infrastructure decision-making, called Energypath Networks. The next steps are to pilot the approach working with the Greater Manchester Combined Authority, Newcastle City Council and Bridgend County Borough Council (together with the Welsh Government).
- The Government published the first community energy strategy in 2014. This vision included a role for local authorities to support community energy through partnerships, through investment and by providing a positive planning and policy environment. A number of local authorities have set up partnerships with energy suppliers and other organisations to support community energy (examples include Cheshire East Council and Ovo Communities, Oxford City and Oxford County Council and Low Carbon Hub).
- Evaluation of these partnerships within the context of other local energy planning would provide useful evidence for developing a low-carbon heat action plan for the 2020s.

As highlighted in a recent ETI report on heat, there is currently no single body tasked with strategic oversight of electricity, gas and heat infrastructure decision-making and coordination.

- There is little incentive for network operators to engage with developers and community organisations.
- There are a small number of counter-examples of electricity distribution network operators setting up funding for community groups (Northern Power Networks) or going into joint ventures on low-carbon heat such as biomethane.

There is a role for Government in reviewing the structure of the system, and supporting the development of new business models which are adapted to the demands of energy system transition.

Source: ETI (2015), *Smart systems and heat Decarbonising Heat from UK Homes.* LCP (2014) *Modelling the impacts of additional Gas CHP capacity in the GB electricity market.* Which? (2015), *Turning up the Heat.*

4. Residential buildings

(a) Implementation of measures

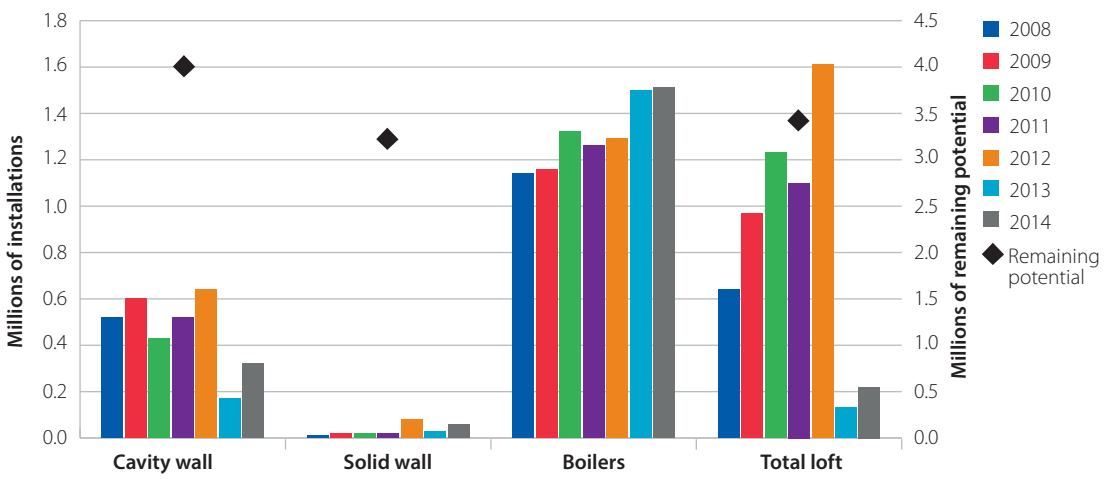
Improving energy efficiency through better **insulation** is important for reducing emissions, energy bills and fuel poverty. In 2014, the second year of the new policy to drive energy efficiency in the residential sector (the Energy Company Obligation and the market-based Green Deal), there was an improvement in installation rates[17] for insulation measures compared to 2013. However, uptake continued to remain well below rates under the previous schemes (Carbon Emissions Reduction Target and Community Energy Saving Programme) which operated during the first carbon budget period (Figure 2.4):

17 Installation rates are based on uptake delivered under ECO, Green Deal Finance, cashback (England and Wales only) and the Green Deal Home Improvement Fund (England and Wales only). Due to lack of data availability, we are unable to report on the delivery of measures under the Green Deal Communities Fund and devolved schemes (e.g. Arbed in Wales).

- **Lofts:** Although installation rates of loft insulation increased by 67% to 217,000 in 2014, this remains a quarter of the level during 2008-12. The high uptake achieved during the first carbon budget means that the cumulative uptake by 2014 was above our indicator trajectory. However, uptake would fall below our trajectory by 2019 if annual uptake remained at 2014 levels. As in 2013, ECO was the main mechanism driving uptake, while Green Deal Finance only delivered around 700 installations.
- **Cavity walls:** There was an 87% increase from 2013 to 2014, with the number of installations in 2014 totalling around 321,000. ECO delivered the bulk of measures, equally split between easy-to-treat and hard-to-treat cavity wall insulation. In terms of cumulative uptake, levels are slightly below our indicator trajectory for 2014.
- **Solid walls:** The uptake of solid wall insulation more than doubled to over 60,000 measures in 2014, although cumulative uptake is almost 500,000 short of our indicator trajectory. The ECO accounted for around 80% of the uptake, while the additional injection of money under the new Green Deal Home Improvement Fund (GDHIF) accounted for a further 14% of installations.

There still remains a large number of lofts and cavity walls to insulate in order to meet carbon budgets (Figure 2.4), as well as a high number of solid wall homes.

Figure 2.4. Annual installation rates (2008-14) and remaining potential



Source: DECC (2014), CCC calculations.
Note: Remaining potential to meet fourth carbon budget. Savings from boilers are not included in cabon budgets as uptake is included in the baseline.

As in previous years, **boiler replacement** proceeded well. Driven by the 2005 Building Regulations, which mandated highly efficient condensing boilers, 1.5 million new efficient boilers were installed in the existing housing stock in 2014. This takes the cumulative uptake to 9.3 million boilers, which is 2.5 million above our indicator trajectory. Energy efficiency policy only delivered a small proportion of these new boilers, with ECO's Affordable Warmth sub-obligation subsidising around 124,000 boilers.

Electricity demand from households peaked in 2005 at 126 TWh and has been declining since. Improvements in the energy efficiency of **appliances** have more than offset the increase in the number and use of those appliances. However, stock penetration of wet and cold appliances with the highest efficiency ratings still remains low:

- **Cold appliances:** A++ or higher still only accounts for around 1% of the total stock in 2013, which is below our indicator trajectory of 6%.

- **Wet appliances:** A+ or better accounted for 14% of the total stock in 2013, compared with our indicator trajectory penetration rate of 21%.

Minimum energy efficiency standards under the EU Ecodesign Directive are being tightened gradually but there is no specific policy to drive uptake of the most efficient appliances, other than the EU energy labelling scheme.

Numbers of efficient **LED lamps** have only seen a small increase to just over 4.6 million out of a total lighting stock of 724 million. The EU Commission recently postponed the phase-out of inefficient halogen lamps by two years to September 2018. This decision is likely to delay LED uptake.

Energy efficiency measures continue to provide scope for cost-effective abatement. Insulation measures are also important to make the housing stock more suitable for heat pumps. Furthermore, energy efficiency plays a key role in fuel poverty alleviation. It is therefore crucial that the new Government improves the effectiveness of energy efficiency policy.

(b) Policy

Energy Company Obligation & Green Deal – current status

The GB-wide Energy Company Obligation (ECO) was introduced in January 2013 with the dual purpose of carbon reduction and fuel poverty alleviation. Paid for by a levy on energy bills and worth around £0.8 billion per year[18], it provides support for a range of energy efficiency measures. In Scotland and Wales, ECO delivery is supplemented by a number of devolved policies, the majority of which are focused on fuel poverty alleviation (Chapter 7). In Northern Ireland, energy efficiency policy is fully devolved.

The ECO was amended in April 2014 after just over one year of operation. The overall funding envelope (down from around £1.4 billion) and ambition of the obligation were reduced and the focus changed towards delivering more low-cost measures. This resulted in a large increase in the volume of loft and cavity wall insulation being installed in 2014, although these remain below pre-ECO levels. Solid wall insulation numbers have dropped. Delivery to fuel poor households has also been affected.

- The carbon saving ambition under the Carbon Emissions Reduction Obligation (CERO) was reduced by 33% from 20.9 $MtCO_2$ lifetime savings to 14 $MtCO_2$ as suppliers switched away from the more costly solid wall insulation. It accounts for around 30% of ECO spending.
- Targets for the Carbon Savings Community Obligation (CSCO) and the Home Heating Cost Reduction Obligation (HHCRO) remained unchanged and have been extended to March 2017. Boilers under HHCRO accounted for 70% of all measures in 2014. Following early delivery of the target by suppliers, total measures fell by 30% in 2014 compared to 2013.

There is evidence that the ECO currently fails to target fuel poverty effectively. In 2013, the number of households in fuel poverty in England was estimated at 2.35 million, representing approximately 10% of all English households. The level of fuel poverty has seen little change over the last decade. The devolved nations, which use a different measure of fuel poverty, have even higher percentages of households in fuel poverty (Chapter 7).

Estimates[19] suggest that while almost all CERO support goes to able-to-pay households, even the ECO elements targeted at fuel poverty alleviation fail to reach the fuel poor. Only 12% of measures under CSCO and 30% of measures under HHCRO are estimated to reach the fuel poor, although many more are going to other lower-income households. If England's new fuel poverty targets are to be achieved, a policy better targeted at the fuel poor and with additional funding is required (Box 2.3). Fuel poverty

18 Based on DECC's estimate of 2015-17 average delivery costs in the 2014 ECO Impact Assessment. Actual spend may differ.
19 Energy Bill Revolution and Association for the Conservation of Energy (2015) *Left out in the cold.*

targets in the devolved administrations are also currently off-track (Chapter 7) and both the Scottish and Welsh governments have identified the changes in the ECO as a particular reason for a scaling-down of delivery over the last year.

Cuts in the ECO were supposed to be carbon-neutral and compensated for by additional measures funded by the taxpayer, although as yet no assessment is available of the amount of carbon saved by these.

- The Green Deal Home Improvement Fund (GDHIF) was first launched in June 2014, with a further two rounds following in December 2014 and March 2015 and a total spend of around £220 million. The GDHIF has proved very popular with eligible households in England and Wales and by the end of February 2015 it had accounted for the delivery of over 18,000 measures. Most of the funding has gone to owner-occupied households, with a small proportion claimed by registered social landlords. 70% of GDHIF funds have been used to support solid wall insulation.
- The Green Deal Communities schemes provided £88 million in 2014 to 24 local authorities in England. The aim was to provide energy efficiency measures to 32,000 homes, to be rolled-out on a street-by-street basis.

In contrast to the popularity of the GDHIF, the 7% financing costs of taking out a Green Deal plan continues to hinder uptake, with a total value of Green Deal finance plans by April 2015 of only £48 million. This compares to an initial ambition of up to £1.3 billion by the end of 2015. While there has been an increase in delivery in early 2015 (over 2,500 measures from January to March, compared to 7,000 for the whole of 2014), it is unlikely that a much higher uptake can be achieved without a reduction in the costs of the scheme. In terms of the measures being delivered, over half were for solar PV and condensing boilers, which raises the question as to whether the scheme is delivering additionality (i.e. whether the measures would have been taken up in the absence of Green Deal finance).

Box 2.3. England's new fuel poverty target and strategy

In 2014, a statutory instrument was adopted in England which sets out a new fuel poverty objective of ensuring that as many (as is reasonably practicable) of the homes of persons living in fuel poverty have an energy performance certificate (EPC) rating of Band C, by 31st December 2030.

Analysis conducted by CSE for the Committee in 2014, which fed into our response to DECC's consultation on a new fuel poverty strategy, indicated that effective targeting of energy efficiency and low-cost heat measures to the fuel poor could significantly reduce fuel poverty levels in England from around 11% in 2013 to below 5% by 2030. Furthermore, this could be achieved while also meeting the fourth carbon budget.

Our analysis estimated that meeting the Government's EPC target of C by 2030 would require annual funding of at least £1.2 billion a year, with current funding commitments under the ECO (nominally around £0.7 billion annually for England) falling short of this, as well as being only partially focussed on fuel poverty. We therefore recommended more funding be made available in order to achieve the target (e.g. from infrastructure funding).

In the Government's fuel poverty strategy, which was published in March 2015, there were no long-term funding commitments beyond the financing of short-term pilots and extra funding for off-grid homes:

Box 2.3. England's new fuel poverty target and strategy

- **Pilots:** to encourage innovation, DECC is making available £3 million funding to run new pilots, which will be used to feed into the design and delivery of future support:
  - *'Warmth on prescription'*: £1 million has been allocated to nine local authorities to fund a one-year pilot to improve health and well-being. Working in partnership with the NHS, doctors will be invited to prescribe energy efficiency home improvements to patients they judge to be ill in part because of fuel poverty. A similar scheme in Sunderland demonstrated the health benefits, with reduced GP and hospital visits for patients with chronic obstructive pulmonary disease following the uplifting of the EPC of their homes from a G to a C rating.
- *Local fuel poverty innovation funding*: A further £2 million will be spent on piloting projects that can provide innovative approaches to alleviating fuel poverty for off-gas grid, park homes and community energy approaches.
- **Improving the reach of support to certain high fuel-cost homes:**
  - *Non-gas homes*: For the second phase of the ECO (2015-17), the design of the scheme has been revised to boost delivery to these homes. DECC estimates this will increase the amount of Affordable Warmth funding going to this group from 2% (Jan 2013-Sep 2014) to 30%. At the same time, DECC will improve the mapping and identification of non-gas homes.
  - *Central heating fund*: A £25 million fund was launched in March 2015 for local authorities to support up to 8,000 fuel poor off-grid households. This will focus on the delivery of first-time central heating systems.
  - *Park homes*: The Government will undertake additional research on the specific drivers of fuel poverty for residents of park homes (mobile homes occupied as permanent residences).

Progress towards the 2030 target will be reported against key indicators, which will set out the scale and extent of action taken to tackle fuel poverty. The indicators include SAP rating, the number of fuel poor with condensing boilers, central heating, loft and cavity wall installation, renewables installed in non-gas homes; and children in fuel poverty. However, DECC has not included a reliable indicator for health and wellbeing, and work is on-going to remedy this.

Future policy for home energy efficiency

Over the past few years, energy efficiency policy has seen numerous changes, substantially affecting the delivery of measures and eroding confidence in the supply chain. Energy efficiency is important for decarbonisation and for meeting fuel poverty targets. We have previously raised concerns about the overall level of funding available and issues of targeting and design.

The ECO currently only runs to 2017. DECC should, by mid-2016, put in place an extension or replacement policy for a period of at least five years, thus providing clarity to the supply chain. This should focus on:

- Meeting targets for fuel poverty: we have previously identified that fuel poverty spending in England is insufficient to meet the newly legislated fuel poverty target, while targets in the devolved nations are also not being met. Future policy needs to address this deficit through a combination of GB-wide and nation-specific policies.
- Improved delivery: Preliminary evidence from the Green Deal Communities scheme and programmes in place in Wales and Scotland suggests that local authority-led delivery may be effective. It also offers opportunities for a better integration of energy efficiency, fuel poverty and low-carbon heat approaches. DECC should therefore consider a larger role for locally-led delivery. This should build on a comprehensive evaluation of existing schemes.

A potential challenge to the future uptake of energy efficiency measures is the June 2015 ruling from the European Court of Justice (ECJ) that the UK's reduced VAT of 5% rate for energy-saving materials for housing (such as insulation) violates the EU's VAT Directive. The low VAT rate also applies low-carbon heat options such as heat pumps. Applying a 20% VAT would make these measures less cost-effective and may have to be compensated for.

Government and others are still reviewing the implications of the ruling and next steps. We will consider whether the ruling has a significant impact on the UK's ability to meet carbon budgets or on the ambition for the fifth carbon budget.

Domestic RHI

The domestic RHI has supported 33,000 installations since its launch in April 2014, 70% of which were legacy applications.[20, 21] This included 14,100 air source heat pumps and 4,400 ground source heat pumps of which 70% were legacy applications. Addressing the awareness and upfront cost barriers are critical. Options include:

- Linking the RHI to the Green Deal could help raise its profile as well as boost uptake.
- Examples of awareness raising include the Scottish Government funding the Energy Saving Trust to send 40,000 letters to residents promoting the domestic scheme as part of the 'Feel the Heat' campaign in 2014.

Beyond this, tackling the barrier created by high upfront costs would help fuel poor consumers to benefit from the financial returns available under the RHI. These currently mainly benefit householders with existing financial resources to cover the upfront investment. Other options discussed in our 2014 Progress Report include targeting part of the RHI to the fuel poor, or ring-fencing part of the budget towards capital subsidies. Ongoing work to make funds available through third parties may also have a beneficial effect.

Other policy developments

During the last 12 months, there have been new developments in a number of policy areas which will result in carbon reductions over time.

- Minimum energy performance standards for the private rented sector: Regulations passed into law in early 2015 will require private landlords in England and Wales to improve the energy efficiency of the least efficient properties. From 2018, no F and G rated properties can be rented out although in practice, landlords only have to install measures that can be funded under the Green Deal. There is also no provision for tightening the regulations over time, as we have previously recommended. The regulations will affect just over 15% of homes but exclude around one million household spaces[22] that can be defined as Housing in Multiple Occupancy (HOM). Many of the occupants living in HOMs are vulnerable and/or fuel poor. Scotland is currently preparing a consultation for its own energy performance regulations which may include owner-occupied housing.
- Zero carbon homes: From 2016, homes in England will have to be built to zero carbon standards, with the devolved administrations following by the end of 2020 to conform with EU requirements for 'nearly zero energy' buildings under the Energy Performance of Buildings Directive. For England, the 2015 Infrastructure Act provides enabling powers for off-site carbon abatement measures (so-called 'allowable solutions'). A further tightening of Part L of the Building Regulations is also required, although as yet there is no clear timetable as to how the introduction of the Zero Carbon

20 DECC (2015) *RHI statistics, April release.*
21 Installations commissioned between 15th July 2009 and 9th April 2014 (before the start of the domestic RHI) are referred to as 'legacy' installations.
22 Future Climate & the Centre for Urban Research and Energy (Manchester University) (2015), *'Housing in multiple occupancy: energy issues and policy'.*

Homes standard will be achieved in 2016. Furthermore, due to exemptions and the way allowable solutions will be implemented, it is unlikely that carbon savings will be maximised.

  - In spring 2015, the Government announced an exemption for small developments below 10 units. No rationale was provided for this exemption, although it has committed to a review after three years. Together with changes highlighted in our earlier Progress Reports, the Zero Carbon Homes standard has now been watered down from its initial ambition. No further exemptions should be granted.
  - While in principle, allowable solutions can be a sensible way to achieve cost-effective solutions, we remain concerned about the risk that they will disincentivise low-carbon heat options, as set out in our 2014 Progress Report.

  The Department for Communities and Local Government (DCLG) should now implement the zero carbon homes standard without further weakening, ensuring investment in low-carbon heat. Additionally, as discussed in our Adaptation Progress Report, DCLG should evaluate the evidence and introduce a new standard or regulation on overheating in new homes.

- **Products policy**: in 2014, under the Ecodesign Directive new minimum performance standards were introduced for vacuum cleaners and cooking appliances. These appliances account for a relatively small amount of residential electricity consumption (e.g. 7.5% for ovens and hobs).

5. Non-residential buildings

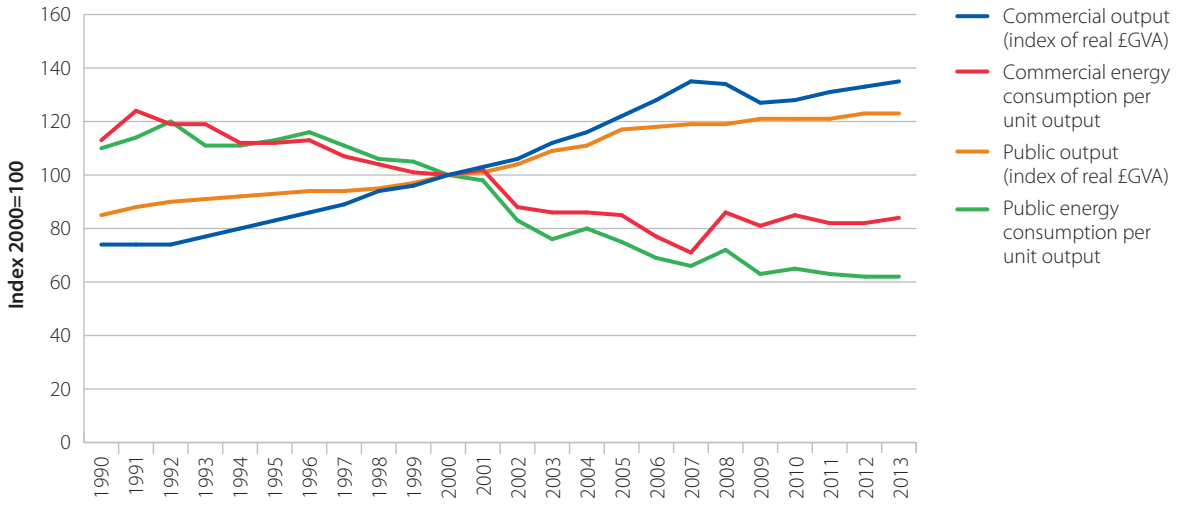
(a) Tracking progress

Tracking progress in non-residential buildings is made difficult by the lack of data on energy efficiency uptake. There is however little evidence of sector-wide progress.

- Energy intensity (measured as energy consumption per unit of output) has remained flat since 2007 in both public and commercial buildings (Figure 2.5).
- The CRC Energy Efficiency scheme covers 76% of electricity consumption and 50% of gas consumption in non-residential buildings, as well as large industrial and agricultural firms outside the ETS. Although scheme participants recorded a 5% drop in total energy consumption in the last two years of data (covering 2012/13 and 2013/14), there is little evidence of any additional impact in public and commercial buildings.
  - Public gas consumption in the CRC fell by 11%, compared to a sector-wide fall of 17%. Commercial gas consumption in the CRC fell 10%, compared to a sector average of 16%.
  - Commercial electricity consumption fell by 3% for organisations in and outside the scheme. Public sector electricity consumption is the exception, falling by 7% for organisations in the CRC, compared to a sector average fall of 1%.
  - Since the reporting of turnover has been dropped, it is not possible to compare between years on a like-for-like basis (using an energy intensity metric). There is a good case for reinstating this metric or another measure of output.

Our scenarios for meeting carbon budgets include opportunities for reducing energy consumption by around 18%, although more may be possible. This suggests that significant cost-effective abatement potential remains.

Figure 2.5. Energy intensity of public and commercial buildings



Source: DECC (2014) Energy consumption in the UK.

There are several sub-sectoral schemes which demonstrate some progress in both the public and commercial sector.

- In the commercial sector, voluntary schemes include one set up by the British Retail Consortium, whose members achieved an 8% reduction in absolute carbon emissions between 2005 and 2013.[23] They have now signed up to a new set of targets.
- In the public sector, the Central Government 'Greening the Government' scheme and the Higher Education Funding Council for England (HEFCE) have both established mandatory reporting and targets. NHS England has a voluntary scheme in place. Beyond this, research by the ETI shows a spectrum of activity from local authorities.[24]
  - The 'Greening the Government' scheme set a number of environmental targets including one to cut GHG emissions from the central government estate by 25% by 2015. With one year to go, a 20% cut was reported in 2014; 16 out of 25 departments have met the target, through a combination of downsizing and some large-scale energy efficiency programmes. The most notable of these is a £105m spend-to-save programme set up by the Ministry of Defence, which makes up half the total emissions and has so far achieved a 15% reduction in emissions.
  - The HEFCE scheme requires universities to report on emissions and set targets. This is supported by a 'Revolving Green Fund' for energy efficiency measures.[25] The NHS England scheme is voluntary and without additional financial support.
- The Scottish Government is currently putting in place a requirement on public bodies to monitor and report on emissions, which will facilitate energy savings and provide a means of tracking progress.

Key elements of success for sectoral approaches are mandatory monitoring and reporting of emissions, and having an overarching strategy and targets in place which are adequately resourced.

23 See CCC (2014) *Progress Report*.

24 Energy Technologies Institute and Hawkey, D., Tingey M., and Webb, J. (2014) *Local Engagement in UK Energy Systems, A Pilot Study of Current Activities and Future Impact*. Available online: http://www.eti.co.uk/wp-content/uploads/2014/07/Edinburgh-Report-Version11.pdf

25 Under the current funding round (round 4), £28.8 million has been awarded for projects to date, with 50% of the funding coming from Salix Finance and 50% of the funding coming from HEFCE.

(b) Policies

Policy rationalisation

In last year's Progress Report, we highlighted the overly complex nature of the policy landscape, which has a number of overlapping carbon price instruments and information requirements. There is scope for rationalisation while providing more consistent incentives, along with plugging gaps (such as SMEs). In principle, there is only need for one instrument for each of the following functions:

- **Carbon price instruments**. There is a wide variation in current levels of carbon pricing across firms and fuels.[26] This should be consistent to minimise distortion. We recommended previously that the carbon price aspect of the CRC Energy Efficiency Scheme should be abolished and the Climate Change Levy increased, with a uniform carbon price across fuels, unless there is compelling evidence to suggest this would reduce the corporate profile of energy efficiency.
- **Regulation**. Commercial rented premises will be subject to minimum standards from 2018, similar to privately rented homes (Section 4). With 60% of commercial sector premises being rented, this should drive uptake for energy efficiency measures. A clear timetable for ratcheting up the standards over time would improve investor confidence and unlock additional retrofit.
- **Information**. A clear source of information on operational energy consumption is essential to understand and reduce energy consumption, but one good quality source would be preferable to multiple weak sources. This source could be enhanced energy audits or enhanced mandatory Display Energy Certificates (DECs). Only with such a mechanism in place would it be justified to drop the reporting requirements under the CRC.
  - **Energy Savings Opportunities Scheme (ESOS) energy audits**. Businesses will undertake the first round of audits in 2015, but the extent to which they will lead to uptake of the top cost-effective measures identified remains uncertain. The implementation of the audits in the UK, as required under the EU Energy Efficiency Directive, has been weak (audits every three years, no reporting requirement). The new Government should assess the case for enhancing the audits (e.g. through signposting to finance, follow-up support, mandatory reporting and benchmarking), and extending their scope to SMEs.
  - **Display Energy Certificates**. These would need to be enhanced to meet the Energy Efficiency Directive requirements. DECs are currently the only effective source of benchmarked operational energy demand data. They are an important tool for identifying energy efficiency opportunities which can help limit the impact of rising energy prices on public finances.[27]

Data availability continues to be a major issue affecting decarbonisation policy for non-domestic buildings. Steps to address this would benefit policy makers and energy planners, including at a minimum plans for DCLG to publish DEC data on the Government website.

Energy efficiency policy for SMEs remains a significant gap in the current policy framework and is likely to be an area where additional measures are needed. Good practice in this area includes low-cost finance by the KfW bank in Germany (see below), along with the Scottish and Welsh Resource Efficient initiatives, which provide support to business for developing and implementing energy efficiency initiatives.

26 CCC (2014) *Progress Report*.
27 See the Committee's letter to the Secretary of State for Communities and Local Government in response to the consultation on the future of DECs, available at: http://www.theccc.org.uk/publication/letter-response-to-the-consultation-on-changes-to-the-display-energy-certificates-regime-in-public-buildings/

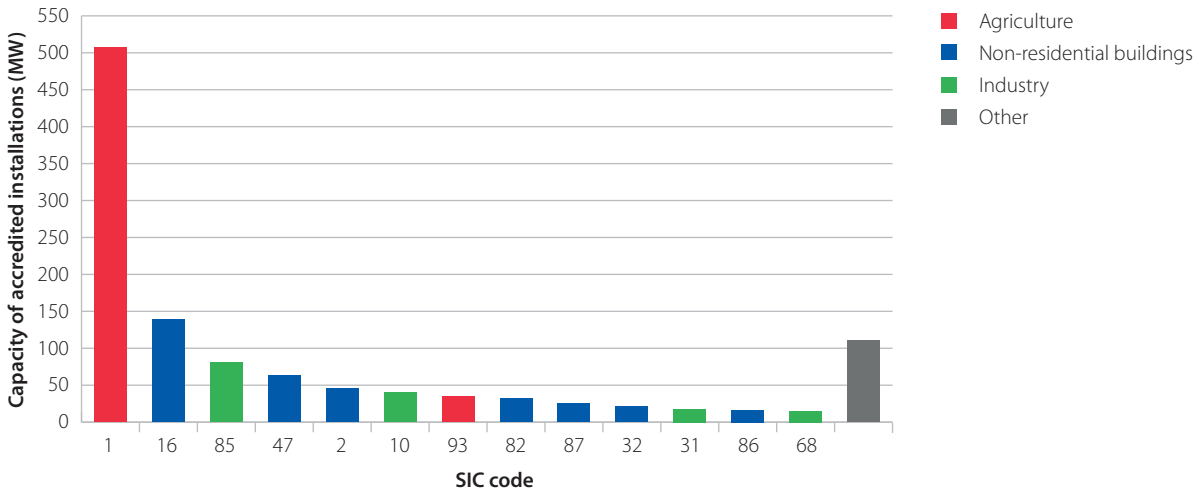
Non-domestic RHI

The non-domestic RHI is the main policy instrument for meeting both the renewable heat share of the 2020 Renewable Energy target and the 2020 level of abatement in the carbon budgets, which are aligned. It is therefore the cornerstone of low-carbon heat policy to 2020.

- The 2013 tariff review resulted in a new tariff of 2.5 p/kWh for air source heat pumps, alongside the existing ground and water source heat pump tariff. This has not succeeded in broadening the mix of technologies taken up beyond bioenergy.
- Overall delivery has increased however, with total investment now at the level envisaged by the budget caps, after the initial years of underspend.
- Over 30% of the RHI has funded biomass capacity in agriculture and forestry (Figure 2.6) where it is likely that there are existing sources of waste feedstock.
- Only a fraction of uptake to date has been in the public sector. This is a key area where the Government could look to address the shortfall to 2020.

This underlines the need for a major push for low-carbon heat to reduce the carbon gap in meeting the fourth carbon budget, with a focus on non-domestic heat pumps replacing fossil fuel boilers.

Figure 2.6. Non-domestic RHI delivery (MW capacity) by SIC code



1 Crop and animal production, hunting and related service activities
16 Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
85 Education (SIC code: 85)
47 Retail trade, except of motor vehicles and motorcycles
2 Forestry and logging (SIC code: 02)
10 Manufacture of food products
93 Sports activities and amusement and recreation activities
82 Office administrative, office support and other business support activities
87 Residential care activities
32 Other manufacturing
31 Manufacture of furniture
86 Human health activities
68 Real estate activities
Sectors < 1% installed capacity

Source: DECC (2015) *RHI monthly deployment statistics April 2015.*

Financing energy efficiency and low-carbon heat

Commercial finance

Finance to businesses for energy efficiency and low-carbon heat is piecemeal, with no central source for firms.

- The non-domestic Green Deal has not been financed to date.
- Finance at commercial rates is available from the Green Investment Bank, although this has been mainly geared towards a small number of larger investments in areas such as street lighting or district heating.
- Siemens, in partnership with the Carbon Trust, are providing commercial rate loans up to a total of £550m for energy efficiency projects.
- 0% finance is available to businesses in Wales and Northern Ireland.

This compares to loans totalling 3.2 billion euros made available by the German KfW bank in 2014 to all businesses, including SMEs, at interest rates of 1%. The scheme is currently set to expire at the end of June 2015.

To improve access to finance in the UK, the focus should be in the first instance on linking and signposting to existing sources of finance. One option would be to do this as part of the ESOS energy audit report. Over time, additional sources of low-cost finance could help unlock energy efficiency in the commercial sector, particularly in small- and medium-sized enterprises.

Public sector reporting and finance

The public sector can play an important role by setting an example, unlocking wider social benefits and driving down installation costs. Currently, public sector procurement is not sufficiently harnessed due to a combination of capacity constraints and possible reluctance to take on additional debt.

Monitoring and reporting of emissions is an essential first step in understanding and curbing waste – there is an opportunity cost to not having a mechanism in place. Good information on energy demand is the cornerstone of putting together a business case for energy efficiency finance. Discussions with fund administrators suggest that the pipeline for the HEFCE Revolving Green Fund may have been weakened by the loss of capacity and expertise in this area, although demand for Salix funding[28] remains healthy.

Reporting of carbon emissions used to be a statutory requirement under the National Indicator Framework and National Indicator 186, but it was abolished in 2010. Any reporting requirement would need to be adequately resourced in light of the current strain on the delivery of public services.

- Sectoral approaches such as the HEFCE scheme and Greening the Government highlight the benefits of taking an integrated approach to carbon mitigation through energy efficiency and low-carbon heat, with target setting, reporting and adequate resourcing.
- The Scottish public bodies duty (Chapter 7) provides a template for requiring reporting of carbon emissions. To be more effective, this could be enhanced with a requirement on public bodies to put in place a strategy and targets.

28 Salix Finance provides 100% interest-free loans to the public sector for energy efficiency projects. Salix, an independent, publicly funded company, has been operating since 2004, and its loans are currently available across England, Scotland and Wales.

- Whilst the public sector can apply to the Salix loans scheme, which totalled £48 million in 2013/14 and £73 million in 2014/2015,[29] this only covers the capital costs of energy efficiency, implying gaps for developing the business case, monitoring energy and emissions, and for financing low-carbon heat. Green bonds are a potential way to plug the funding gap, as an alternative to pay-as-you-save schemes.[30]

The case for enhancing public bodies monitoring and reporting requirements should be assessed following an evaluation of the previous monitoring and reporting duties, early lessons from the introduction in Scotland, and drawing on international experience.

Other policy areas

New standards to deliver '**nearly zero energy' buildings** will be required under the 2010 recast of the EU Energy Performance of Buildings directive, to apply to all new public sector buildings from 2018 and all other buildings from the end of 2020. Additionally, previous governments committed to zero carbon non-domestic buildings by 2019. Meeting this timetable requires an interim stage during which Part L of the Building Regulations are tightened in 2016. This implies consulting on proposals later this year. DCLG should set out a timetable for achieving this, along with a clear definition of the 2019 standards.

Funding of £20 million has been allocated to an **Electricity Demand Reduction (EDR) pilot**, which is open to commercial, industrial and public sector organisations. The first auction took place in January 2015. A total of £1.3 million was allocated in the auction to help reduce demand by at least 1.9 GWh during the winter peak, at a weighted average price bid of £229/kW. The Government is currently reviewing progress to date, including scheme cost-effectiveness.

6. Forward look

In our Fourth Carbon Budget Review, we proposed that emissions from buildings should fall to 69 $MtCO_2$ by 2025, as part of a cost-effective path to meet carbon budgets.

Based on the latest DECC energy and emission projections, non-traded emissions (that is, those not covered by the EU ETS) could be 94 $MtCO_2$ in 2025, falling to 82 $MtCO_2$ if current policies deliver. Adjusting our emissions trajectory to reflect the slightly lower projected baseline emissions suggests that non-traded emissions should fall to 66 $MtCO_2$ in 2025.

This implies a policy gap of 16 $MtCO_2$ to 2025, mostly due to low-carbon heat. Currently, there are no proposed policies for heat after 2020.

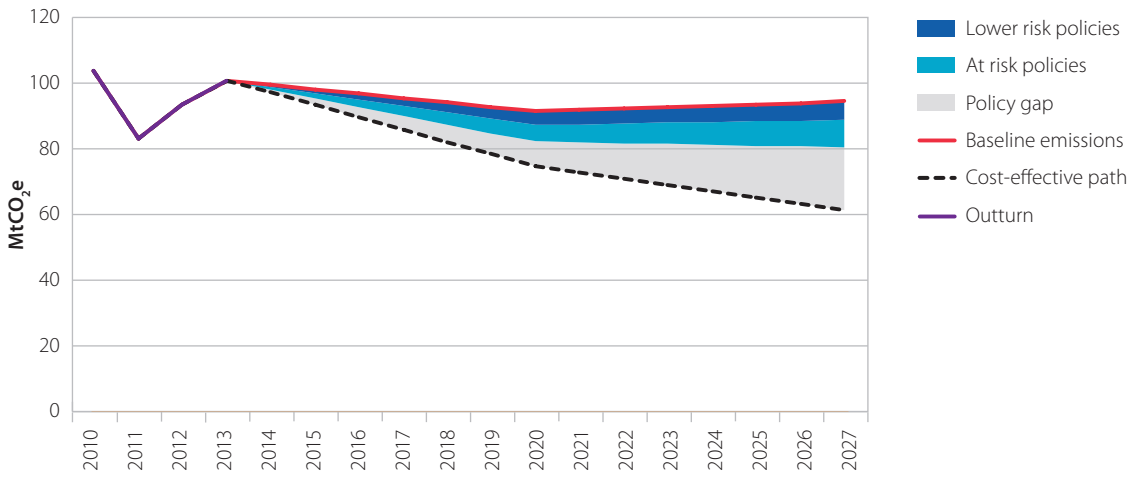
Furthermore, not all policy savings assumed by DECC are assured. In our 2014 Progress Report, we made an assessment of current policies to meet the carbon budgets. This assessment remains valid. Of the 13 $MtCO_2$ abatement forecast from current policies, 7 $MtCO_2$ are at risk due to lack of funding, or design or delivery problems (Figure 2.7).

- Policies with design and delivery problems include the ECO, Green Deal, EU Products Policy, the CRC Energy Efficiency Scheme, as well as Zero Carbon Homes.
- The main unfunded policy is the RHI post-April 2016. There is also no clarity about funding for the ECO after the end of 2017.

In order to deliver the necessary reductions in buildings emissions, it is therefore important that new policy approaches are developed. These are summarised in Section 7.

29 See technical annex.
30 Sustainable Homes recently launched a green energy bond, aimed at local authorities.

Figure 2.7. Assessment of current and planned policies - all buildings (non-traded)



Source: Source: DECC (2014) Updated emissions projections; CCC analysis
Notes: All data is consistent with UEP 2014; outturn values will therefore differ from latest provisional emissions estimates.

7. Summary

Buildings are important for achieving carbon budgets, both in terms of direct emissions but also in terms of electricity demand savings, which will reduce the need for additional low-carbon power capacity. However, bridging the large gap to the achievement of the carbon budgets identified above will require action across a number of areas.

- Low-carbon investment. Meeting carbon budgets at least cost will only be possible with investment in supply-chains, heat networks and improvements to the building stock now in order to avoid incurring more significant costs in the long-run.
  - Financial incentives are required in the near-term to drive uptake of low-carbon heat – without appropriate incentives in place, the UK will struggle to meet the carbon budgets without incurring significant other costs. Costs for the RHI are sensitive to assumptions on tariff degression and the ability to reduce funding costs through tackling non-financial barriers, but could be in the region of several billion pounds in 2020. It is therefore critical to bring down the costs by addressing barriers to uptake. Continued support of heat network roll-out over the next few years is required to realise the benefits of the initial investment in local authority feasibility studies. Finally, clarity over the introduction of zero-carbon home standards is needed to unlock private sector investment.
  - Much of the potential for low-cost home energy efficiency measures such as loft and easy-to-treat cavity wall insulation has already been realised. There is still significant potential for measures such as solid wall and hard-to-treat cavity insulation, as well as other measures such as floor insulation. However, these are generally more costly and often best done as part of a whole house renovation project. Grants and subsidies will need to be provided for fuel-poor and/or low-income homes. The Green Deal, a market-based mechanism for able-to-pay homeowners, has not been successful to date and further incentives and/or regulation may be required to drive the able-to-pay market (e.g. stamp duty incentives).

- **Developing future options and innovation.** Heat pumps and low-carbon heat networks are currently the two main options for decarbonising heat in buildings. A plan is required for the 2020s which ensures that we keep open these options to 2050, in the context of wider decisions about infrastructure for heat. More broadly, technical, social and financial innovation will facilitate the transition to a low-carbon building stock and unlock abatement potential from more difficult options such as solid wall or floor insulation. There is a continued role for public finance in supporting research, development and demonstration.
  - Technology advances include cheaper and easier methods to insulate solid walls, floor insulation robots which improve access to difficult spaces and reduce installation costs, phase change materials which act as 'heat batteries' in buildings, along with new approaches for integrating energy supply with demand-side management and storage.
  - Innovative financing solutions include joint ownership of renewables and green bonds, whilst new business models and tools can also help guide investment.
- **Low-carbon choices.** One of the most significant challenges in decarbonising the building stock lies in understanding consumer behaviour and choices, and reflecting this in policy development. Home energy efficiency for example is an area where many measures are cost-effective, yet consumers do not always make rational choices. Policy often underestimates non-financial costs to consumers. Regulation has been successful in some cases, as demonstrated through improvements in boiler and lighting efficiency and the energy efficiency of new homes. Other approaches, such as roll-out of energy efficiency measures on an area basis (e.g. in Wales and Scotland) have shown some promise in recent years, but a comprehensive evaluation of these schemes is needed to inform future policy. Financial incentives can be effective but potentially costly over time, especially when trying to compensate for high barrier costs. For low-carbon heat, it is therefore particularly important to address non-financial barriers such as improving consumer understanding and confidence.

Transforming the UK's buildings to high levels of energy efficiency and decarbonising their heat supply will require long-term policy commitments from governments. It is also important that buildings are made suitable for a warming climate through appropriate passive cooling measures such as enhanced ventilation and shading. A low-carbon and resilient building stock will have a range of lasting auxiliary benefits – lower energy bills, increased indoor comfort and health benefits.

Chapter 3: Progress reducing emissions from industry

1. Industry emission trends and drivers
2. Opportunities and challenges to reduce emissions
3. Policy progress
4. Industrial competitiveness opportunities and challenges
5. Forward look
6. Summary

Key messages and recommendations

Industrial activity directly accounts for a quarter of UK greenhouse gas emissions and includes manufacturing and construction, refining of petroleum products and other energy supply (extraction and production of oil, gas and solid fuels). In this chapter we assess industrial emissions and energy consumption over the period 2009-2013, preliminary 2014 data, as well as policy progress to unlock abatement potential.

Our key messages are:

- **Energy and emission trends**. Despite growth in industrial output, both provisional energy consumption and emissions appear to have fallen in 2014:
  - Direct CO_2 emissions fell by 6% in 2014 according to provisional estimates, following an annual average 1% decrease over the period 2009-2013. The fall in emissions to 2013 can mainly be explained by the disproportionate impact the recession had on carbon-intensive sectors. While we have seen a fall in refining output in 2014, there is no clear explanation for the 6% drop in manufacturing emissions in 2014, as output grew 3% during the year and verified industrial EU Emission Trading System (EU ETS) emissions fell by only 0.4%.
  - Manufacturing grid electricity consumption also fell by 7% in 2014 according to provisional estimates, following an annual average 0.4% decrease over the period 2009-2013. This suggests some energy intensity improvement to 2013. However, there is currently no clear explanation for the 2014 fall in consumption.
  - Previous provisional energy and emission statistics have been readjusted significantly in following years. Provisional figures need to be interpreted with care and greater significance should be placed on the longer trend.
- Three abatement options are most likely to play a role in future emissions:
  - **Energy efficiency.** At present it appears that there is unlikely to be sufficient progress to meet our estimates of potential in the fourth carbon budget: the EU ETS carbon price remains low, as does ambition in the Climate Change Agreements.
  - **Low-carbon heat.** Use of bioenergy could make the biggest impact in reducing industrial emissions through to the fourth carbon budget. The main policy driver is the Renewable Heat Incentive (RHI). Uptake of low-carbon heat in industry is currently ahead of our indicator, although uptake needs to accelerate in the coming years to stay on track with our indicator. Limited bioenergy resource is likely to be particularly valuable in industry, so further incentives need to be explored to drive uptake of large low-carbon heat projects.
  - **Carbon Capture and Storage (CCS).** The most important industry option to meet the 2050 emission reduction target is CCS. We have previously recommended that the Government should set out an approach to demonstration and commercialisation of industrial CCS within the 2020s. Action is now urgent. Given the limited progress to date and long lead in times, the Government should consider proposals for a Teesside industrial cluster CCS project, and reflect on how these could accelerate deployment of CCS to other industrial clusters.

Key messages and recommendations

- **Industrial Decarbonisation and Energy Efficiency Roadmaps to 2050.** Published in March 2015 for eight of the most heat-intensive industrial sectors. The reports identified key abatement options for many of the sectors in line with those identified above.
- **Forward look**. Overall, policy is not on track with our indicators to deliver the long-term abatement we have identified, leaving a gap of 15 $MtCO_2$ in 2025.

Our recommendations for DECC, working with BIS, are:

Ahead of 2016 Progress Report

- **Develop joint work with industry into action plans:** publish plans setting out specific actions and clear milestones to move abatement efforts forward along the paths developed with industry in the "Roadmaps".

Ahead of 2017 Progress Report

- **Complete roll-out of "Roadmaps" to other industrial sectors:** taking account of lessons learned, roll-out roadmaps to industrial sectors not covered in first wave.
- **Join-up industrial CCS with power sector projects:** set an approach to commercialisation of industrial CCS alongside the approach adopted for the power sector, including ensuring industry can link into planned infrastructure.
- **Evaluate effectiveness of compensation to at-risk industries for low-carbon policies:** independent evaluation of industries that are at-risk and effectiveness of the compensation framework.

We set out the analysis that underpins these conclusions in six sections.

1. Industry emission trends and drivers
2. Opportunities and challenges to reduce emissions
3. Policy progress
4. Industrial competitiveness opportunities and challenges
5. Forward look
6. Summary

1. Industry emission trends and drivers

(a) Overview

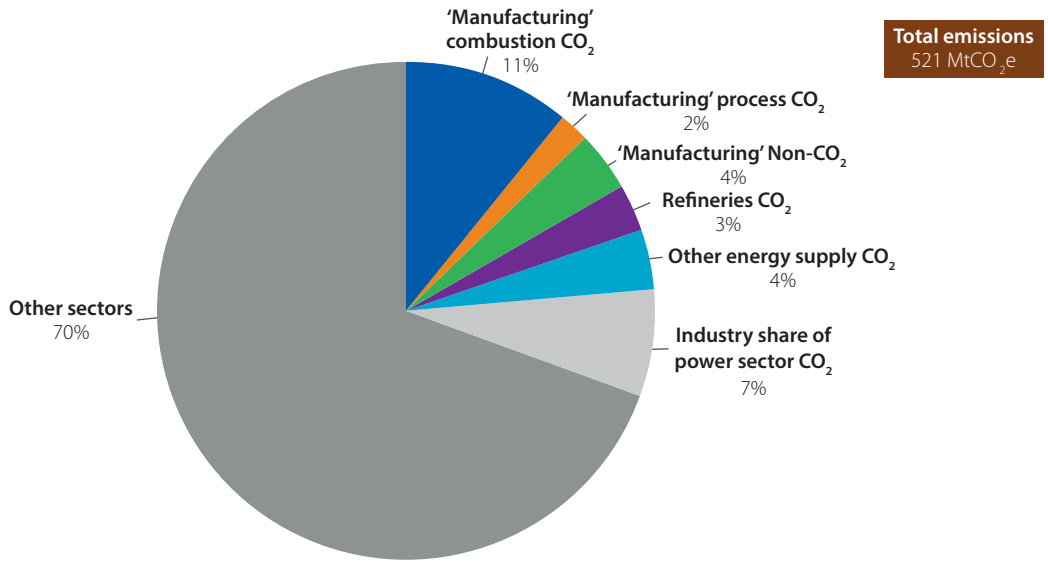
Industrial activity includes the manufacturing and construction sectors, refining of petroleum products and other energy supply (extraction and production of oil, gas and solid fuels).[1]

Direct emissions from industry accounted for around a quarter of UK greenhouse gas (GHG) emissions in 2014 (120 $MtCO_2e$), of which around four-fifths are CO_2 (Figure 3.1). Of industry direct CO_2 emissions, two-thirds comes from manufacturing (split between combustion of fossil fuels and chemical processes). Industry consumes around a third of UK electricity produced which is around 7% of UK GHG emissions.

Within the manufacturing and refining sectors, around four-fifths of all CO_2 emissions and two-thirds energy consumption is accounted for by eight industries, which make up almost a sixth of UK GHG emissions (Figure 3.2).

Under the Infrastructure Act 2015, the Committee has a new duty to advise the Secretary of State about the impact of the exploitation of onshore petroleum on achieving the carbon budgets. That advice must be delivered in March 2016. It will consider in detail the extraction and production of both onshore and offshore oil and gas.

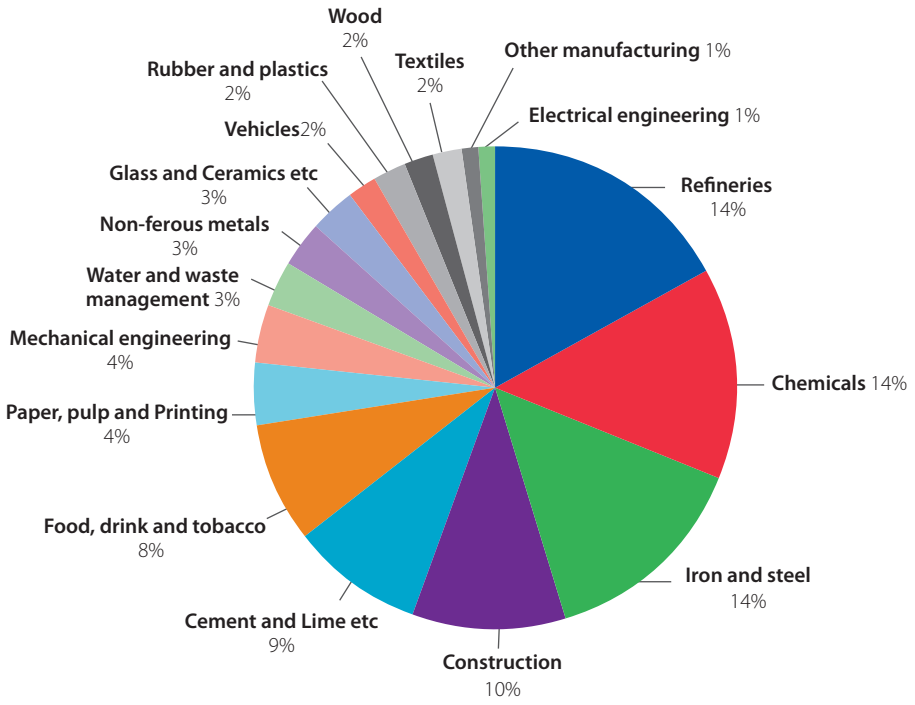
Figure 3.1. GHG emissions from industry in the context of total UK emissions (2014)



Source: DECC Provisional GHG statistics, ONS Environmental Accounts, CCC analysis
Note: 2014 emission estimates are provisional. Percentage figures may not add up to 100% due to rounding.

1 From this point forward references to manufacturing will also include the construction sector.

Figure 3.2. Manufacturing and refining CO_2 by sector (2012)



Source: ONS Environmental Accounts.
Note: Percentage figures may not add up to 100% due to rounding.

(b) Emission trends

Provisional estimates suggest that in 2014 direct industry GHG emissions fell by 6%, following an annual average 1% decrease over the period 2009-2013 (Table 3.1). While refining output fell, there is no clear explanation for the 6% drop in manufacturing emissions in 2014, as production grew 3% during the year and verified industrial EU Emission Trading System (EU ETS) emissions fell by only 0.4%. Provisional statistics are prone to revision, so we focus our assessment on the longer term trend in manufacturing emissions (Box 3.1). We will return to the 2014 emission changes in our 2016 Progress Report, when the statistics will have been finalised with a sectoral breakdown:

- Direct CO_2 industrial emissions fell by 6% in 2014, following an annual average 1% decrease over the period 2009-2013.
  - Manufacturing CO_2 emissions over the period 2009-2013 initially fell and then rose back up again to their 2009 levels. This can be largely attributed to the recession, which had a disproportionate impact on carbon-intensive sectors (Box 3.2).
  - Refineries and other energy supply CO_2 emissions fell 6% in 2014, following an annual average 3% decrease over the period 2009-2013. These falls can be attributed to an equal fall in output, with the 2014 fall explained by the closure of Milford Haven as well as disruptions at other refineries.
- Non-CO_2 emissions in industry fell by 2% in 2014, following an annual average 2% decrease over the period 2009-2013. This reflects the introduction of technologies to abate N_2O emissions in industrial processes and reduced methane emissions from the gas distribution network and coal mines.

- Manufacturing grid electricity consumption also fell by 7% in 2014, following an annual average 0.4% decrease over the period 2009-2013. The falls in grid electricity consumption over the period 2009-2013 suggest some potential energy intensity improvement to 2013. However, there is currently no clear explanation for the 2014 fall in consumption.

The recession, which had a disproportionate impact on carbon-intensive sectors, largely explains the fall in industrial direct emissions over 2009-2013. This structural movement towards a less carbon-intensive mix of industrial output was the largest contributor to falling direct emissions, with some improvement in energy intensity and changes in the fuel mix also reducing emissions (Box 3.2).

In our 2014 Progress Report, we set out an indicator framework for monitoring progress in industry towards meeting carbon budgets. From 2007 to 2013, industry direct CO_2 emissions declined in line with the indicator we set out (Figure 3.3)[2]. Provisional estimates for 2014 suggest direct emissions have fallen further than our indicator, but as discussed above provisional estimates are prone to revision.[3]

Falling investment in new plant and equipment may also suggest continued use of older, less efficient plant. Investment in new plant and equipment fell by 24% between 2007-2009, and only in 2014 has investment surpassed its pre-recession levels.[4] The rise is a positive effect of industry returning to growth after the recession, suggesting an increased ability to replace older equipment with the latest more energy-efficient technology.

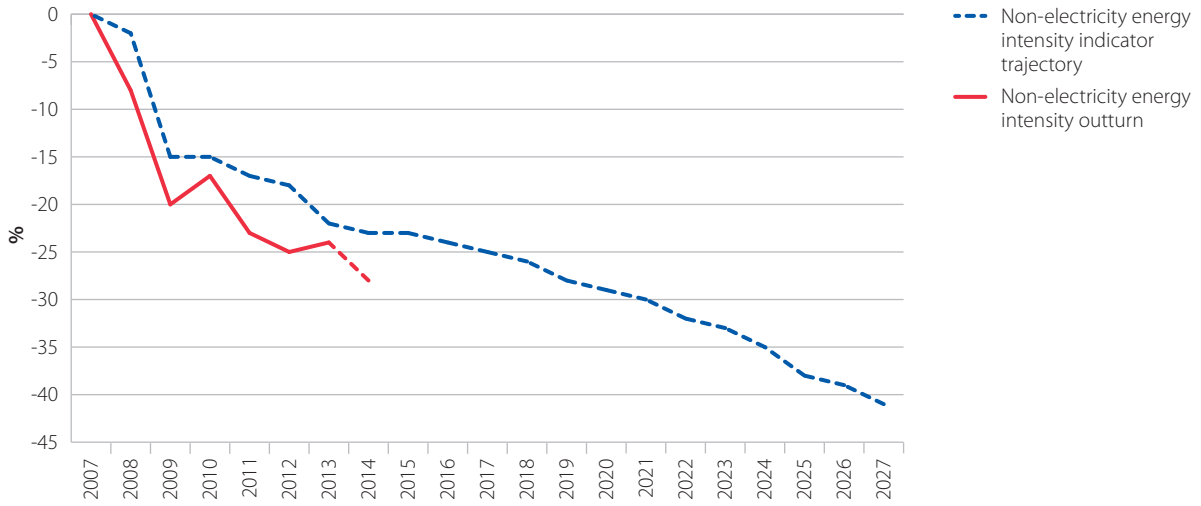
Table 3.1. Annual changes in industrial GHG emissions (2009-2014)

	2009-2013 annual % change	2014 % change
Manufacturing – combustion CO_2 emissions	-1%	-7%
Manufacturing – process CO_2 emissions	5%	-2%
Manufacturing – total CO_2 emissions	0%	-6%
Refineries and other energy supply – direct CO_2 emissions	-3%	-6%
Total industry direct (non-electricity) CO_2 emissions	-1%	-6%
Total industry direct non-CO_2 emissions	-2%	-2%
Total industry direct GHG emissions	-1%	-6%
Grid electricity energy consumption (TWh)	-0.4%	-7%

Source: NAEI *GHG inventory*, DECC (2014) *Provisional GHG emissions*, DECC (2015) *Digest of UK Energy statistics (DUKES)*, DECC *Energy Trends*, CCC analysis
Notes: Manufacturing process CO_2 emissions increased from 2009-2013 mainly due to recovery in steel production after the recession, where production had declined by 30% from 2007 to 2009.

2 For analysis of other CCC indicators see Technical Annex 3.
3 See Technical Annex 3.
4 ONS Gross fixed capital formation statistics. Available at http://www.ons.gov.uk/ons/index.html

Figure 3.3. Industry direct (non-electricity) CO_2 emissions and CCC indicator (% change from 2007)



Source: NAEI *GHG inventory*, DECC Provisional GHG estimates and CCC analysis.

Box 3.1. Industrial energy provisional estimates

Provisional estimates of 2014 manufacturing combustion CO_2 emissions, which come from burning fossil fuel, show a fall in emissions of 7%, despite a growth in production of 3%.

Provisional manufacturing energy statistics as published in DECC's *Energy Trends* are reported for the iron & steel sector and for the rest of the manufacturing sector under 'other industries'. Estimates of fuel consumption by the iron and steel sector are based on data from the Iron & Steel Statistics Bureau (ISSB). 'Other industries' estimates are mainly based on surveys of fuel suppliers, plus the difference between ISSB and fuel suppliers estimates for 'iron and steel'. In addition, for 'other industries' coal consumption, proportions of 'unallocated' coal imports are added.

Fossil fuel consumption increased 5% in the iron & steel sector, which accounts for 8% of manufacturing's final fossil fuel consumption (Table B3.1). Therefore, the 2014 fall in industry combustion CO_2 emissions may be due to the decrease in fossil fuel consumption in the 'other industries' sectors.

The provisional estimates of 'other industries' fossil fuel consumption suggests a 3% fall in 2014. Oil and gas consumption have been estimated to fall 2% each in 2014. The other contributing factor for the provisional estimate of a fall in industries' fossil fuel consumption and CO_2 emissions was a significant fall in coal. Provisional 2014 statistics for 'other industries' indicate a 14% reduction in coal consumption.

While we do not have a sectoral breakdown for coal consumption for the 2014 provsional estimates, we can look at the 2013 breakdown and production growth of the heavy coal users to see if this explains the drop in coal consumption. DECC's *Digest of United Kingdom Energy Statistics* (DUKES), shows that in 2013 54% of *Energy Trends* 'other industries' coal consumption was from the mineral sector and 25% from DUKES definition of 'other industries' (wood, rubber & plastics, other manufacturing etc). However, in 2014 the mineral sector grew by 16% and DUKES 'other industries' grew by 4%. Therefore, there is no clear reason why coal consumption fell 14% in 2014.

Table B3.1. DECC *Energy Trends* manufacturing fossil fuel consumption

TWh	Fuel	2013	2014	2013-2014 change	2013-2014 % change
Manufacturing	Fossil fuel*	164	160	-4	-3%
'Iron & Steel'	Fossil fuel*	11.9	12.4	+0.5	+5%
'Other industries'	Fossil fuel*	152	147	-5	-3%
	Coal	*16*	*13*	*-2*	*-14%*
	Gas	*85*	*83*	*-2*	*-2%*
	Oil	*51*	*50*	*-1*	*-2%*
	Other	*7*	*7*	*0*	*-1%*

Source: DECC (2015) *Energy Trends*, CCC analysis.
Notes: *These figures do not include fossil fuel used for industrial heat or electrical autogeneration.

Provisional estimates for fossil fuel energy consumption for 'other industries' for the years 2011-2013 changed by 5-20 percentage points when they became final estimates the following year. Therefore, we cannot rule out that once the 2014 energy consumption and emission statistics are finalised, they may show no divergence with industrial production.

We will return to the 2014 energy consumption and emission changes in our 2016 Progress Report, when the statistics will have been finalised with a sectoral breakdown.

Notes: DECC (2015) *Energy Trends* available at https://www.gov.uk/government/collections/energy-trends

Box 3.2. Manufacturing and refining industries non-electricity energy and emission decomposition analysis

In 2014, we commissioned Ricardo-AEA to produce a decomposition model for energy and emissions in the UK manufacturing and refining sectors. It allows us to analyse the factors that contribute to a change in emissions.

Falls in industrial direct CO_2 emissions could be caused by:

- **Output effects** (e.g. recession-related emission reductions).
- **Structural effects** (e.g. relative mix of manufacturing output moving towards less carbon-intensive sectors),
- **Switching to fuels with lower direct emissions** (e.g. coal to gas, or fossil fuel to electricity).
- **Energy intensity** (e.g. improvements in energy efficiency, changes in product mix or plant utilisation).

This analysis shows that between 1992 and 2007 improvements in energy intensity and switching to lower-carbon fuel were the largest contributors to the reduction in direct CO_2 emissions in the manufacturing and refining sectors. Improvements in energy intensity averaged around 1.3% per annum over this period and switching to lower direct emission fuels saved 0.8% per annum.

Between 2009 and 2012, for which the latest data is available, the fall in direct CO_2 emissions can be attributed mainly to the recession's disproportional impact on carbon-intensive industrial sectors. This structural movement towards a less carbon-intensive mix of industrial output was the largest contributor to falling direct emissions, with some improvement in energy intensity and changes in fuel mix also reducing emissions.

There are distinct differences in the results between the major industrial sectors. It is possible to distinguish groups of sectors with similar experiences since 2009:

- **Output down, energy intensity higher** – in the refineries sector, there have been significant falls in output, while at the same time energy intensity has increased since 2009. This sector has seen under-utilisation of plant during the recession, as operators have either been unable or unwilling to rationalise, although there have been closures in recent times.
- **Output down, energy intensity little changed** – in the steel and chemical sectors there have been falls in output, but energy intensity has not changed significantly.
- **Output down, energy intensity down** – in the cement & lime, paper, and ceramics & glass sectors, both output and energy intensity have fallen. Cement sector energy intensity has been affected by a product-mix change towards less intensive production and the paper sector has seen closures of less efficient plants.
- **Output up, energy intensity down** – the food and drink sector and motor industries have shown growth in output since 2009 (although output did fall early in the recession). There has been considerable rationalisation of plant, which has reduced energy intensity and improved utilisation.

This analysis can only give us some indication about whether and where industrial energy efficiency is improving. However, energy intensity is only a proxy for technical energy efficiency, and also includes the effects of changing product mix and utilisation of plant and equipment.

Source: CCC analysis
Notes: for this analysis the manufacturing does not include the construction or wastewater sectors.

2. Opportunities and challenges to reduce emissions

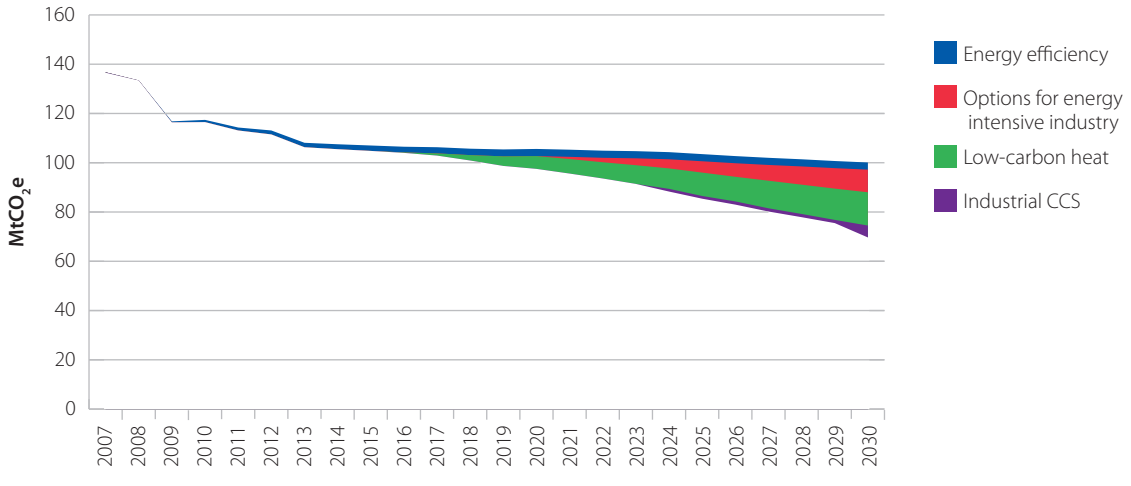
(a) Opportunities to reduce industry emissions

The *Fourth Carbon Budget Review* published in December 2013 updated our view on the scope for reducing direct emissions in industry from around 140 $MtCO_2$ in 2007 to around 70 $MtCO_2$ in 2030 (Figure 3.4):

- **Energy efficiency improvement**. There is significant but uncertain potential. Our best estimate comes from the ENUSIM model that suggests scope for reducing direct annual emissions by around 3 $MtCO_2$ in the period to 2020.[5]
- **Options in energy-intensive industry**. Further cost-effective options for energy-intensive industry could reduce direct annual emissions by 9 $MtCO_2$ by 2030. These include increased electric-arc steel production, clinker substitution in cement and optimisation of refineries.[6]
- **Low-carbon heat and use of bioenergy**. Modelling conducted by NERA for the Committee suggests the potential to reduce direct annual emissions by 13 $MtCO_2$ by 2030. This is primarily through use of biomass and biogas within sustainability limits, with smaller contributions from heat pumps and combined heat and power (CHP).[7]
- **Industrial carbon capture and storage (CCS)**. CCS could be feasible and cost-effective for deployment in a range of industrial sectors during the 2020s, reducing annual emissions by 5 $MtCO_2$ by 2030. By 2050 industrial CCS could contribute to cost-effective reductions of around 33 $MtCO_2$ per year.

The '*Industrial Decarbonisation and Energy Efficiency Roadmaps to 2050*' reports were published in March 2015 for eight heat-intensive industrial sectors that make up 70% of manufacturing and refining direct CO_2 emissions.[8] The reports identified that the key abatement options for many of the sectors are in line with those identified above. We will review this new evidence base and report on what this means for opportunities for reducing industry emissions in our *Fifth Carbon Budget Advice* later this year.

Figure 3.4. 4th Carbon Budget Review industry emission cost-effective pathway ($MtCO_2$)



Source: CCC analysis, Fourth Carbon Budget Review.

5 The Energy End-Use Simulation Model (ENUSIM) is a technology based, bottom-up industrial energy end-use simulation model which projects the uptake of energy-saving and/or fuel-switching technologies taking into account the cost effectiveness of technology options under future carbon and fossil fuel prices.
6 Ricardo-AEA (2013) Updating and extending carbon budget trajectories: A review of the evidence. Available at: http://www.theccc.org.uk
7 NERA (2010), Updating Decarbonising Heat: Low -Carbon Heat scenarios for the 2020s, Available at: http://www.theccc.org.uk
8 Cement, ceramics, chemicals, food & drink, glass, iron & steel, oil refining, and paper & pulp.

(b) Challenges to reduce industry emissions

We set out the main challenges in our 2014 Progress Report. They are worth reiterating:

- **Refurbishment cycles**. The abatement measures that we have identified for carbon-intensive industry in the 2020s typically have long lead times. Given the difficulty of retrofitting, and to avoid missing low-carbon investment opportunities, it is important to prepare abatement in line with refurbishment cycles.
- **Capital constraints**. Many of the cost-effective opportunities in energy-intensive industry have substantial upfront requirements for capital and longer payback periods. For firms to plan and finance abatement opportunities, there needs to be a mechanism for reflecting the value of carbon (e.g. a robust carbon price) with long-term certainty to ensure that this investment is prioritised in a capital-constrained world.
- **Infrastructure and markets**. Some abatement will need provision of infrastructure or creation of markets outside the control of specific industries. For instance, to take full advantage of the potential abatement from industrial CCS, there needs to be adequate CO_2 transport and storage infrastructure.

Government policy has a role to support industry in meeting these challenges. The '2050 Roadmaps' focused in more depth on these barriers for the eight sectors covered. The next steps will be for government to work with industry on a series of actions, incentives and mechanisms to overcome these barriers. The next section assesses progress to date against our policy indicators.

3. Policy progress

Parsons Brinckerhoff and DNV GL were appointed by the DECC and BIS to produce a set of **'Industrial Decarbonisation and Energy Efficiency Roadmaps to 2050'** for eight heat-intensive sectors with a cross-sector report identifying conclusions that apply across multiple sectors and technology groups.[9] The roadmaps, published in March 2015, are based on a collaborative process featuring contributions from industry sector trade associations, their members, officials from DECC and BIS, and other experts.[10]

The purpose of each roadmap is to establish decarbonisation pathways that could be possible while ensuring sectors remain competitive. The pathways give a view of the range of technology mixes that the sector could deploy over coming decades to enable transition towards a low carbon economy. We will review the roadmaps' evidence base and what this means for industry cost-effective abatement pathway in our *Fifth Carbon Budget Advice*.

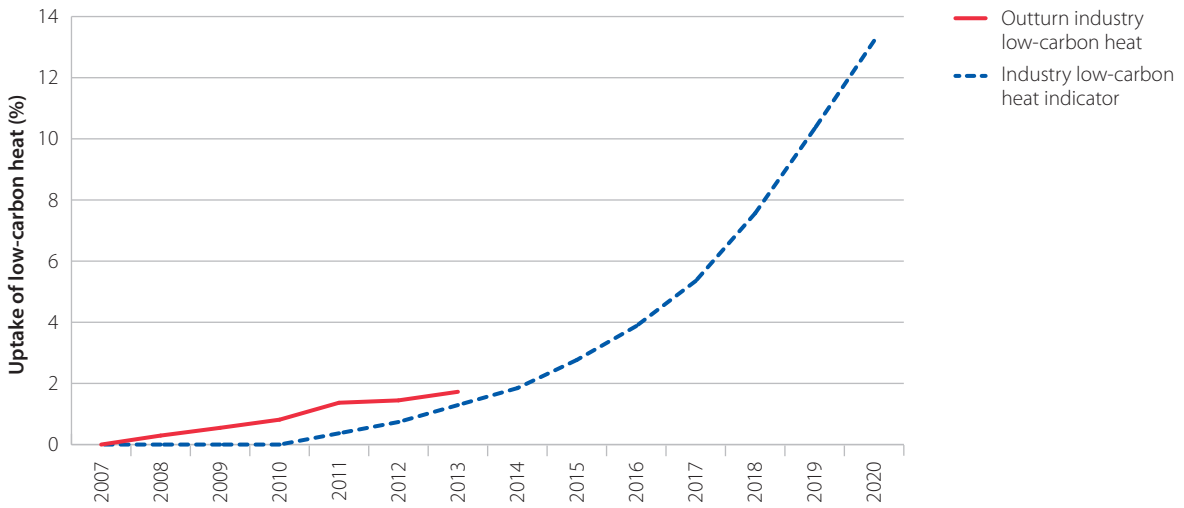
The sector-specific approach to the roadmaps reflects the nature of the challenges and opportunities for each sector, including the barriers and enabling actions to abatement. Overall, the publication of these roadmaps is the first step to enable industry sectors to make deeper emissions reductions over the longer term while staying competitive. We recommended that the UK Government continue to jointly work with industry to develop and publish a set of plans, setting out specific actions and clear milestones to move abatement efforts forward along the paths developed.

To encourage the level of private investment in the best equipment currently available and develop breakthrough technologies needed to implement the roadmaps, a stronger policy framework than currently exists is required:

9 Cement, ceramics, chemicals, food & drink, glass, iron & steel, oil refining, and paper & pulp. These sectors represent around 70% of manufacturing and refining CO_2 emissions.
10 https://www.gov.uk/government/publications/industrial-decarbonisation-and-energy-efficiency-roadmaps-to-2050

- **EU ETS.** Total verified emissions have been consistently below the allocation of allowances, largely because of the recession, causing the market value of carbon to fall and remain at a low level. The combination of a limited carbon price signal, and uncertainty over the EU ETS in the 2020s mean the incentives for energy-intensive industries to prepare for and make long-term investments in line with the fourth carbon budget are weak. Structural reform of the EU ETS is necessary (Overview Chapter).
- **Renewable Heat Incentive (RHI).** Industrial uptake of low-carbon heat technologies has been in line with our indicators (Figure 3.5). However, over the next few years our indicator sets out an acceleration in low-carbon heat uptake which may be difficult to meet . Funding for the RHI is only guaranteed to 2016, and funding to 2020 needs to be agreed as soon as possible (Chapter 2). This is important to achieve supply-chain growth and deliver the increased uptake consistent with meeting carbon budgets. Beyond 2020, the Government needs to put in place a policy framework to ensure investment in large scale industrial low-carbon heat projects.

Figure 3.5. Industry low-carbon heat uptake and trajectory (2007-2020)



Source: CCC analysis.

- **Promotion of industrial carbon capture and storage (CCS).** Industrial CCS is a key technology to meet the 2050 target:
  - The development of CCS infrastructure in the power sector provides an opportunity for co-located industrial plant to be included in a CCS commercialisation strategy across both the power and industrial sectors (Chapter 1).
  - The Teesside Collective has been awarded £1m by DECC to develop a business case, including potential funding mechanisms, for deploying an industrial cluster CCS development that could save up to 5 $MtCO_2$ by the 2020s (Box 3.3).
  - Given that CCS is a key technology in industry, the Government needs to develop a joined-up approach for CO_2 infrastructure and CCS development between power sector projects and industrial clusters (such as in Teesside) that is compatible with widespread deployment in the second half of the 2020s.
- **Climate Change Agreements (CCAs).** Voluntary agreements that allow eligible energy-intensive sectors to receive up to 90% reduction in the Climate Change Levy (CCL) if they sign up to government-agreed absolute or relative energy efficiency targets. Since our 2014 Progress Report, DECC have launched a review of the 2020 targets. We have previously said that the targets are not

strong enough and we suggest that the review should consider all possible cost-effective energy efficiency opportunities, tightening targets accordingly. We will report on this review in our 2016 Progress Report.

- **Energy Savings Opportunity Scheme (ESOS).** Chapter 2 gives an overview of the new ESOS scheme which has the opportunity to aid in companies identification of further energy efficiencies.
- **Combined Heat and Power (CHP).** A range of incentives exists to encourage take-up of CHP in industry. At present, these primarily encourage investment in gas-fired CHP. Due to high efficiencies, gas CHP does result in some CO_2 emission reductions. However, as grid electricity decarbonises in the 2020s, these savings will erode. Policy therefore should encourage low-carbon CHP.
- **Enhanced Capital Allowances (ECAs).** Companies can write off 100% of the cost of new energy-saving plant or machinery against business taxable profits in the financial year the purchase was made. At Budget 2015, the Government announced that it will make a number of changes to the ECA scheme for energy saving technologies later this year, including adding Waste Heat Energy Recovery to the scheme. This captures energy from heat that would otherwise be wasted, improving on-site energy saving and reducing grid electricity consumption.

Based on the slow progress to date, the Government needs to closely monitor uptake of low-cost measures, commit to long-term funding of existing measures (e.g. RHI), and work with industry to strengthen incentives for more expensive measures that could significantly decarbonise industrial sectors to 2030.

Box 3.3. International progress in industrial CCS and the Teesside Collective

Of the 22 CCS projects in operation or under construction across the world, nine are being developed for industrial sites. Of these, the Emirates Steel plant in Abu Dhabi is the world's first iron and steel project to apply CCS at large scale. It moved into construction in the latter part of 2013 and is scheduled to be completed by 2016.

In the UK, £1m funding was awarded by the Government to the Teesside Collective, an industrial cluster in the Teesside area, to develop:

- Feasibility study on CO_2 capture, transport and storage from multiple sources in Teesside (Amec Foster Wheeler).
- Possible investment models and funding mechanisms for industrial CCS in the Teesside cluster (Societe Generale).
- Business case for the project (Pale Blue Dot).

Work on the project has yielded positive results to date. Initial engineering and design work by Amec Foster Wheeler has found that capturing the carbon from Teesside's vital industries – hydrogen, ammonia, plastics and steel – is feasible and cost-effective.

The business case and financing options will be complete by summer 2015, and will provide insight into the required policy framework structure needed to deploy CCS in industrial clusters. If the Teesside Collective industrial CCS cluster was established, it would be Europe's first CCS equipped industrial zone and is estimated to cut CO_2 emissions in the North East by up to 5 million tonnes a year in the 2020s, with more reductions over time.

A report commissioned from Cambridge Econometrics on economic impacts of the project has concluded that the project would create a strong incentive for new process plants to re-locate to the Tees Valley and join the CCS network. This would have a significant impact on local employment and GVA above and beyond the benefit of helping to retain the existing industrial base.

Notes: More information on the Teesside Collective available at: http://www.teessidecollective.co.uk/

4. Industrial competitiveness opportunities and challenges

Decarbonisation raises both challenges and opportunities for UK competitiveness. We have previously considered how the transition to a low-carbon economy creates opportunities for new businesses, can save existing businesses money through increased energy- and resource-efficiency and mitigate risks from fossil fuel prices.

These changes provide economic opportunities for UK manufacturing. Investment in renewables and energy-efficient technologies will require new infrastructure and equipment for the power sector, commercial and industrial businesses, and households. That will provide growth opportunities for UK manufacturing. This potential is not limited to supplying just the UK market. EU members and other countries, from China to Mexico, are setting challenging emission targets and creating new markets.

In our 2013 *Managing competitiveness risks of low-carbon policies* report, we highlighted that the UK has a comparative advantage in some key low-carbon technologies.[11] Parts of heavy engineering and construction, as well some energy-intensive sectors such as parts of chemicals and plastics could contribute to low-carbon power and heat sector supply chains. Some energy-intensive industries have already developed new low-carbon technologies and processes which make them well placed to compete in new markets on the path to a low-carbon world (e.g. low-temperature detergents, low-resistance tyres and lightweight materials in aircraft and cars). To succeed there will need to be innovation in new technologies and use of materials, growth of a skilled workforce, supported by a consistent government policy framework that will help build growth in these supply chains.

Our 2013 report also noted that there are potential competitiveness risks for electro-intensive industries that are subject to international competition and face higher relative energy costs if other countries are slower to act on climate change policies than the UK. These firms could see a squeeze on profits which could potentially drive output and jobs overseas.

While our 2013 assessment of competitiveness risks concluded that low-carbon policies have not caused any significant industry relocation to date, it is important to ensure that increased energy costs due to low-carbon policies do not result in offshoring of UK industry. Output moving abroad would not have any benefits for the UK's overall carbon footprint (i.e. including consumption emissions) and therefore global emission reductions, and would not be desirable from a wider economic perspective.

The UK Government has recognised these risks and plans to or already has put in place support arrangements:

- **Compensation for the EU ETS and Carbon Price Floor (CPS)**[12] impact of rising electricity prices for electro-intense industries (e.g. iron/steel).
- **Compensation for the Renewables Obligation and small-scale Feed-in-Tariff** energy bill cost impacts, from the date of State Aid approval .
- **Exemption from the impact of Electricity Market Reform and Contracts for Difference (CfDs)** on electricity prices.

These are due to offset up to around 80% of the costs to support low-carbon electricity sector investment for those sectors that qualify through to 2019-20.

11 Available at: http://www.theccc.org.uk/

12 Carbon Price Floor (CPF) is minimum a carbon price for fuels, where the Carbon Support Price (CPS) tops up the carbon price from the EU ETS to the CPF.

These measures to alleviate competitiveness risks aim to stop existing energy-intensive sectors relocating to other countries and to encourage new investment in these sectors. It is important that competitiveness impacts are closely monitored to ensure there is appropriate support for specific sectors at risk. The measures should also be transitional on the path to a global climate change deal which would, over time, ensure a level playing field and reduce the need for support.

By the end of 2016, the Government should evaluate the impact of the compensation measures to date, assess whether these are addressing sectors at risk effectively, and assess what compensation may be needed post-2020. The Government should consider, as part of the evaluation, whether these measures should be further targeted to help industry invest in reducing its emissions.

5. Forward look

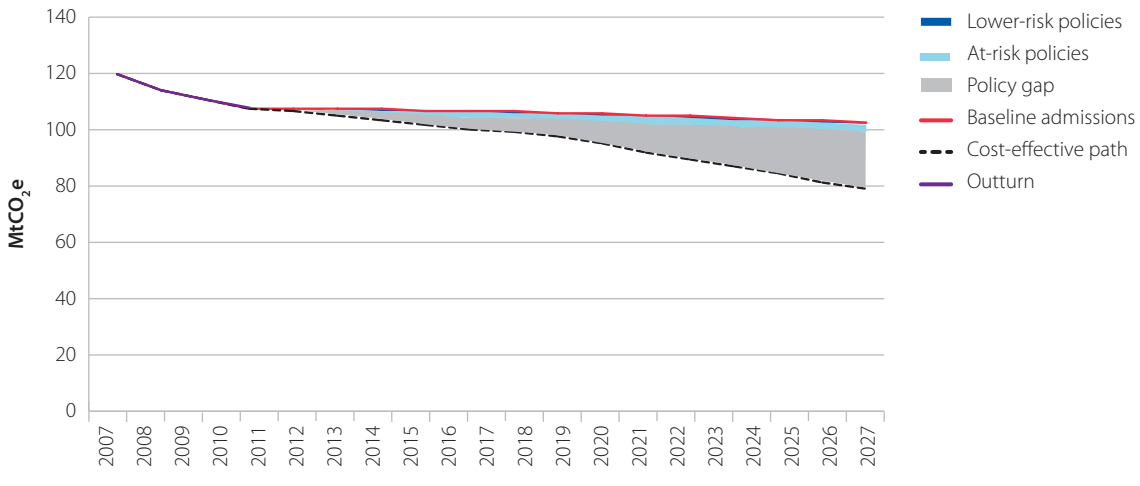
In our *Fourth Carbon Budget Review,* we suggested that direct industry emissions could fall to 84 $MtCO_2$ in 2025 to meet carbon budgets (Figure 3.6). According to DECC's *Energy and Emissions Projections* (EEP), industry direct emissions in the absence of policy would be 101 $MtCO_2$ in 2025, falling to 99 $MtCO_2$ when estimated savings of current and planned government policies are included.

This leaves a gap of around 15 $MtCO_2$ in 2025 which needs to be addressed to stay on the cost-effective path we have identified to meet carbon budgets. This gap comprises uptake of low-carbon heat (9 $MtCO_2$), further options in energy-intensive sectors (5 $MtCO_2$) and initial deployment of industrial CCS (1 $MtCO_2$).

Not all policy savings are necessarily assured. We have assessed the risk associated with the policies in DECC's projections. While 0.4 $MtCO_2$ is to be delivered by lower-risk policies, 2.5 $MtCO_2$ savings are dependent on policies with design/delivery problems or which are currently underfunded (Table 3.2).

We have identified three key areas where there is a lack of policy – low-carbon heat (post 2020), further options for energy-intensive sectors and industrial CCS. The Government's industrial roadmaps project was an important first step towards identifying barriers to unlocking cost-effective abatement potential, but these now need to be translated into a delivery plan for an industrial low-carbon policy framework strong enough to support the level of investment required.

Figure 3.6. DECC industry emission projection risk assessment (2007-2027, $MtCO_2$)



Source: NAEI *GHG inventory*, DECC EEP 2014, CCC analysis.

Table 3.2. DECC Industry emission projection risk assessment		
	Policies	**DECC estimated abatement in 2025**
Low risk	• RHI to April 2016	0.4 $MtCO_2$
At risk policies	• EU Products policy tranche 1 & 2 • Building regulations part L 2010 & 2013 • RHI from April 2016 • ESOS • Private Rented Sector Regulations	2.5 $MtCO_2$
Source: DECC EEP 2014 CCC analysis **Notes:** See *Technical Annex 3* for more details.		

6. Summary

To realise industry's significant abatement potential, it is necessary to support the growing low-carbon sectors of the economy and ensure those sectors at risk remain competitive while they decarbonise. Many large investment decisions taken by the private sector are made at a strategic level and for these to go ahead, there needs to be confidence in a long-term industrial abatement plan. From our analysis of the current policy framework for industry, there are significant gaps to realise cost-effective abatement within industry.

To bridge the gap requires action in three key areas:

- **Low-carbon investment.** For the abatement potential to be realised this will require continued investment in new plant and equipment through to 2050. For the private sector to invest, there needs to be confidence in the right policy framework in place to incentivise large-scale projects. The results of the Teeside Collective study will set out possible funding mechanism options for investment in the industrial CCS cluster, '2050 Roadmaps' action plans should focus on how to overcome investment barriers and the Government should to consider if there needs to be a change in large scale low-carbon heat project incentivisation.
- **Developing future options and innovation.** The '2050 Roadmaps' and other forward looking analysis have highlighted the potential for significant abatement of emissions from breakthrough technologies and processes that are currently not fully developed, such as industrial CCS. Investment in innovation is needed to ensure that these technologies and processes are ready for commercialisation in line with refurbishment cycles in industry. To support this, sectors need access to innovation funds in the UK and across the EU, such as Horizon 2020 and NER 300, with government assistance on how to secure funding from these programmes for the development of these new technologies.
- **Low-carbon choices.** Discussions with those working within industry and evidence from the '2050 Roadmaps' projects suggest that energy efficiency and other abatement opportunities are not generally high up on the corporate agenda. It is important that industry takes a long-term and strategic lead on how to compete in a carbon constrained world. It is equally important that the UK Government ensures that there is a long-term and credible policy framework that supports sectors at risk of competition and rewards real action.

Transforming UK industry through energy efficiency and the decarbonisation of their its supply will require long-term policy commitments from the Government. There are significant challenges to industrial decarbonisation, including development of breakthrough technologies, large capital outlays, refurbishment cycles and issues with international competition. However, a low-carbon industrial sector will benefit in the long-term from lower energy costs and an opportunity to supply new industrial materials and products to a low-carbon global market. It is essential that the Government takes a leadership role in working with industry to create action plans with real commitments and milestones to monitor progress.

Chapter 4: Progress reducing transport emissions

1. Trends in transport emissions
2. Progress in reducing emissions from surface transport
3. Progress in changing travel behaviour
4. Progress in reducing emissions from aviation and shipping
5. Forward look
6. Summary

Key messages and recommendations

Domestic transport accounted for 22% of total UK greenhouse gas emissions in 2014. Transport emissions fell between 2009 and 2013 but increased in 2014. With travel demand increasing, there is a need to decarbonise transport more rapidly to meet future carbon budgets. There is significant potential to reduce emissions through further efficiency improvements in conventional vehicles, switching to ultra-low emission vehicles (ULEVs), and changing travel behaviour.

The key messages from this chapter are:

- **Emissions trends:** In 2014 transport sector emissions increased by 1.1%, a reversal of recent trends. Between 2009 and 2013 transport emissions fell by 1.1% on an average annual basis. Road travel demand is increasing across all modes. There were continued improvements in the efficiency of new cars but slower improvements for vans and heavy goods vehicles (HGVs).
- **New vehicle CO_2:** New car and van CO_2 intensity has continued to improve and is broadly in line with our indicator, but there is growing evidence that the gap between test-cycle and real-world emissions has widened. There has been little progress in agreeing post-2020 EU targets for new cars and vans or in developing regulation for CO_2 from new HGVs.
- **Electric vehicles:** There has been strong growth in UK electric vehicle (EV) sales, which more than quadrupled in 2014, significantly outperforming our indicator. The number of models available has also increased in the last year.
- **Biofuels:** Penetration of biofuels increased from 2.9% by energy in 2013 to 3.2% in 2014 but remains below our indicator. Sustainability continues to improve, with average GHG savings of 69% for biofuels delivered in 2013/14 and almost half of biofuels derived from waste.
- **Travel demand:** There has been less progress in reducing travel demand. Whilst there was a small increase in the number of projects funded by the Local Sustainable Transport Fund, it has not been extended beyond 2015/16 and evidence of the CO_2 impact of the schemes remains weak.
- **Forward look:** Emissions reductions from announced policies are estimated to fall short of our indicator by around 17 $MtCO_2$ in 2025.

As well as cutting CO_2 emissions, many of the measures covered in this chapter could have additional co-benefits, such as improving air quality, boosting UK manufacturing and improving public health.

Our key policy recommendations are:

- **Provide motor industry with greater certainty to 2030:** Push for clear, stretching 2030 EU targets for new cars and vans that take account of the need for ultra-low emission vehicles and use realistic testing procedures.
- **Tackle barriers to EV uptake:** Maintain support for upfront costs while they remain more expensive than conventional vehicles, provide a national network of charge points and roll out local incentives such as access to parking.
- **Ensure the tax regime keeps pace with technological change:** Align existing fiscal levers (e.g. Vehicle Excise Duty) to ongoing improvements in new vehicle CO_2, including a greater differentiation between rates for high and low emission vehicles.

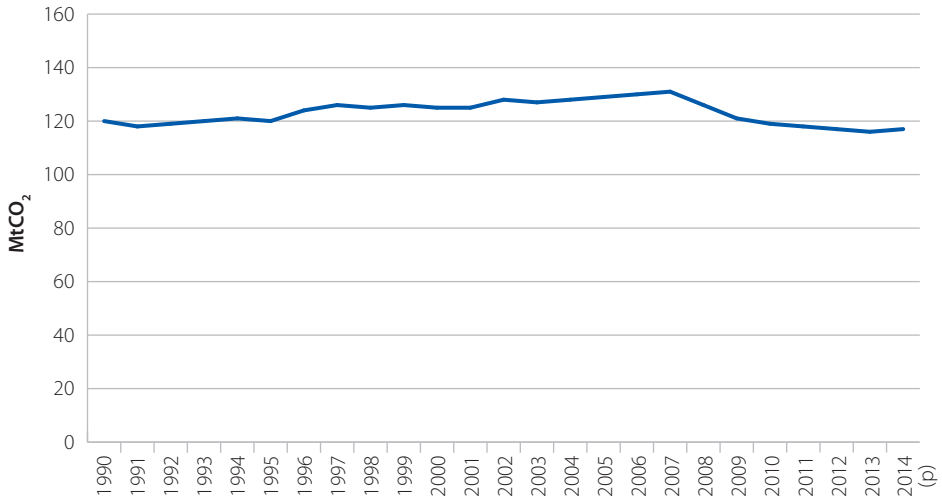
Key messages and recommendations

- **Extend successful emissions-reduction schemes for freight operations:** Larger freight operators have pioneered schemes to reduce fuel costs and emissions that should be rolled out across the industry, including small operators.
- **Ensure lessons from schemes to reduce travel demand are applied:** Sustainable travel schemes should be properly evaluated and extended if they provide cost-effective emissions reductions.
- **Publish an effective policy framework for aviation emissions:** Plan for UK 2050 emissions at 2005 levels (implying around a 60% increase in demand) and push for strong international and EU policies.

1. Trends in transport emissions

UK domestic transport CO_2 emissions for 2014 are provisionally estimated to be 117 $MtCO_2$ (28% of UK CO_2 emissions)[1]. This represents an increase of 1.1% from 2013, compared with an average annual decrease in emissions of 1.1% between 2009 and 2013 (Figure 4.1).

Figure 4.1. Total transport CO_2 emissions to 2014



Source: NAEI (2015), DECC provisional estimates.
Note: p=provisional.

More detailed data on domestic transport emissions are now available for 2013, providing splits between emissions from different greenhouse gases (GHGs) and from different modes of transport.

- In 2013, CO_2 emissions accounted for 99% of transport GHG emissions[2].
- Surface transport accounted for 95% of domestic transport emissions, the remaining 5% being due to domestic aviation and shipping.

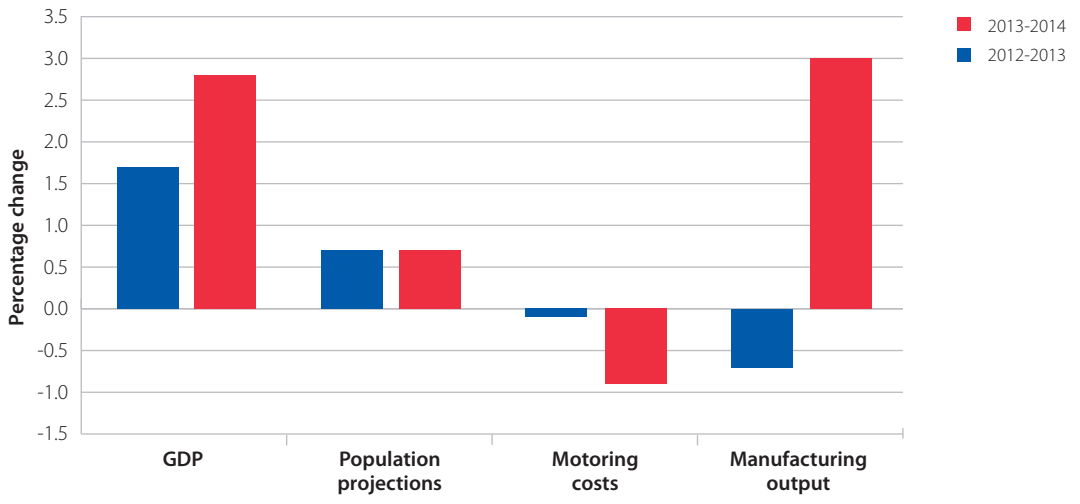
Surface transport emissions

(a) Economic context

Historically, demand for road transport has been largely driven by changes in GDP, population and motoring costs, although demand for freight transport has been more closely related to manufacturing output than GDP[3]. Whilst manufacturing output fell in 2013, all other key drivers moved to increase demand for road transport. This trend accelerated in 2014, with strong growth in GDP and manufacturing output alongside lower motoring costs, largely driven by the falling oil price (Figure 4.2).

1 All outturn emissions data are based on the National Atmospheric Emissions Inventory (NAEI). Available at: www.gov.uk/.
2 This chapter focuses on CO_2 emissions.
3 DfT (2015) *Road Traffic Forecasts 2015*. Available at: www.gov.uk/.

Figure 4.2. Key Economic Indicators



Source: CCC calculations based on Office for National Statistics data and DfT (2014) Transport Statistics Great Britain.

Whilst these economic drivers continue to play an important role in determining demand for travel, there is some evidence that the relationships have weakened in recent years. Understanding these drivers in more detail will help to improve the Government's forecasts of travel demand, which inform the required scale of future emissions reductions (Box 4.1).

Box 4.1. Forecasts of travel demand

Government forecasts of demand for travel are produced using the National Transport Model (NTM). These forecasts are used to help inform the required scale of future emissions reductions and also to inform decisions on the level of investment needed in the road network. Our work draws on these forecasts but we continually review their performance against outturn data to ensure that our emissions projections are based on robust projections of demand.

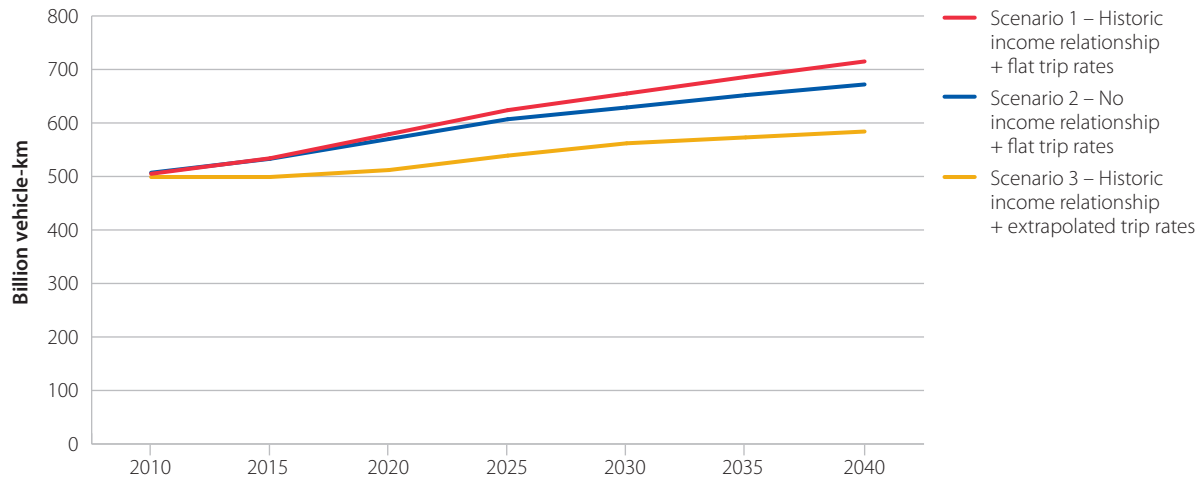
There is some evidence that demand for car travel has been slowing since the early 2000s. To investigate this trend, DfT recently carried out a review of evidence of the drivers of demand for car travel[4]. The report demonstrates diverse trends for different road types, different groups of people and in different locations. The relationships between drivers of demand are found to be complex and interacting. For example, divergent trends between different age and gender groups are partially explained by differences in income, but it is also possible that cultural and generational differences have played a role. Uncertainty around the extent to which these factors will continue to be important makes it difficult to accurately project future demand.

To address this DfT has included two additional scenarios in its road traffic forecasts. (Figure B4.1), whilst continuing to include scenarios that demonstrate sensitivity to future GDP and fuel prices.

Though recent work has focused on car travel, DfT has recognised the need to improve its forecasts of demand for van and HGV travel. Our analysis suggests that some emerging trends, such as the rapid increase in van demand, are not fully reflected in DfT forecasts (Section d).

DfT will be carrying out more work to improve the evidence base and refine forecasts. We will monitor these developments closely and consider the implications for future carbon budgets.

Figure B4.1. Forecasts of demand for travel



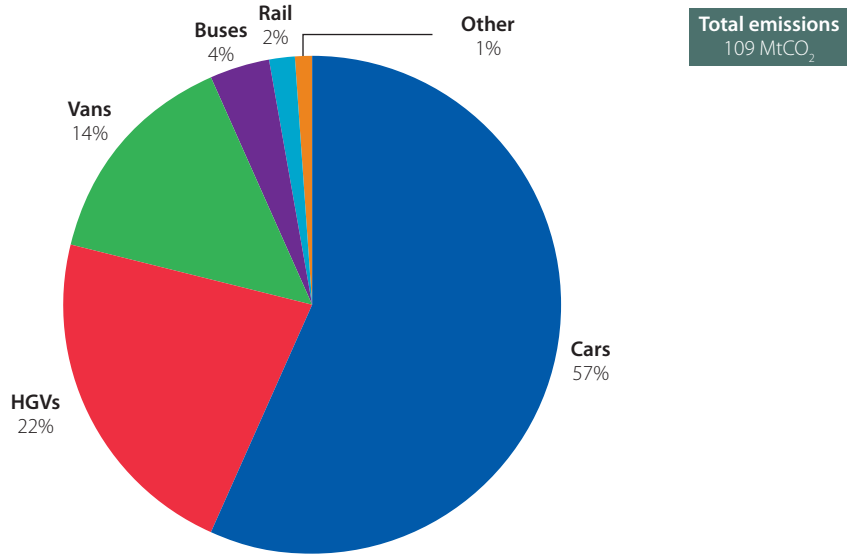
Source: DfT (2015) Road Traffic Forecasts.

4 DfT (2015) *Understanding the drivers of road travel: current trends in and factors behind roads use.* Available at: www.gov.uk/.

(b) Emissions trends

Within surface transport 98% of emissions come from road transport, with the remainder coming from rail and various non-road transport vehicles (Figure 4.3).

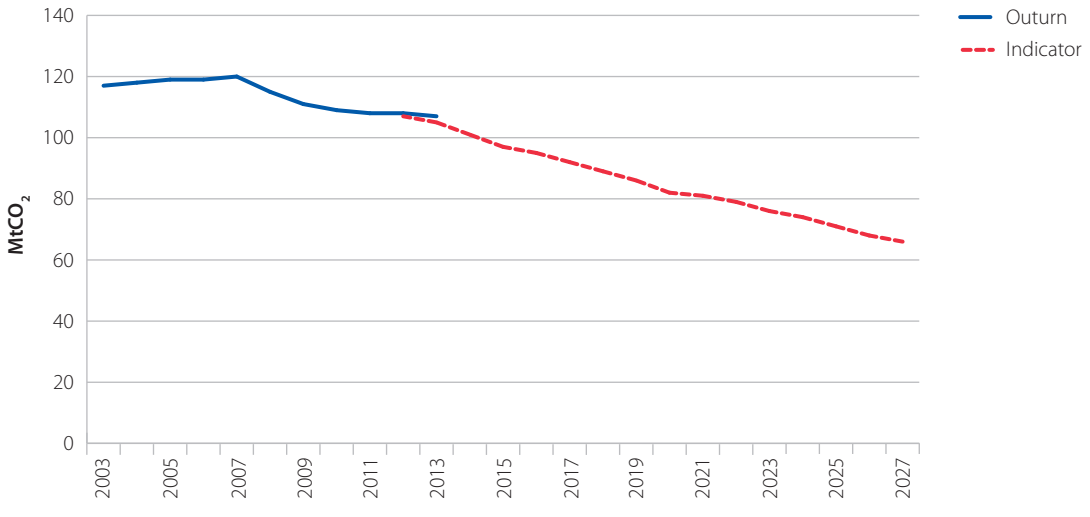
Figure 4.3. Surface transport CO_2 emissions by mode in 2013



Source: NAEI (2015).
Note: 'Other' includes motorcycles and mopeds, liquefied petroleum gas emissions (all vehicles), aircraft support vehicles and other road vehicle engines.

Road transport emissions decreased by 1.1% in 2013, as against a 2.5% reduction in our cost-effective path (Figure 4.4).

Figure 4.4. Total road transport CO_2 emissions against CCC indicator (2003-2013)



Source: NAEI (2015), CCC modelling.

Official data are not yet available for road transport emissions in 2014, but it is possible to estimate emissions using data on sales of petrol and diesel. These data suggest that road transport emissions may have increased by over 1% in 2014, compared to a decrease of around 3.7% under our cost-effective path.

We now examine the three most significant sources of surface transport emissions; cars, vans and HGVs. Other modes are considered in the Technical Annex (Technical Annex 4 -Transport).

(c) Car emissions

Car emissions fell by 2.1% in 2013 to 62 $MtCO_2$, in line with our indicator. This compares with an average annual reduction of 2.5% between 2009 and 2013. The main reason for the decrease in emissions was a fall in CO_2 intensity of the car fleet as the distance travelled by cars (car-km) remained broadly flat (Figure 4.5):

- In 2013 car-km were roughly flat, falling just below our indicator, but increased by 1.5% in 2014. Economic factors may not fully explain these changes.
  - GDP, population and real car costs per km, have all moved to increase car-km. Using DfT's estimated elasticities for these drivers[5], we would expect demand for car travel to have increased by 4.9% between 2012 and 2014, compared to the outturn increase of 1.4% (Technical Annex 4 – Transport).
  - This estimate should be treated with caution as the elasticities are not designed to capture changes in demand over short time intervals and the discrepancy could be within the margin of modelling error.
  - However, it is also possible that this difference could indicate a weakening of the relationship between these economic drivers and demand for car travel.
- Data on emissions and car-km imply that average car CO_2 intensity fell by 2.0% in 2013, compared to a 3.8% decrease in our indicator. Although there was higher fuel efficiency as a result of reductions in new car CO_2, there was a lower than expected increase in biofuel penetration and a residual impact of slow stock turnover during the recession[6] (Table 4.1).

Table 4.1. Drivers of car CO_2 intensity

Driver	Change in 2013	Percentage point (pp) contribution
Biofuels	Biofuel penetration by energy increased from 2.9% to 3.3%	-0.3pp
New cars in 2013	The CO_2 intensity of new cars fell by 3.6%	-0.2pp
Stock turnover	The CO_2 intensity of existing fleet fell by 1.9%[7]	-1.6pp

Source: CCC calculations based on data from NAEI, the HMRC Hydrocarbon Oils Bulletin and SMMT.

Data for car emissions in 2014 are not yet available but we can make an estimate based on provisional data for distance travelled, biofuels penetration and new car CO_2.

- Car-km increased by 1.5% in 2014.
- Biofuel penetration in the car fleet increased from 3.3% to around 3.5%.

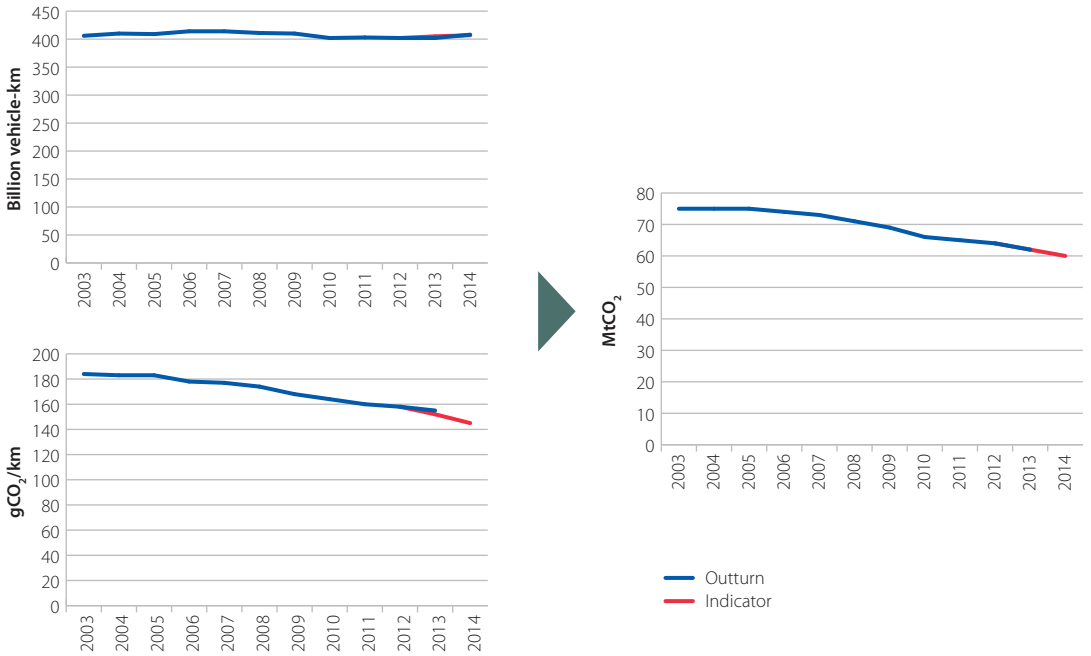
5 DfT (2013) *Road Traffic Forecasts 2013*. Available at: www.gov.uk/.

6 Turnover of cars has slowed in recent years and the average age of the fleet has increased in every year since 2009 (7.9 years in 2014, compared to 7.1 years in 2009). However, there are signs this trend is reversing, with sales of new cars increasing by 9% in 2014.

7 Due to older vehicle leaving the fleet.

- New car CO_2 intensity decreased by 2.8%, which implies that the intensity of the fleet fell by around 1.9% when stock turnover is taken into account.
- Together these data suggest that car emissions are likely to have fallen by less than 1% in 2014, though this should be treated with caution given the uncertainties in the data.

Figure 4.5. Car emissions to 2013/Car-km to 2014/Car CO_2 intensity to 2013 against CCC indicator



Source: NAEI (2015), DfT (2015) Road Traffic Statistics.

(d) Van emissions

Van emissions increased by 2.7% in 2013 to 16 $MtCO_2$, as against a decrease of over 2% on our cost-effective path. This is stronger growth than in recent years, with van emissions increasing by 1.4% on an average annual basis between 2009 and 2013. The 2013 increase was largely a result of continued strong growth in demand, partially offset by a fall in fleet CO_2 intensity (Figure 4.6).

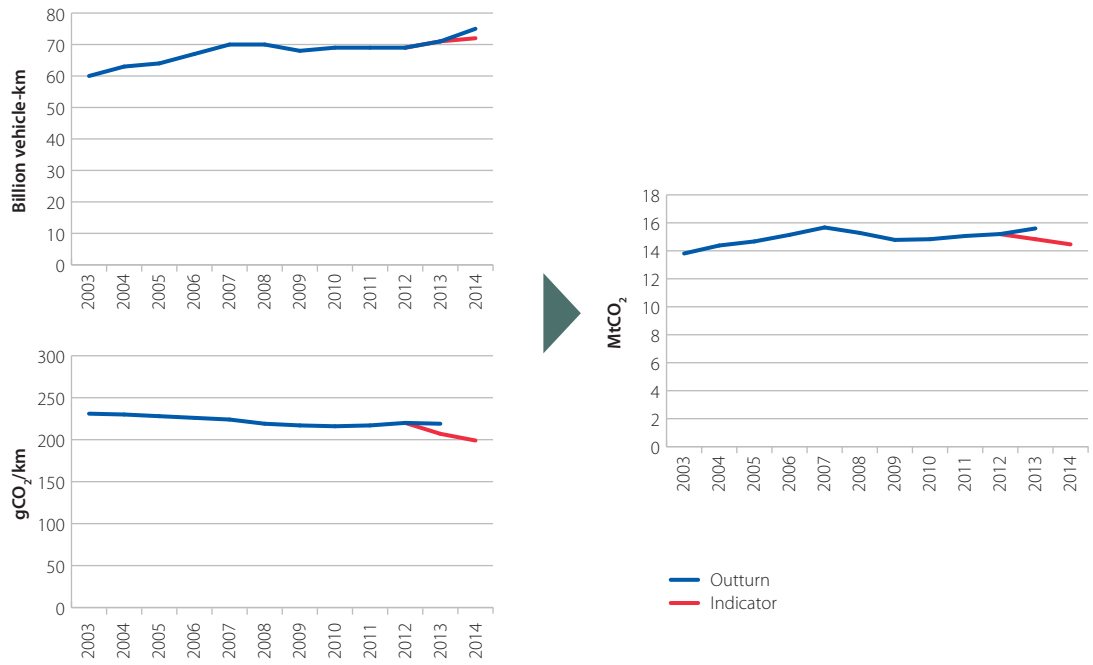
- Van-km increased by 3.2% in 2013 and by 5.8% in 2014. Changes in GDP, population and fuel costs together with estimated elasticities suggest that van-km might have been expected to increase by around 6.4% between 2012 and 2014, compared to the actual increase of 9.2%. The rapid increase in van-km is not fully understood, but the continued increase in deliveries of online sales and a rise in the number of self-employed tradespeople may be contributing factors[8].
- Combining data on emissions and van travel demand shows that average CO_2 intensity of the van fleet decreased by 0.5% in 2013, compared with a 5.7% decrease in our indicator. It is not possible to accurately attribute the change in CO_2 intensity to different factors, due to a lack of historical data, but changes in biofuels penetration, new van CO_2 and stock turnover will have played a role (Table 4.2).

8 DfT recently commissioned a research project into trends in demand for van travel, due to be published later this year.

Table 4.2. Drivers of van CO_2 intensity	
Driver	**Change in 2013**
Biofuels	Biofuel penetration by energy increased from 2.4% to 2.8%
New vans in 2013	The CO_2 intensity of new vans fell by 2.0%
Stock turnover	The average age of vans increased by 0.2 years[9].
Source: CCC calculations based on data from NAEI, the HMRC Hydrocarbon Oils Bulletin and SMMT.	

We do not have data on van emissions in 2014 but it is likely that they increased, with higher van-km outweighing improvements in van emissions intensity. We will continue to monitor this trend and if it poses a risk to meeting carbon budgets we will advise DfT to take appropriate action.

Figure 4.6. Van emissions to 2013/Van-km to 2014/Van CO_2 intensity to 2013 against CCC indicator



Source: NAEI (2015), DfT (2015) Road Traffic Statistics.

(e) HGV emissions

HGV emissions were 24 $MtCO_2$ in 2013, broadly unchanged from the previous year and above the level suggested by our cost-effective path. There was an increase in HGV-km, offset by a reduction in the emissions intensity of the fleet (Figure 4.7).

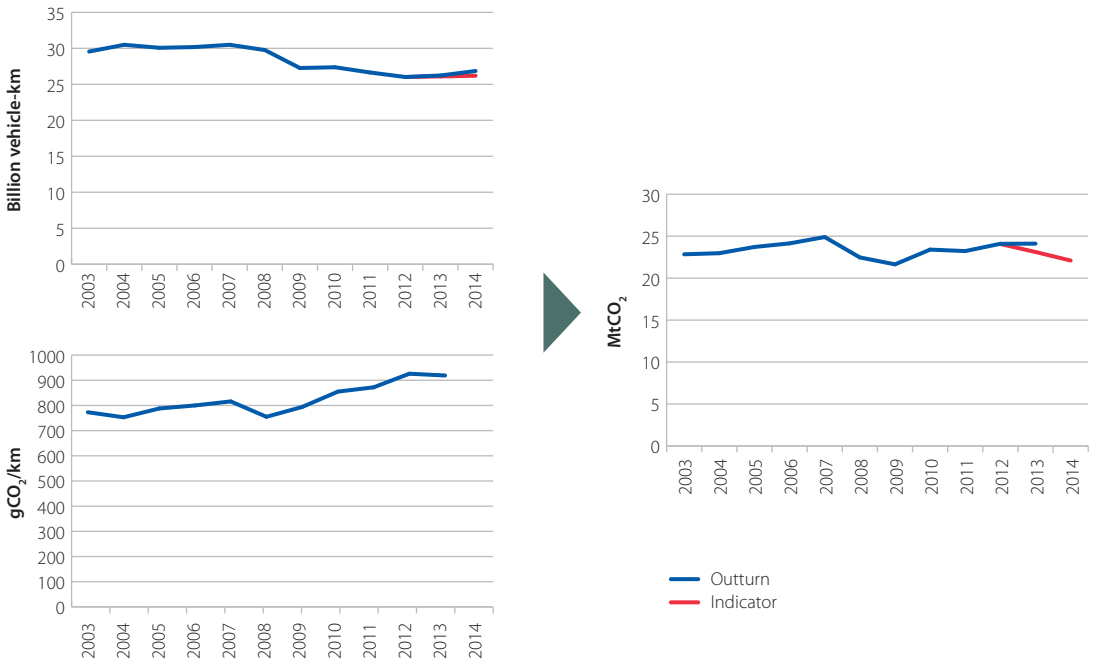
- HGV-km increased by 0.8% in 2013 and by 2.4% in 2014. Given economic outturn data and estimated elasticities we might have expected HGV-km to increase by 2.3% between 2012 and 2014, as against the actual increase of 3.2%.
- There is uncertainty surrounding emissions from HGVs and their CO_2 intensity. In our 2014 Progress Report, we identified issues with the NAEI methodology for calculating emissions from HGVs that suggested a large range of uncertainty around these estimates (Technical Annex 4 – Transport). Consequently, we have decided not to track progress against our indicator for CO_2 intensity until these estimation issues can be resolved.

9 The average age of vans increased by 0.2 years per year between 2009 and 2013, but the increase is beginning to slow (up 0.1 years in 2014).

- HGV CO_2 intensity will have been affected by biofuel penetration and fleet turnover, but changes in the way HGVs are operated may also be having an impact on their emissions per kilometre.
  - The percentage of biofuels in HGV fuel increased from 2.3% to 2.7% by energy in 2013.
  - Turnover of HGVs slowed over the last 5 years, with the average age of HGVs increasing by 0.1 years per year between 2009 and 2013. This trend appears to be continuing, with a similar increase in average age in 2014.
  - The CO_2 intensity of HGV operations can also be expressed in terms of emissions per tonne-kilometre. An HGV that is fully loaded will have higher emissions per kilometre, but will usually have lower emissions per tonne-kilometre compared to a half-full HGV. Our analysis suggests that while emissions per kilometre increased by nearly 9% between 2009 and 2013, emissions per-tonne-kilometre decreased by about 6%. This is likely to have been driven by a significant shift to heavier vehicles, but other factors may have contributed (Technical Annex 4 – Transport).

We do not have data for HGV emissions in 2014 but it is likely that HGV emissions increased due to rising freight demand.

Figure 4.7. HGV emissions to 2013/HGV-km to 2014/HGV CO_2 intensity to 2013 against CCC indicator



Source: NAEI (2015), DfT (2015) Road Traffic Statistics.

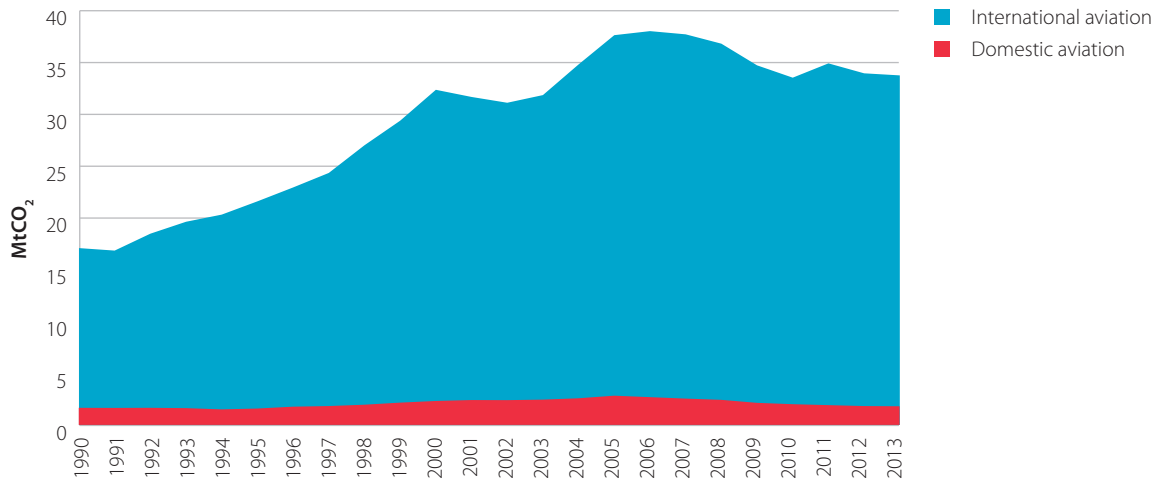
Emissions from aviation and shipping

(a) Aviation

Total UK aviation emissions were 34 $MtCO_2$ in 2013, a reduction of 0.6% on 2012. This is in line with the trend in recent years, where aviation emissions fell by 0.7% on an average annual basis between 2009 and 2013 (Figure 4.8). Both domestic and international emissions fell in 2013.

- Domestic emissions fell 1.1% in 2013 to 1.8 $MtCO_2$.
- International emissions (which are not formally included in carbon budgets) fell 0.6% in 2013 to 32 $MtCO_2$.

Figure 4.8. UK aviation CO_2 emissions (1990-2013)



Source: DECC (2015).

Passenger numbers and flights increased in 2013 by 3.5% and 0.8% respectively. This suggests the reduction in emissions in 2013 was due to changes on the supply side (e.g. increases in load factor, improved fuel efficiency) and/or a shift in the route mix towards closer destinations.

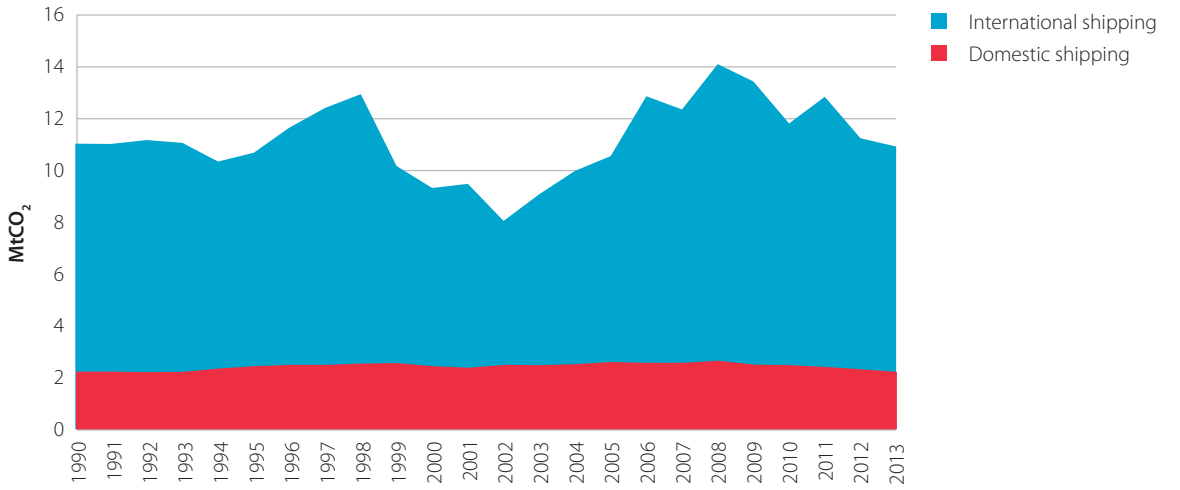
A further set of tracking and monitoring indicators for aviation can be found in the Technical Annex (Technical Annex 4 – Transport).

(b) Shipping

Emissions from UK shipping were 11 $MtCO_2$ in 2013, a reduction of 2.9% on 2012. Whilst there is some volatility in year-on-year changes in shipping emissions this is in line with the trend in recent years, where shipping emissions fell by 5.1% on an average annual basis between 2009 and 2013 (Figure 4.9). Both domestic and international shipping emissions fell in 2013.

- Domestic shipping emissions fell 4.4% in 2013 to 2.2 $MtCO_2$
- International shipping emissions (which are not formally included in carbon budgets) fell 2.5% in 2013 to 8.7 $MtCO_2$.

Figure 4.9. UK shipping CO_2 emissions (1990-2013)



Source: DECC (2015).

Total demand for UK shipping (as measured in tonne-km) increased by 3.8% in 2013. However, the number and average size of ships using UK ports fell (by 2.1% and 1.8% respectively), suggesting the reduction in emissions in 2013 was due to changes on the supply side. Factors that may have reduced reported UK shipping emissions include falling ship speeds, improvements in fuel efficiency of ships, and changes in bunkering patterns.

A further set of tracking and monitoring indicators for shipping can be found in the Technical Annex (Technical Annex 4 – Transport).

2. Progress in reducing emissions from surface transport

Progress in improving new vehicle emissions intensity

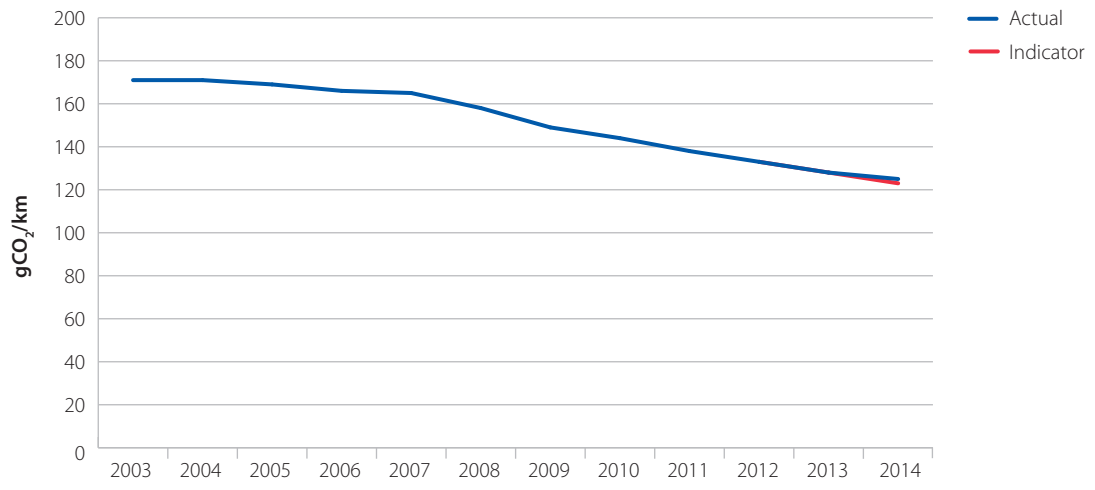
(a) Cars and vans – Progress to date

EU regulations on average CO_2 intensity have been in place for new cars since 2009 and for new vans since 2011. For cars, there are targets in place for 2015 (130 gCO_2/km) and 2020/21 (95 gCO_2/km)[10]. For vans, the targets are for 2017 (175 gCO_2/km) and 2020 (147 gCO_2/km). The regulations apply to the average of a manufacturer's fleet of new cars and vans sold in the respective year.

The EU regulations have been effective in delivering test-cycle emissions reductions. In 2014, new car CO_2 fell by 2.8% to 124.7g CO_2/km and new van CO_2 fell by 2.0% to 181.9gCO_2/km. For both cars (Figure 4.10) and vans this is a slight underperformance against our indicator.

10 The regulation will be phased in over one year, with 95% of sales counting towards the target in 2020, before rising to 100% in 2021.

Figure 4.10. New car CO_2 against CCC indicator



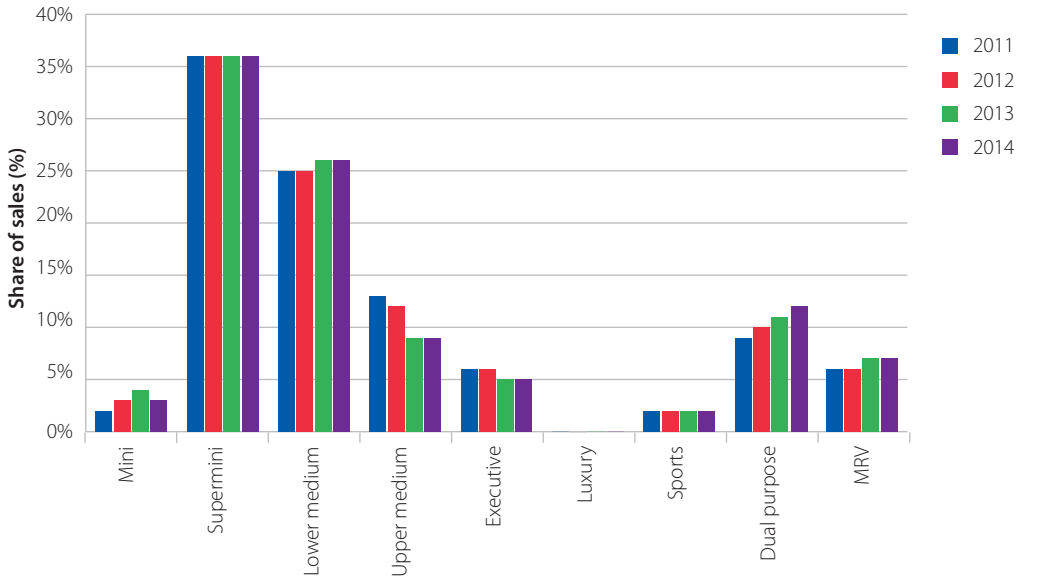
Source: SMMT (2015), CCC Modelling.

Sales data suggest that emissions reductions have been driven largely by the supply of more efficient cars as manufacturers work towards EU targets, while the impact of consumer purchase decisions on CO_2 reduction has remained broadly neutral in the last few years.

- Sales by car size remain polarised, towards smaller and larger car segments, but the share of sales across different segments did not change significantly between 2013 and 2014 (Figure 4.11).
- The share of sales for petrol and diesel fuelled cars has remained broadly unchanged at 50% for each in 2013 and 2014.

More detailed analysis of CO_2 intensity for different types of car is available in the Technical Annex (Technical Annex 4 – Transport).

Figure 4.11. New car sales by segment



Source: SMMT (2015)

A recent evaluation[11] of the new car and van CO_2 regulations carried out for the European Commission suggests they have been more cost-effective than initially anticipated:

- It is estimated that there has been a net benefit to society of €100 for every tonne of CO_2 abated since the regulations were introduced.
- The costs of fuel saving technology have been lower than initially anticipated (around €200 per vehicle compared to initial estimate of around €620 per vehicle). In addition, fuel prices were higher than initial projections, which meant that the regulations brought about bigger savings.

Later in 2015, the European Commission will be publishing an assessment of the cost-effectiveness of technologies that could be deployed to meet future targets.

Whilst reductions in test-cycle emissions are positive, there is evidence of a growing gap between test-cycle emissions and those achieved in real-world driving conditions, implying smaller reductions in gCO_2/km on the road (Box 4.2).

11 Ricardo-AEA (2015). Available at: http://ec.europa.eu/clima/events/docs/0103/evaluation_en.pdf.

Box 4.2. The impact of the car and van test-cycle on real-world emissions

Since the 1990s, CO_2 emissions from new vehicles sold in the EU have been tested using the New European Driving Cycle (NEDC). Vehicle emissions are determined by a wide range of factors, including driving speed, vehicle loading and use of auxiliary systems (e.g. air conditioning). The NEDC does not fully account for these factors, which means that a vehicle's measured CO_2 intensity is considered to be only a loose proxy for the real-world value.

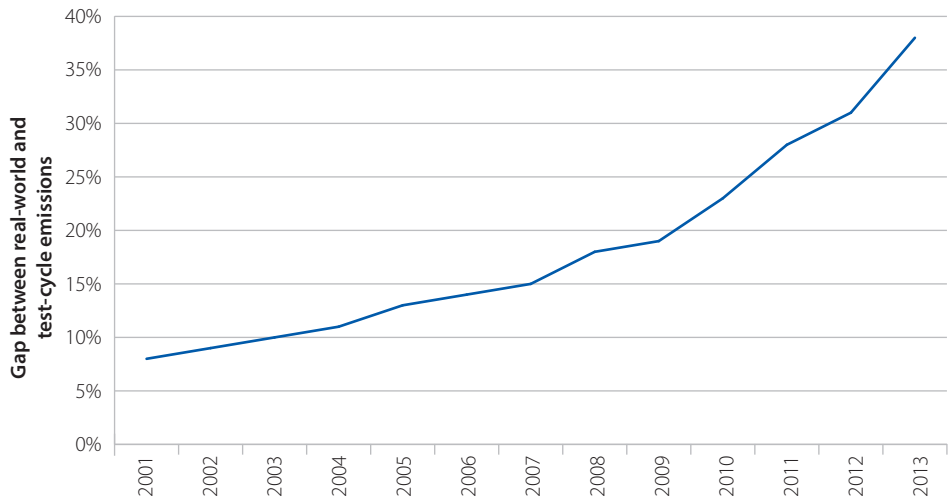
Carbon budgets need to be set on the basis of real-world emissions. Therefore, when estimating the future emissions of the UK vehicle fleet, it is necessary to account for these additional factors, in the form of an "emissions gap" between the regulated target for new vehicles and average real-world emissions.

Recent studies[12] have suggested that this emissions gap is significant and growing. Average real-world emissions intensity of new cars in 2013 may have been around 38% higher than the average NEDC value (Figure B4.2). Reliance on an increasingly inaccurate test as the main policy instrument to decarbonise vehicles could present a problem for climate change mitigation efforts. It also results in higher real-world fuel consumption than implied by the NEDC label. For the average new car driver in 2013, this could mean annual fuel costs over £350 higher than those advertised.[13]

The EU has recognised the problem of the growing emissions gap and has proposed that it is addressed by the introduction of the Worldwide harmonized Light vehicles Test Procedure (WLTP). This test will be more representative of real-world driving and is expected to close some of the loopholes that manufacturers have been able to exploit in the NEDC. However, the WLTP may not entirely close the gap.[14]

We have commissioned a research project to look at the historical relationship between NEDC and UK CO_2 emissions to assess whether total emissions have been higher than expected, given the improved performance of vehicles on the test-cycle in recent years. The project will then assess the extent to which this might continue to be the case in future, given the proposed introduction of WLTP in 2017. This analysis will be used to monitor the future emissions gap and whether additional effort will be needed to meet climate change mitigation targets.

Figure B4.2. Gap between real-world and test-cycle emissions



Source: ICCT (2014) *From laboratory to road: A 2014 update.*

12 ICCT (2014) *From laboratory to road: A 2014 update.* Available at: http://www.theicct.org/laboratory-road-2014-update

13 The average car drove around 13,000 kilometres in 2013 (based on data from DfT's National Travel Survey). The average pump fuel price was around 140 pence per litre in 2013 (based on data from DECC Quarterly Energy Price Statistics).

14 Emissions Analytics (2014). Available at: http://emissionsanalytics.com/real-driving-emissions-are-you-ready/

(b) Cars and vans – Forward look

Regulation to 2020

New car CO_2 intensity will need to fall at an average annual rate of 4.4% between now and 2020 to reach an average of 95 gCO_2/km in the UK, compared to an average annual rate of 3.6% since 2009. To meet the 2020 target for vans, CO_2 intensity will need to fall at an average annual rate of 3.5%. Evidence suggests that manufacturers could meet the targets.

- Progress to date is ahead of schedule, with both new car and new van CO_2 outperforming trajectories to the 2015 and 2017 targets[15].
- There are stiff penalties for failure to comply with the targets[16], while additional manufacturing costs associated with meeting them appear to be lower than previously estimated (as discussed above).
- For the largest car manufacturers, the rate of progress required to meet their 2020/21 targets is generally lower than the rates of reductions achieved since 2009[17].

As noted above, the introduction of the new WLTP test-cycle provisionally agreed for 2017 should ensure a closer match between test-cycle and real-world emissions. Beyond 2020, new car and van CO_2 targets will be set using the WLTP. The gap between WLTP and real-world emissions should be monitored to check that the targets are realising the intended level of emissions reduction.

Post-2020 regulation

The European Commission is in the process of developing post-2020 targets for new car and van CO_2, with detailed announcements expected no earlier than 2016. It is likely that emissions reductions to 2020 will be delivered mainly through continuing efficiency improvements in conventional vehicles. Beyond 2020, take-up of electric and other ultra-low emission vehicles will be increasingly important to reduce emissions.

- Our analysis has identified scope to reduce test-cycle CO_2 intensity to 80 gCO_2/km for conventional cars and 120 gCO_2/km for conventional vans by 2030[18].
- These conventional efficiency improvements together with penetration of electric vehicles could result in average test-cycle emissions in 2030 of 50 gCO_2/km for new cars and 60 gCO_2/km for new vans.

The market for cars and vans is Europe-wide. To achieve this progress it is important that the UK pushes for stretching EU targets for new car and van emissions in 2030. Moreover, in deciding what level of target to support, it is important to recognise not only the scope for efficiency improvement in conventional vehicles, but also the need to achieve increasing penetration of electric and other ultra-low emission vehicles through the 2020s.

15 The target trajectories imply slower improvements to 2015/17, with the rate of improvement accelerating to 2020. The CCC trajectory assumes that improvements will be made at a more consistent rate all the way to 2020, which is why new car and van CO_2 is outperforming the target trajectory but slightly underperforming against the CCC trajectory.

16 Penalties are currently €5 for exceeding the first g/km, €15 for the second g/km, €25 for the third g/km, and €95 for each subsequent g/km. From 2019, the cost will be €95 from the first gram onwards.

17 Ricardo-AEA (2015). Available at: http://ec.europa.eu/clima/events/docs/0103/evaluation_en.pdf.

18 CCC (2013) *Fourth Carbon Budget Review – Technical report*. Available at: www.theccc.org.uk/.

Fiscal levers

As outlined in our 2014 Progress Report, member states with strong national policies complementing EU regulations have achieved greater improvements in average vehicle efficiency[19]. The UK has a number of fiscal policies in place aimed at encouraging purchase of more efficient vehicles:

- **Vehicle Excise Duty (VED):** Since 2001 VED rates have been differentiated according to CO_2 emissions (gCO_2/km). Currently, there are no bands below 100 gCO_2/km, which means it provides no additional incentive to purchase a ULEV. In order to promote uptake of ULEVs, VED should be graduated below 100 gCO_2/km giving preference to zero emission vehicles, take account of the 95 gCO_2/km EU target for conventional vehicles and have stronger differentiation between bands, including increased rates for higher emission bands.
- **Company Car Tax (CCT):** CCT provides an incentive to purchase a ULEV, with five differentiated rates below 100 gCO_2/km, including a band for zero emission vehicles. Rates have been announced out to 2020 and are set to gradually increase for lower emitting vehicles.
- **Enhanced Capital Allowance (ECA):** Firms are able to claim an ECA on new vehicles below 75 gCO_2/km until 2018. This policy has not been extended to rental and hire companies (including car clubs) or to second hand vehicles.

While CCT provides differentiated incentives for the lowest emitting vehicles, VED offers no additional incentive to purchase a car below 100gCO_2/km. We recommend that all fiscal levers should be adjusted over time to align to new vehicle CO_2 targets, providing additional incentives for ULEVs and higher rates for higher emitting vehicles.

Policies to improve local air quality

Whilst the policies covered in this chapter focus on reducing carbon emissions, they have important implications for efforts to reduce air pollutant emissions from vehicles and improve local air quality. In recent years, decisions to switch from petrol to diesel have reduced CO_2 emissions, whilst increasing air pollutant emissions. In future, an emphasis on reducing demand for car travel in urban areas and moving to ULEVs will help to achieve both objectives simultaneously (Box 4.3).

19 CCC (2014) *Meeting Carbon Budgets – 2014 Progress Report to Parliament*. Available at: www.theccc.org.uk/.

Box 4.3. Air quality and climate change

Vehicles

Reducing emissions of air pollutants and CO_2 can often be achieved in tandem, but historically some measures have acted to reduce one at the expense of the other.

New cars and vans are subject to increasingly strict EU standards for both CO_2 emissions and emissions of air pollutants, such as NOx and particulates. Diesel cars typically have lower CO_2 emissions than their petrol equivalents, but their air pollution emissions can be higher. As with the CO_2 regulations, the effectiveness of the technology used to clean the exhaust fumes is checked using a test-cycle, which is not currently representative of real-world driving. This has led to higher real-world emissions of air pollutants than the legislation intended, particularly for diesel vehicles. At the same time, policies such as VED, which are based on CO_2 emissions, could have incentivised the uptake of diesel cars in recent years.

From September 2015, new diesel cars will meet the Euro 6 standard, which has been found to be relatively successful in reducing particulate and NOx emissions[20]. This suggests that it is possible for manufacturers to reduce emission of both CO_2 and air pollutants, but that a stringent testing regime is required to achieve both objectives under real-world conditions.

To meet carbon budgets in 2030 and beyond, there will be a shift away from both petrol and diesel towards ULEVs, which produce little or no air pollution.

Local air quality policies

Whilst there have been improvements in vehicle technology, air quality remains an urgent problem in some areas of the UK. Several cities and regions in the UK, including London, Birmingham and Glasgow have been in breach of European air quality directives designed to protect public health. In April 2015, the European Court ordered the UK Government to provide updated plans to reduce emissions to legal limits as soon as possible. These plans must be produced by the end of 2015.

Some of these areas are already implementing measures to improve local air quality. These measures can have additional CO_2 benefits and promote the uptake and raise awareness of electric vehicles. For example, London is implementing an Ultra-Low Emission Zone (ULEZ), which will come into operation in 2020. This involves a number of measures to improve local air quality, such as charging higher emitting cars to enter central London and replacing fleets of buses and taxis with hybrid and electric alternatives. Such schemes also play an important role in changing travel behaviour, by encouraging people to choose public transport, cycling or walking over travelling by car.

(c) HGVs – Progress to date

New HGVs are subject to Euro standards, which place mandatory limits on emissions of air pollutants. Their CO_2 emissions, however, are not subject to EU regulation. There is some evidence that the fuel efficiency of new HGVs has remained static throughout the last decade as more stringent limits for NOx and particulate matter (PM) emissions have dominated research and development effort and, in some cases, lead to increased fuel consumption[21].

(d) HGVs – Forward look

Our cost-effective path suggests that there is potential for new HGV CO_2 intensity to fall by around 30% between 2010 and 2030. However, stronger policy is likely to be required to achieve this level of improvement. Last year, the European Commission published a strategy to reduce CO_2 emissions from HGVs (and other heavy duty vehicles). The strategy set out short-term measures to improve the monitoring and reporting of HGV emissions as well as longer-term options for delivering deeper emissions reductions:

- Direct measurement of whole-vehicle emissions is not appropriate for HGVs, due to the diversity of vehicles and operations. As a solution, the European Commission has developed a software

20 Emissions Analytics (2015). Available at: http://emissionsanalytics.com/the-end-of-the-road-for-dirty-diesels/.

21 TIAX (2011) *European Union Greenhouse Gas Reduction Potential for Heavy-Duty Vehicles*. Available at: http://ec.europa.eu/clima/policies/transport/vehicles/heavy/docs/icct_ghg_reduction_potential_en.pdf.

tool (VECTO[22]) to simulate whole vehicles and calculate their emissions based on the performance of individual components. VECTO is currently being rolled out to industry in order to verify its calculations against real-world data before it is used to inform policy. This process is expected to end in mid-2016.

- VECTO will initially be used to certify the emissions performance of new HGVs in order to provide buyers with more accurate information and encourage competition between manufacturers to improve fuel economy. An announcement on the detail of this regulation is expected in late 2015 or early 2016.
- The strategy outlines a medium-term plan to carry out further analytical work to establish the technological potential and cost-effectiveness of deeper abatement, which could be used to inform mandatory new vehicle CO_2 targets, though no dates have been provided.

We recommend that the Government closely monitors the work to develop an EU regulatory framework for CO_2 from HGVs and pushes for the introduction of new vehicle standards as soon as possible.

While European regulation is likely to be required to reduce emissions from new HGVs, there are other opportunities to reduce the CO_2 intensity of the existing HGV fleet by deploying retrofit technologies (Section 3).

The Government has also been investigating whether using natural gas as a fuel in HGVs could reduce emissions (Technical Annex 4 – Transport). We welcome the Government's work to assess the CO_2 benefits of natural gas and continue to recommend that the CO_2 impacts are fully evaluated before rolling out nationwide infrastructure and support.

(e) Buses and rail

There are several policies in place to reduce emissions from buses and rail. As current emissions from these modes make up a very small proportion of surface transport emissions (5%), we do not consider these policies here but they are discussed in the Technical Annex (Technical Annex 4 – Transport).

Progress in developing electric vehicle markets

ULEVs will play an important role in decarbonising transport to 2030 and beyond. In recent years, a wide range of fully or partially electric vehicle models has become commercially available in the UK, with capabilities and costs that are approaching those of conventional cars. At present other ULEV types, such as hydrogen fuel cell vehicles, cannot be deployed at scale due to high costs and a lack of infrastructure. In future, such vehicles may make a significant contribution to decarbonising the fleet, but in this section we focus on the existing market for electric vehicles.

Whilst it is important for the UK to develop a market for EVs as part of the cost-effective path to meeting carbon budgets, the cost reductions needed to accelerate uptake will be driven by growth in the global market for EVs. The global market is growing rapidly and production is being ramped up by key manufacturers, with some evidence that costs are falling more quickly than anticipated:

- The number of EVs in the UK is 3% of the global stock of around 665,000. 67% of the EV stock is located in just three countries; the US, China and Japan[23].
- Global sales increased by 53% in 2014 to around 300,000. The UK was ranked 8th in the world for EVs as a percentage of new sales in 2014[24].

22 European Commission (2014). Available at: http://ec.europa.eu/clima/events/docs/0096/vecto_en.pdf.
23 IEA (2015) *Global EV Outlook 2015*. Available at: www.iea.org/.
24 IEA (2015) *Global EV Outlook 2015*. Available at: www.iea.org/.

- Tesla Motors has started construction of a new "Gigafactory" in California, to reduce the cost of EV battery packs through economies of scale. It will begin production in 2017 and aims to be producing battery packs for 500,000 cars a year by 2020, with projected cost reductions of more than 30%.
- Recent research suggests that battery pack costs have fallen more rapidly than was previously anticipated[25] and estimates that battery pack costs could reach $230/kWh by 2017-2018 if current trends continue. Research we commissioned in 2012[26], suggested that costs would not reach this level until after 2020.

The reliability of batteries is particularly important for the development of EV markets. Data on the growing global fleet of EVs has now been collected for several years and there are early signs that batteries have been performing well.

- In March 2015, Nissan published the results of a study on the performance of 35,000 Leaf vehicles that have been sold in the last five years. Battery failure rates were low at 0.01% and maintenance costs were found to be 40% lower than conventional equivalents[27].
- Glass's, an organisation that publishes detailed analysis of the UK second-hand car market, has decided to review its forecasts of EV residual values in light of the Nissan study.

This new information will help to stimulate a second hand market for EVs, which should in turn provide confidence to new car buyers that EVs can hold residual value.

(a) Current market for EVs

There was a significant increase in UK EV sales in 2014, which has continued in 2015. EV sales are now above our indicator and this will remain the case if sales continue at their current rate in 2015[28].

- EV sales were 15,277 in 2014 compared with 3,765 in 2013 and above our indicator trajectory of 11,250. This represented 0.3% of total new car sales in 2014.
- Sales have continued to increase in 2015; in the first quarter 1.2% of cars sold were EVs.

Manufacturers are providing consumers a varied choice of EV models at different prices and across different size segments. At present 25 models of electric car are available in the UK, up from 19 in 2014[29] (Technical Annex 4 – Transport).

In Budget 2014, the Government announced £500 million to promote the uptake of EVs and other ULEVs to 2020. This funding was allocated to a range of policies including grants to support the purchase of an EV, support for charging infrastructure and support for local authorities to incentivise EV uptake in their area. No new support has been announced but further detail has become available on how the money will be allocated (Technical Annex 4 – Transport).

In addition, the Low Carbon Vehicle Partnership has commissioned a good practice guide to provide local authorities with advice on implementing policies to promote the uptake of Low Emission Vehicles. This covers measures such as parking incentives, infrastructure provision, road charging and access to car clubs and highlights case studies of successful policies implemented by different local authorities.

25 B. Nykvist and M. Nilsson (2015) *Rapidly falling costs of battery packs for electric vehicles*, Nature
26 Element Energy (2012) *Cost and performance of EV batteries*. Available at: www.nature.com/.
27 Nissan (2015) Available at: http://www.newsroom.nissan-europe.com/uk/en-gb/Media/Media.aspx?mediaid=131212
28 Based on data from SMMT.
29 Based on data from nextgreencar.com.

(b) EVs – Forward look

Our cost-effective path to meeting carbon budgets suggests that 9% of new car sales should be EVs by 2020 and 60% by 2030 (a mixture of battery-electric and plug-in hybrid electric vehicles)[30]. Whilst only 0.3% of new cars were EVs in 2014, the share of sales has grown to over 1% in the first quarter of 2015 and policy measures to support higher uptake are in place to 2020.

In our 2014 Progress Report we made a series of recommendations on how EV uptake should be promoted. Progress against these recommendations has been mixed, with significant financial support committed but a lack of longer-term direction for policy. We re-iterate those recommendations in this report and provide more detail on what needs to be done:

- Central and local government should tackle financial and non-financial barriers to electric vehicle uptake; including access to low-cost finance, investment in charging infrastructure and roll-out of softer measures to promote EV uptake.
  - There are likely to be 50,000 electric cars on the road before the end of 2015, at which point the Government will need to review the plug-in car grant scheme. While EVs remain more expensive than their conventional alternatives from a consumer perspective, the Government should continue to provide support for their upfront purchase costs. In the short-term this could continue in the form of a grant, but as EV uptake grows, Government grants could become financially unsustainable. An alternative approach would be to develop low-cost finance deals, with lower interest rates and longer payback periods. This could make EVs competitive with conventional cars by the early 2020s, by spreading the upfront costs over a longer period and taking advantage of their lower running costs[31].
  - Strong progress has been made in rolling out a national rapid charging network on the road network. Installation of rapid chargers is around half way to achieving national coverage requirements. While there has been some progress in the installation of public charging infrastructure in towns and cities, more work is needed to help deliver on-street residential charging infrastructure so that drivers without off-street parking can choose an EV.
  - Progress has also been made in the development of softer measures to encourage EV uptake at a local level, with measures such as the City Scheme and ULEV Taxi Scheme. We recognise the importance of properly trialling these schemes in a limited number of cities before expanding more widely, but recommend that measures found to be successful are promoted at a national level as early as possible.
- In the context of a strong EU target and/or effective measures to tackle of financial and non-financial barriers, the Government should plan for the phasing out EV subsidy and consider whether there is any benefit in announcing this in advance. There will not be an EU target in place before the end of 2015 and many non-financial barriers to uptake remain. We therefore advise that support for upfront costs should continue and not be phased out prematurely.

With the market for EVs growing, there are also early signs that a market for hydrogen fuel cell vehicles may begin to develop in the next few years.

- The first hydrogen fuel cell car is likely to go on sale in the UK in 2015, albeit in limited numbers.

30 CCC (2013) *Fourth Carbon Budget Review – Technical report.* Available at: www.theccc.org.uk/.
31 CCC (2014) *Meeting Carbon Budgets – 2014 Progress Report to Parliament*

- The Government has launched an infrastructure grant scheme for hydrogen refuelling stations. The scheme aims to support the roll-out of a UK hydrogen fuel network, capable of servicing fuel cell electric vehicles. Funding of £3.5 million will be provided to develop up to seven new hydrogen refuelling stations, with a further £2 million being made available to upgrade up to eight existing demonstration stations.

Biofuels in surface transport

(a) Biofuels progress to date

In 2014 biofuel penetration increased to 3.2% by energy. This is below our indicator of 3.7%, partly as a result of EU sustainability standards introduced in 2012, which double-count the contribution from waste-derived biofuels. The percentage of fuel meeting sustainability requirements increased, as did estimated GHG savings:

- In 2013/14 waste-derived biofuels made up 46% of the total, up from 40% in 2012/13. The supply consisted of 47% bioethanol, 49% biodiesel and 2% biomethanol.
- Using the EU estimation methodology, GHG emissions savings from biofuels were 69% in 2013/14, compared to 66% in 2012/13. These savings do not include the impacts of indirect land use change (ILUC).

After seven years of negotiations the EU recently reached an agreement on crop based and advanced biofuels (Box 4.4).

Box 4.4: Latest EU biofuels sustainability accounting framework

In our 2014 Progress Report, we reported the European Council had failed to reach an agreement on proposals to ensure the sustainability of biofuels but that talks were ongoing. In April 2015 the European Parliament gave final approval to an amendment of the Renewable Energy Directive supporting stronger sustainability standards.

The amendment will limit crop based biofuels to 7% of transport energy, within the 10% renewable transport energy target. ILUC emissions will be reported but not included in sustainability requirements at this stage. Member states must also set a national target for the share of advanced biofuels to 2020.

Funding of £25 million was announced in 2013 for up to three demonstration-scale advanced biofuel plants. The competition was launched in December 2014 alongside a feasibility report outlining the potential for the UK to be a global leader in advanced biofuels. Six applications have been approved to progress to the second phase of the competition and the three winning projects will be announced later this year.

(b) Biofuels forward look

The Renewable Transport Fuel Obligation (RTFO) target is currently set at 4.75%[32] for 2015/16. This will need to be reviewed in light of the EU agreement on the detail of the 2020 target. Our previous analysis assumed biofuel penetration of 8% by energy by 2020[33]. We will be reviewing the feasibility of this level of penetration as part of our work for the fifth carbon budget.

In line with EU requirements, the Government should set a trajectory for the RTFO to 2020 which sets a stretching national target for advanced biofuels. The Government should push the EU to take account of ILUC factors in sustainability standards for biofuels as soon as possible following member states' mandatory reporting of these impacts.

32 By volume, including double counting.
33 Consistent with the Gallagher Review (2009).

3. Progress in changing travel behaviour

Behaviour change and its impact on carbon budgets remains an emerging area: evidence of impacts, trials and understanding what works is still developing. The Committee will be looking into this area in more detail over the coming years. In this section we provide a brief overview of current policies and preliminary evidence about their impacts. We focus on measures designed to influence choice of passenger travel mode and measures to improve the efficiency of freight operations. Measures to encourage eco-driving and limit speeding are considered in the Technical Annex (Technical Annex 4 – Transport).

Smarter choices

(a) Progress to date

Smarter Choices cover a range of measures designed to influence choice of transport mode, with the aim of reducing car travel. Whilst there has been some progress in changing passenger travel behaviour in specific locations, progress at a national level has been limited:

- The average distance travelled has fallen since 2005, but the split between modes has remained largely unchanged since 2007.
- In 2013, the most significant percentage of distance travelled was by car (77%), with much smaller percentages for public transport (17%) and walking or cycling (4%)[34].

The Local Sustainable Transport Fund (LSTF) is the main source of funding to support Smarter Choices projects, though environmental benefits are generally a secondary objective to promotion of economic growth. This has included investment in infrastructure to promote walking and cycling, as well as schemes designed to encourage the use of public transport and car clubs. Around £1 billion has been spent on LSTF projects since 2011 and in 2015/16 it will be supporting 44 new projects across approximately 35 local authorities.

There is no comprehensive evaluation of the environmental impact of the LSTF, though DfT estimates that only 1% of expected benefits are due to a reduction in carbon emissions[35]. An interim meta-analysis of LSTF is planned for publication this year. Such evaluations are essential for ensuring carbon savings are maintained within Smarter Choices programmes.

With no plans to continue the LSTF beyond 2015/16, the Local Growth Fund and Door-to-door strategy would be the main sources of funding for Smarter Choices schemes.

- The Local Growth Fund aims to stimulate economic growth across the country by devolving power to Local Enterprise Partnerships. The fund can be used to invest in new infrastructure, including transport infrastructure. Whilst consolidation of funding sources may be beneficial in terms of administration, reduction of carbon emissions is not a key objective of the Local Growth Fund.
- The Door-to-door strategy aims to support sustainable travel through greater use of public transport by considering the full door-to-door journey. The strategy identified four main barriers to public transport; information, ticketing, interchange facilities and connectivity. Two Door-to-door action plans have been published since our last Progress Report. These plans reported on expenditure on improving accessibility and perceptions of public services.

It is difficult to assess the potential impacts of these schemes as expenditure on schemes through the Local Growth Fund has not yet been specified and the Door-to-door strategy schemes have not been fully evaluated.

34 DfT (2014) *National Travel Survey*. Available at: www.gov.uk/.

35 DfT (2014) *Value for Money Assessment for the Local Sustainable Transport Fund.* Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/347894/vfm-assessment-of-lstf.pdf

(b) Forward look

Government emission projections assume that the LSTF contributes a 1% reduction in road transport emissions in 2015, with savings declining over time after the scheme ends. This assumption appears reasonable given the available evidence, notwithstanding uncertainties.

Our analysis of the cost-effective path suggests a nationwide rollout of Smarter Choices by the third carbon budget period, resulting in a total reduction of 5% in car-km and a carbon reduction of around 3 $MtCO_2$, based on published evaluations of the scheme[36].

The reported co-benefits of Smarter Choices appear to support the wider and longer-term rollout of local projects aimed at shifting transport away from private vehicles[37]. However the Government should ensure evaluation of carbon savings from current schemes is carried out in order to implement cost-effective co-beneficial programmes.

Freight operations

(a) Progress to date

Freight operators have strong incentives to save fuel, with fuel costs making up about 20-40% of all operating costs[38]. There are opportunities for operators to reduce their fuel consumption, either by reducing the number of kilometres per tonne of goods moved through more efficient logistics or by improving the fuel efficiency of kilometres driven.

HGV operators can reduce their total kilometres driven by implementing measures such as improved routing, improved vehicle fill and use of high capacity vehicles. There is evidence from DfT's Road Freight Statistics that uptake of these measures is increasing amongst operators[39] (Technical Annex 4 – Transport).

- Between 2009 and 2013, the percentage of HGVs making use of GPS technology increased from 33% to 49%.
- The average tonne-km moved by an HGV while loaded compared to its potential maximum tonne-km provides a measure of vehicle fill. This percentage increased from 57% to 63% between 2009 and 2013[40].
- The percentage of tonne-km moved by the heaviest HGVs (44 tonne articulated HGVs) increased from 60% to 67% between 2009 and 2013.

Further improvements to logistics operations could reduce kilometres driven and save fuel[41]. This includes measures such as reducing empty running, use of consolidation centres and use of higher capacity vehicles:

- Collaboration between operators can help to reduce empty running by enabling the use of return journeys to carry loads for other operators. Consolidation centres offer similar opportunities to improve vehicle fill by matching freight from a number of operators to a shared final destination. There are barriers to collaboration within the industry, such as a lack of information about whether such practises infringe on competition law. Clear guidance from the Government or the Competition and Markets Authority on the legal implications of increased collaboration could help to increase uptake.

36 CCC (2013) *Fourth Carbon Budget Review – Technical report*. Available at: www.theccc.org.uk/.
37 DfT (2015) *Local Sustainable Transport Fund Annual Report 2013/14*. Available at: www.gov.uk/.
38 FTA (2014). Available at: http://www.fta.co.uk/policy_and_compliance/fuel_prices_and_economy/fuel_prices/fuel_fractions.html.
39 Based on CCC analysis of an extract from DfT's Road Freight Statistics.
40 This does not take account of the percentage of kilometres vehicles run empty, which has stayed relatively constant at around 29% between 2009 and 2013.
41 A McKinnon, S Cullinane, A Whiteing, Michael Browne (2015) *Green Logistics: Improving the Environmental Sustainability of Logistics*

- There is evidence that using higher capacity vehicles can save fuel by reducing kilometres driven for a given load. In 2012, DfT launched a trial for longer semi-trailers, which are not currently legally allowed on UK roads. The trial is expected to save around 3,000 tonnes of CO_2 from around 1,800 vehicles. There is some opposition to the use of larger vehicles due to concerns over the safety of other road users, which this trial aims to address. If the trial proves successful, a change in regulation should be considered to allow longer vehicles on the road.

In addition to logistics measures, operators can improve the efficiency of kilometres driven by retrofitting their vehicles with fuel saving technologies, such as aerodynamic fairings and low-rolling-resistance tyres, and by training drivers in eco-driving techniques. There are likely to be opportunities to reduce emissions further from roll-out of such measures, but evidence of the extent to which they are already taken up is limited.

Uptake of such measures is currently driven by voluntary, industry-led action. There are a number of industry-led schemes to help members reduce their fuel consumption, the most notable of which is the Freight Transport Association's Logistics Carbon Reduction Scheme (LCRS). Whilst the LCRS has been successful in improving the efficiency of its members' operations, its membership remains relatively small. By May 2015 it had grown to 109 members covering over 59,000 HGVs, (c15% of HGVs). The LCRS has a target to reduce emissions intensity by 8% between 2010 and 2015; this compares to the Government's 5% target for the sector as a whole. Data for 2013 are now available and show that LCRS members achieved a 4% improvement on 2010 levels. LCRS projections suggest that members are now likely to miss the 8% target and achieve around a 6.6% reduction. A post 2015 target for LCRS will not be announced until 2016.

As noted above, the Government has advocated an industry led approach to reducing emissions from the freight sector. However, there are a number of recently launched Government schemes that may promote new fuel saving opportunities to freight operators:

- The Government is currently supporting the Low Carbon Vehicle Partnership in the development of an accreditation scheme for fuel saving technologies. The scheme will verify the fuel savings achieved by fitting technologies to specific truck types, so that operators can have confidence that a particular investment will be cost-effective. It is anticipated that that the scheme will not require financial support from Government but will receive endorsement and support in raising awareness. The scheme is due to be launched later this year.
- In 2014 the Government launched the Energy Savings Opportunity Scheme (ESOS) to comply with the EU Energy Efficiency directive. Under ESOS, large companies[42] will have to undertake energy audits every four years to identify cost-effective energy saving measures. For many companies, vehicle fleets are likely to fall within the scope of ESOS. The extent to which compliance with ESOS will encourage companies to adopt new fuel saving measures is uncertain, but it may provide an opportunity to disseminate information on the most cost-effective measures.

We have commissioned a research project to investigate the potential for reducing emissions by implementing demand-side measures across different sectors of the freight industry as well as different vehicle and journey types. The analysis will also consider barriers to uptake and how these might be addressed. The Committee will consider the outputs from this work in developing its recommendations for the fifth carbon budget.

42 ESOS applies to companies that employ 250 or more people, or have an annual turnover in excess of £38 million, and an annual balance sheet total in excess of £33 million.

(b) Forward look

Our analysis of the cost-effective path suggests a 6.5% reduction in HGV-km by 2030, relative to business as usual. This is achieved through supply chain rationalisation, better vehicle utilisation and some modal shift to rail and water. Progress in achieving uptake of demand-side measures through industry-led action has been limited to date. More work needs to be done to understand the nature of barriers to adoption and whether Government can play a role in supporting the whole industry to reduce emissions and become more efficient.

- The LCRS has demonstrated that demand-side measures can achieve emissions reductions and fuel savings, but the scheme's impact on emissions from the whole HGV fleet is small due to its limited membership.
- The Government should undertake a wider review of policy levers to improve the CO_2 intensity of freight operations. This should identify the barriers to uptake of technology and logistics measures, including collaboration between operators, and suggest policies to overcome those barriers.
- Policies should recognise the diversity of HGV operations and promote the implementation of proven cost-saving measures.
- Policies should help both small and large operators save fuel and become more efficient. Policy design could involve both DfT and BIS and consider whether support could be delivered in the context of BIS policies to provide advice and support to small and medium sized enterprises.

Our forthcoming research project will help to improve the evidence base in this area.

4. Progress in reducing emissions from aviation and shipping

Recent developments in aviation and shipping policy reflect progress developing existing and agreed approaches, at international, EU and UK levels:

- International – For aviation, the International Civil Aviation Organisation (ICAO) continues to develop a Market Based Measure (MBM) to control international aviation emissions. In 2013 it was agreed this would be decided at their 2016 General Assembly, to come into force in 2020. Since then, the ICAO has established an Environment Advisory Group to oversee technical work related to the development of a global MBM system, and has recently completed a comprehensive stakeholder engagement programme. For shipping, the International Maritime Organisation (IMO) continues to support implementation of the Energy Efficiency Design Index, which entered into force in 2013. In 2014 the IMO published updated projections of global shipping emissions to 2050, and also reached agreement in principle to develop a data collection system for fuel consumption in shipping.
- EU – Intra-EU aviation emissions continue to be covered by the EU ETS; this is a reduction of around 75% in the original full coverage which also included EU flights to and from non-EU countries. This reduction in coverage is in place until 2016, in order to allow the ICAO time to develop a global measure. In April 2015 the EU adopted legislation requiring ships using EU ports to report their annual greenhouse gas emissions from 2018. This is designed to contribute to building an international reporting system, and is the first step in the EU's shipping strategy (where the second stated step is for emission reduction targets, and the third step is for further measures, including market instruments, in the medium to long-term).

- **UK** – In November 2014 the Airports Commission launched a consultation on the three options for airport expansion identified in their 2013 Interim Report. The purpose of the consultation was to inform their final report which is expected in summer 2015 and which will recommend one of the three options to Government.

In future, both aviation and shipping emissions are projected to rise in the absence of further measures. They can be reduced through a combination of fuel efficiency improvements, use of biofuels and, in aviation, a moderation in demand growth.

In the context of future policy and infrastructure investment decisions, appropriate long-term assumptions for Government planning are for aviation emissions to be around 2005 levels in 2050 (implying around a 60% increase in demand over the same period), and for shipping emissions to be around one-third lower than 2010 levels. Government should publish an effective policy framework for aviation emissions on this basis.

These planning assumptions should be regarded as proxies for outcomes under long-term international agreements. The Government should therefore continue to push for strong international and EU policies consistent with the 2°C climate objective, which will be required to unlock the full range of abatement potential whilst limiting risks of competitive distortions.

5. Forward look

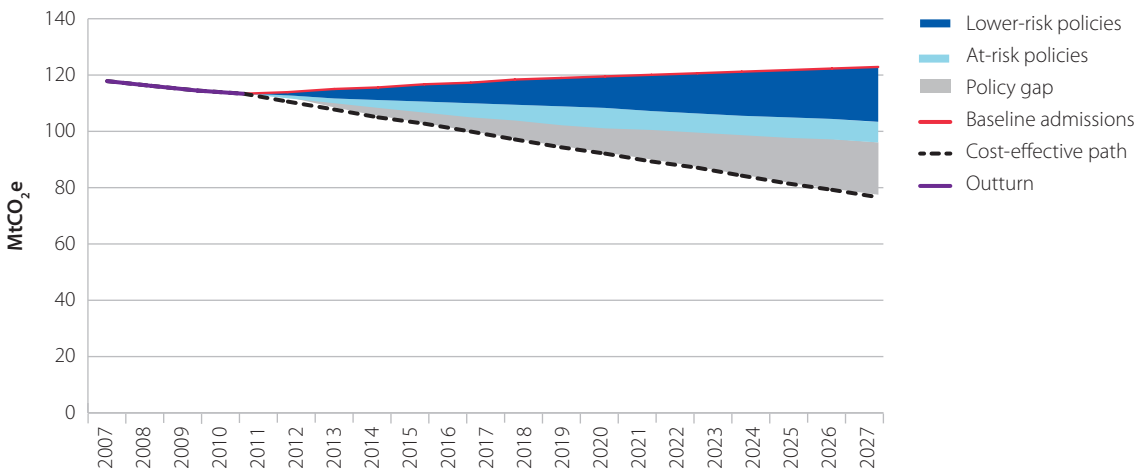
We have advised that domestic transport emissions should fall to around 81 $MtCO_2$ by 2025 as part of the cost-effective path to meeting carbon budgets.

We have considered the extent to which existing and planned policies are likely to deliver the measures required to meet carbon budgets. Our analysis suggests that policies will go some but not all of the way to delivering these measures (Figure 4.12).

- According to DECC's updated emissions projections, transport emissions in the absence of policy would be 123 $MtCO_2$ in 2025, falling to 98 $MtCO_2$ when estimated policy savings are included.
- This leaves a significant gap to be addressed in order to meet carbon budgets. Our cost-effective path suggests this could be achieved with further conventional vehicle efficiency beyond EU 2020 targets, penetration of electric vehicles, some further use of sustainable biofuels, together with ongoing demand-side measures in the passenger and freight sectors.
- In addition, we have limited confidence in the savings that will be delivered by current and planned policies (Technical Annex 4 – Transport). If only those savings from low-risk policies are delivered, transport emissions would be higher than DECC's projections in 2030, leaving an additional gap to be addressed.

In order to deliver necessary reductions in transport emissions, it is therefore important that new policy approaches are developed; our key recommendations are summarised at the start of this chapter.

Figure 4.12. Assessment of emissions savings from current and planned policy against the cost-effective path in transport



Source: DECC (2014) Updated emissions projections, CCC analysis.

6. Summary

Decarbonisation of the transport sector is achievable and can be done cost-effectively. It will require a combination of measures to be implemented, targeting investment, innovation and behaviour change:

- Low-carbon investment: Under our cost-effective path, the car and van market will be transformed by 2030, with 60% of new sales being an ultra-low emission vehicle. This transition will require vehicle manufacturers to continue to make significant investments in new supply chains and skills. Strong EU regulatory targets should incentivise manufacturers to invest and deliver a supply of affordable new vehicle models. EU regulation should be coupled with strong domestic policy to incentivise uptake, such as support for the upfront costs of ultra-low emission vehicles, while they remain higher than conventional vehicles, and a fiscal regime that strongly favours the lowest emission vehicles. Continued public and private sector investment in charging infrastructure will also be required to encourage uptake of electric vehicles.
- Developing future options and innovation: Innovation will play a key role in providing the cost reductions and technological improvements required to decarbonise transport. For example, improving the range and charging time for electric vehicles whilst reducing their costs will be vital to increase their uptake. Given the nature of the vehicle manufacturing industry, innovation in technology is likely to be driven at an international scale. As with investment, a strong EU regulatory regime to 2030 is crucial to incentivise manufacturers to innovate and deliver the required improvements. The UK should continue to invest in research and foster collaboration between industry and academia in technology areas where it has a strong position to help develop lower emission vehicles.
- Low-carbon choices: There is significant potential for reducing emissions by changing behaviour; avoiding unnecessary journeys, shifting to more sustainable modes or choosing to buy an ultra-low emission vehicle. In passenger transport, the CO_2 benefits of reducing demand for car travel need to be reemphasised alongside economic and public health benefits and measures need to be supported by a strong evidence base. In freight, the Government should review the barriers to adoption of technology and logistics measures and develop policy to address these barriers. In supporting an early market for electric vehicles, the Government should continue to roll out policies to tackle barriers to uptake, ensuring appropriate financial and non-financial incentives, access to charging infrastructure and a higher level of public awareness and acceptance.

Chapter 5: Progress reducing emissions from agriculture

1. Agriculture emissions trends and drivers
2. Progress against indicators
3. The policy framework
4. Forward look
5. Land use, land use change and forestry (LULUCF)
6. Summary

Key messages and recommendations

This chapter presents the latest evidence of UK greenhouse gas (GHG) emissions in agriculture and the land use, land use change and forestry (LULUCF) sectors. These sectors are affected by the changing climate, which is likely to impact future agricultural productivity and GHG emissions, for example, potentially extending growing periods for some crops, and reducing organic matter in soils. These are set out in more detail in our Adaptation Progress Report, and we will be producing further joint work in the future.

In 2013 agriculture accounted for around 9.5% of UK GHG emissions, while the LULUCF sector was a net carbon sink of 5 $MtCO_2e$ (equivalent to abating 1% of UK GHG emissions). The estimates of GHG emissions in the sectors are highly uncertain. This creates significant problems in tracking progress, and more widely for understanding whether carbon budgets are being met.

Our key messages are:

- Agricultural emissions reached 54 $MtCO_2e$ in 2013, broadly unchanged from the previous year. Inventory changes mean that in 2013 estimated emissions of methane in agriculture are now higher than nitrous oxide.. The LULUCF sector increased net absorption rates over the same period by 6%.
- Nitrous oxide emissions intensity improved for crops in 2013 but deteriorated for livestock. For crops, lower fertiliser use, associated with poor weather, and higher arable crop output combined to reduce nitrous oxide intensity. For livestock, higher inorganic fertiliser use on grasslands and a much lower rise in livestock output led to an increase in nitrous oxide intensity.
- Methane emissions intensity of livestock output improved by 1% in 2013, as methane emissions decreased slightly and output rose. The main driver of the reduction in methane emissions was reduced cattle numbers rather than efficiency gains, while output of other livestock products rose.
- The GHG Action Plan is the only policy directly aimed at reducing agricultural emissions in England. It is not possible to fully assess the effectiveness of the plan in delivering emission reductions given the lack of effective monitoring and evaluation. This needs to be addressed and stronger policies may be required to deliver emissions reduction consistent with the Committee's estimates of the cost-effective path to 2030.
- While 2013 emissions are broadly on track with our indicators, our trajectory to the fourth carbon budget continues to be at risk given the absence of policy options beyond 2022. Preparation for deeper cuts is needed to keep the sector on track to the 2050 target.
- Mitigation in agriculture and forestry is a devolved issue. Action is being undertaken in each of the four countries of the UK to either reduce agriculture emissions or improve emissions intensity, and to increase tree planting rates. It is unclear if actions taken to reduce emissions are consistent with our carbon budgets and this needs to be addressed.

Our key recommendations are:

- **Deliver the Smart Inventory to the current timeline:** the Smart Inventory is essential for effective measurement of emissions from agriculture and should be delivered in 2016, without further delays.
- **Strengthen the current voluntary approach to reduce agricultural emissions:** the farming industry should develop robust indicators to properly evaluate the GHG Action Plan. Government should consider stronger measures as part of its 2016 review if it cannot assess the effectiveness of the existing scheme.
- **Co-ordinate effort to reduce emissions from agriculture and forestry:** ensure measures being implemented across the four nations are feasible, cost-effective and consistent with UK carbon budgets.

We set out the analysis that underpins these conclusions in the following sections:

1. Agriculture emissions trends and drivers
2. Progress against indicators
3. The policy framework
4. Forward look
5. Land use, land use change and forestry
6. Summary

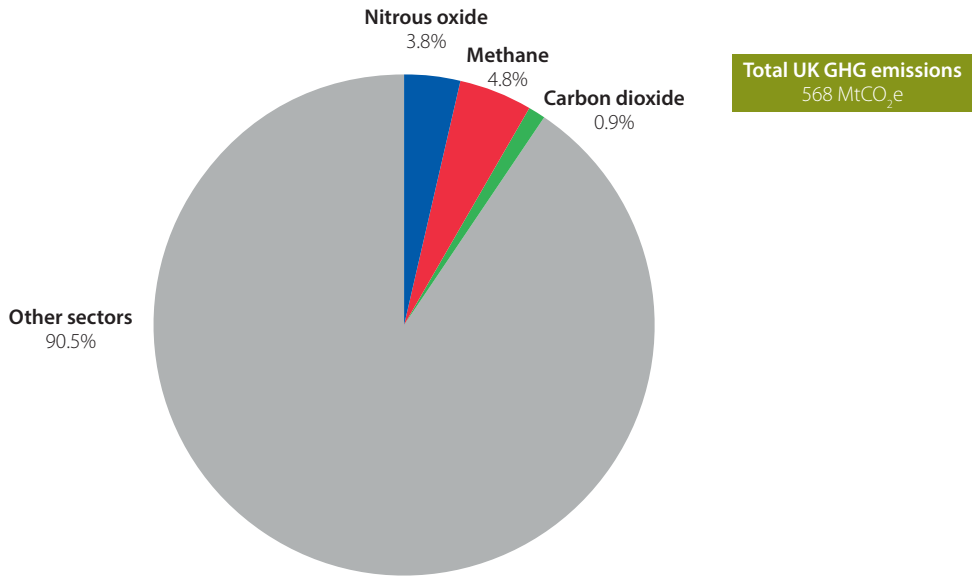
1. Agriculture emissions trends and drivers

Emissions in agriculture are dominated by non-CO_2 greenhouse gases. We are only able to report on 2013 emissions because of the lag in reporting non-CO_2 data. In this section we set out how emissions have changed and the drivers of change in the year to 2013 and the recent past.

Emissions trends

Current data suggest that overall agriculture emissions remain unchanged in 2013 from the previous year at around 54 $MtCO_2e$. The sector accounted for 9.5% of total UK greenhouse gas emissions (Figure 5.1).

Figure 5.1. GHG emissions from agriculture in the context of total UK emissions (2013)



Source: NAEI (2015).
Note: Emissions from other sectors excludes international aviation and shipping sectors.

Emissions by gas and source were similar to 2012 levels with the exception of carbon dioxide which declined by 4% from the previous year (Table 5.1). Total emissions decreased by an annual average of 0.2% between 2009 and 2013, which represents a slowdown of the longer-term trend of a 19% decline since 1990 (equivalent to an annual average decline of 0.9%).

Table 5.1. Change in emissions by gas and source (2013)			
By GHG	**Actual 2013 emissions ($MtCO_2e$)**	**change from 2012**	**average annual change (2009-13)**
Methane	27.0	-0.4%	-0.2%
Nitrous oxide	21.8	0.5%	0.1%
Carbon dioxide	4.9	-4%	-1.4%
Total	**53.7**	**-0.4%**	**-0.2%**
By source			
Enteric fermentation	23.5	-0.6%	-0.2%
Soils	20.5	0.5%	0.1%
Wastes & manure management	5.3	0.5%	-0.2%
Mobile & stationary machinery	4.5	-1.6%	0
Source: NAEI (2015) and CCC calculations			

Although overall emissions have remained largely unchanged from 2012, amendments to the way the inventory is calculated have changed the overall level of emissions and the composition of emissions by gas and source from previous inventories (Box 5.1):

- GHG emissions are now lower across the time series than previously estimated (Figure 5.2).
- Methane emissions are now estimated to be higher than emissions of nitrous oxide (N_2O), accounting for 50% of emissions (compared to 39% of 2012 emissions as reported in last year's inventory).
- Emissions from enteric fermentation (which occurs due to the digestive process of ruminant animals) rather than soils are now estimated to be the largest source of emissions.

Box 5.1. Main changes to calculating the 2015 agriculture inventory

Changes to the method for calculating emissions in the 2015 agricultural inventory reflect the adoption of the IPCC 2006 guidelines and improvements in estimates made by Defra. The result is a proportional shift from nitrous oxide emissions to methane emissions.

The main changes by moving from the 1996/2000 to 2006 IPCC guidelines are:

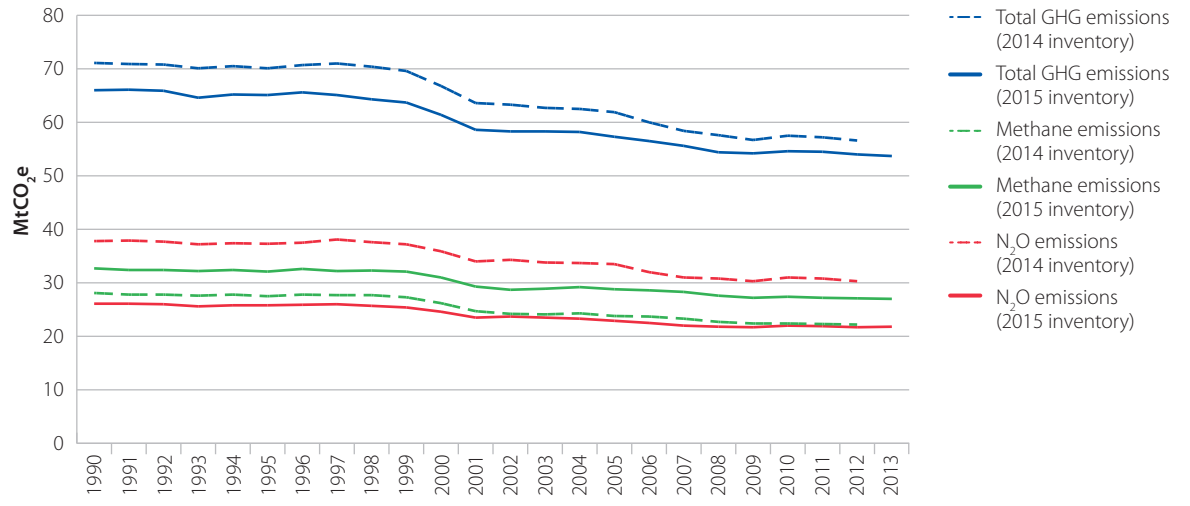
- Revisions in the Global Warming Potential (GWP) values, with methane up from 21 to 25, while the GWP value for nitrous oxide is now lower at 298 compared to 301.
- A downward revision in some of the emissions factors for soils (e.g. leached nitrogen) and an upward revision for enteric fermentation (e.g. the proportion of energy in the diet converted to methane for cattle increased from 6% to 6.5%).

In addition, new research funded by Defra has updated estimates for the weights of beef cattle, which are now heavier than previously calculated. This has the effect of increasing methane emissions.

Source: 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Defra GHG Platform (projects AC0114 and SCF0102)

Although these inventory amendments represent an improvement in emissions reporting, the estimates are still subject to a large degree of uncertainty, with a range that puts emissions as low as 43 $MtCO_2e$ to a high of 76 $MtCO_2e$. This has serious implications for the sector in understanding whether the UK as a whole is on track to meet the fourth carbon budget. It is vital that measurement in this area is improved. The new Smart Inventory, due to be rolled-out in 2016 should improve the accuracy of these estimates and reduce the range of uncertainty associated with agricultural emissions. It is important that this is delivered on time.

Figure 5.2. Impact of methodology changes to the agricultural inventory



Source: NAEI (2015).

Emissions drivers

Given the lack of progress in reducing emissions in 2013, it is important to understand emissions drivers to assess whether any progress has been made to implement measures to reduce emissions intensity (e.g. emissions per unit of economic output). Our assessment is, however, subject to the large degree of uncertainty in the measurement of emissions as previously set out. It further emphasises the importance of improving the accuracy of measurement in this area.

Nitrous oxide

Agricultural soils accounts for almost 90% of nitrous oxide emissions, three quarters of which are due to the application of fertiliser from both inorganic and organic sources (e.g. from grazing returns and manure application) (Table 5.2). There was a slight (0.5%) rise in soils emissions in 2013 compared to 2012 as all sources of emissions with, the exception of inorganic fertiliser, increased.

The remaining sources of nitrous oxide are wastes and manure management (8%) and machinery (2%), with the former declining by less than 1% and the latter unchanged.

Agricultural soils have experienced significant changes in the way they are managed over recent decades, raising concerns around soil organic matter and soil erosion. These could affect their vulnerability to future climate change impacts and productivity. Further details are given in Chapter 5 of the Adaptation Progress Report.

Table 5.2. Main sources of nitrous oxide emissions from agricultural soils (2013)		
Source of soils emissions	**$MtCO_2e$**	**% change from 2012**
Inorganic fertiliser	6.9	-0.4%
Grazing returns	5.9	0.3%
Manure application	1.6	0.7%
Crop residues	3.4	2.9%
Cultivation of organic soils	1.1	0
Sewage sludge	0.3	1.4%
Total	**19.2**	**0.5%**

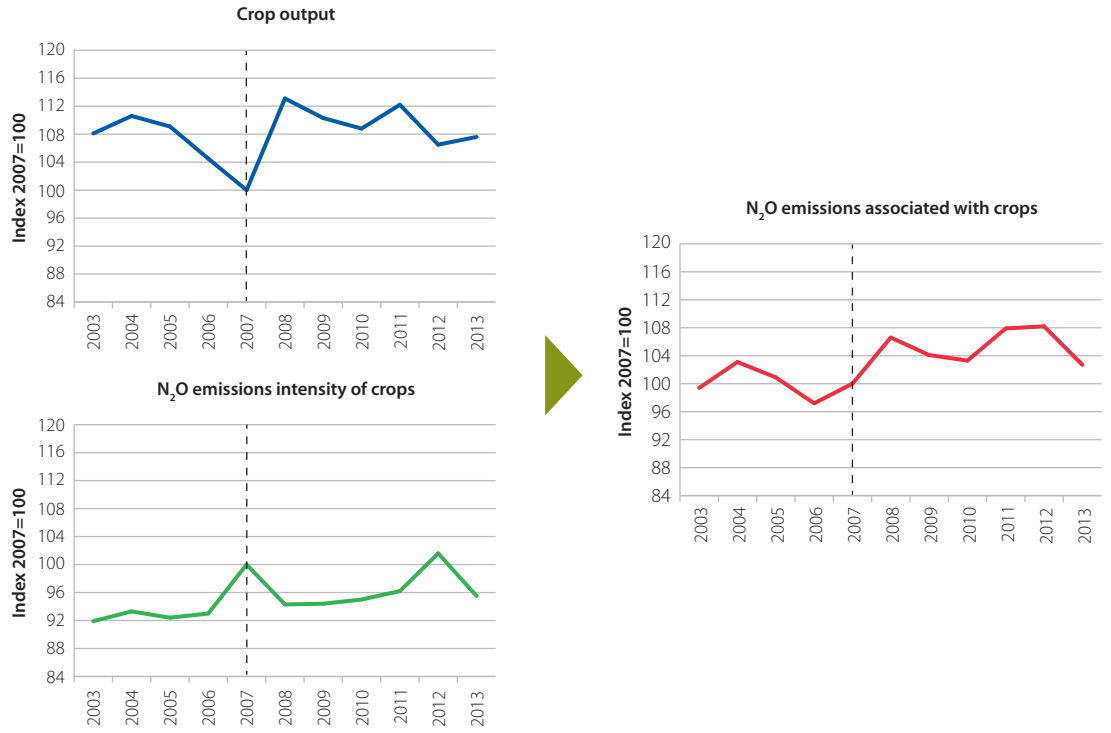
Source: NAEI and CCC calculations

(a) Crops

The nitrous oxide emissions intensity of crop output declined by 6% in 2013 due to the combined impact of a 1% increase in output and a 5% fall in nitrous oxide emissions associated with growing arable crops:

- Nitrous oxide emissions decreased largely due to adverse weather conditions in the autumn of 2012, which affected the sowing and early growth of winter crops. Arable farmers responded by sowing more crops the following spring, which due to having a shorter growing period require less fertiliser, thereby reducing emissions.
- Output of arable crops increased by 1% as a fall in wheat output was offset by increases in barley, protein and forage crops. The total area of cropland declined by 2%, largely due to poor weather conditions leaving many farmers unable to plant crops.
- The move to spring crops and reduced total cropland led to a 6% decrease (to 136kg/ha) in nitrogen fertiliser use compared with the previous year.
- Reduced nitrous oxide emissions, combined with a 1% increase in crop output in 2013, led to an improvement in nitrous oxide emissions intensity of crops of 6% (Figure 5.3).

Figure 5.3. Crop output, N_2O emissions associated with crops and emissions intensity of output (2003-2013)



Source: NAEI (2015), Agriculture in the UK (2014), CCC calculations.
Note: Base Year (2007) = 100.

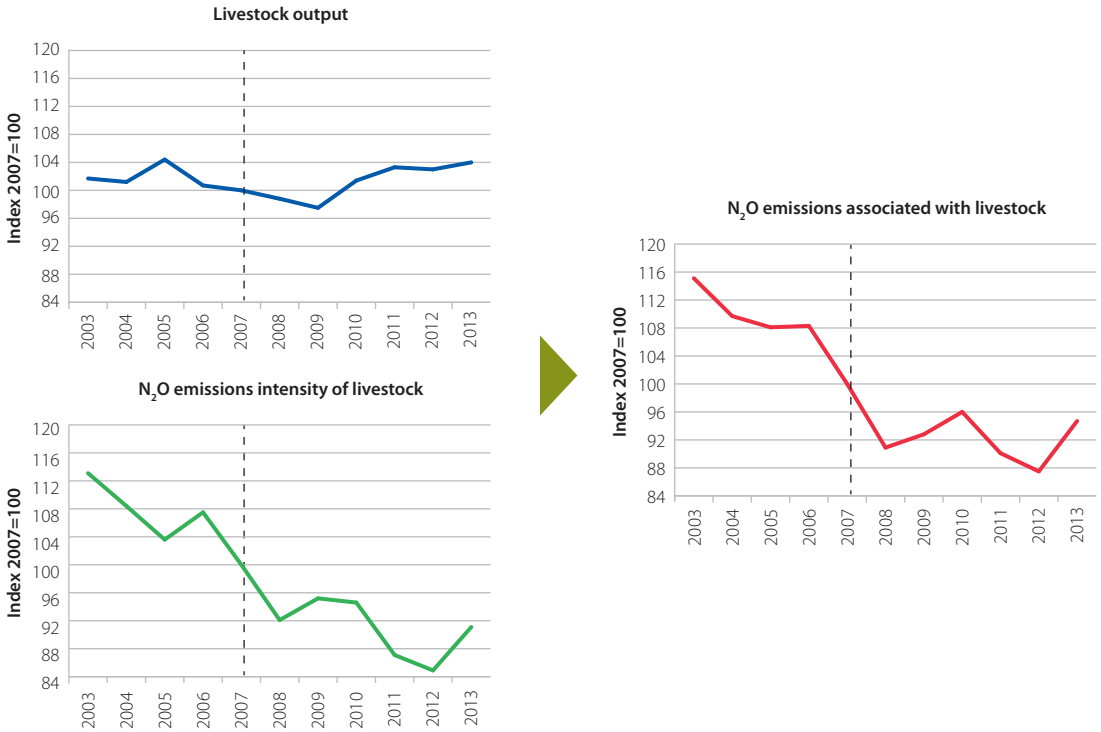
(b) Livestock

The nitrous oxide intensity of livestock products worsened in 2013 due to an increase in nitrous oxide emissions, which exceeded the rise in livestock output (Figure 5.4):

- The 8% increase in nitrous oxide emissions was largely due to a 7% rebound in the use of inorganic fertiliser on grasslands in 2013, after levels had dipped to a 30 year low of 55kg/ha in 2012 (Figure 5.5).
- Livestock output increased by 1% in 2013, with higher output of lamb and poultry partially offset by reduced cattle output. Weather affected the quality and quantity of forage feed at the start of the year which resulted in lower average dressed carcase weights for beef.
- The combined impact was an increase in nitrous oxide emissions intensity of livestock output of 7%.

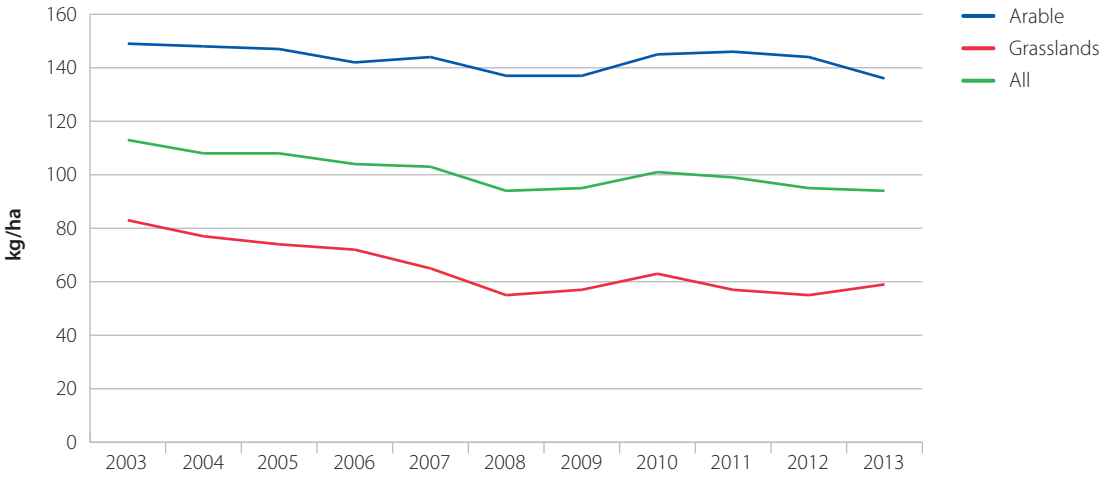
While efficient use of organic and inorganic sources of fertiliser is important for reducing emissions, there are also co-benefits in terms of reducing diffuse water pollution and improving biodiversity.

Figure 5.4. Livestock output, N_2O emissions associated with livestock and emissions intensity of output (2003-2013)



Source: Source: NAEI (2015), Agriculture in the UK (2014), CCC calculations.
Note: Base Year (2007) = 100.

Figure 5.5. Inorganic fertiliser use (2003-2013)



Source: British Survey of Fertiliser Practice (2014).

Methane

Methane intensity of livestock output improved by 1% in 2013, as methane emissions declined and output rose (Figure 5.6):

- Methane emissions declined by 0.5% in 2013, driven by a 1% reduction in cattle numbers compared to the previous year. Cattle account for almost 80% of methane emissions so any change in the size of the herd has a big impact on methane emissions. With both cattle numbers and the average dressed carcass weights for beef declining by 1% in 2013, it would appear that the reduction in methane has been primarily driven by reductions in the size of the cattle herd in the absence of any productivity gains.
- Despite the fall in beef output, livestock output as a whole increased by 1% in 2013, as output from poultry products, sheep and pig meat rose.
- The combination of these factors led to an improvement in the methane intensity of output of 1% in 2013.

Figure 5.6. Total livestock output, methane (CH_4) emissions and CH_4 emissions intensity of output (2003-2013)

Source: NAEI (2015), Agriculture in the UK (2014), CCC calculations.
Note: Base Year (2007) = 100.

Carbon dioxide

CO_2 emissions in this sector are dominated by emissions from stationary and mobile machinery (79%) and urea and lime application (21%). Emissions from both sources decreased in 2013, by 1.8% from machinery and 20% from urea and lime application, resulting in an overall reduction in emissions of 4% from this source. CO_2 emissions were lower in 2013 than at any time in the period from 1990, although it is unclear how much of this was due to economic factors, improvements in energy efficiency or increased use of renewable energy.

2. Progress against indicators

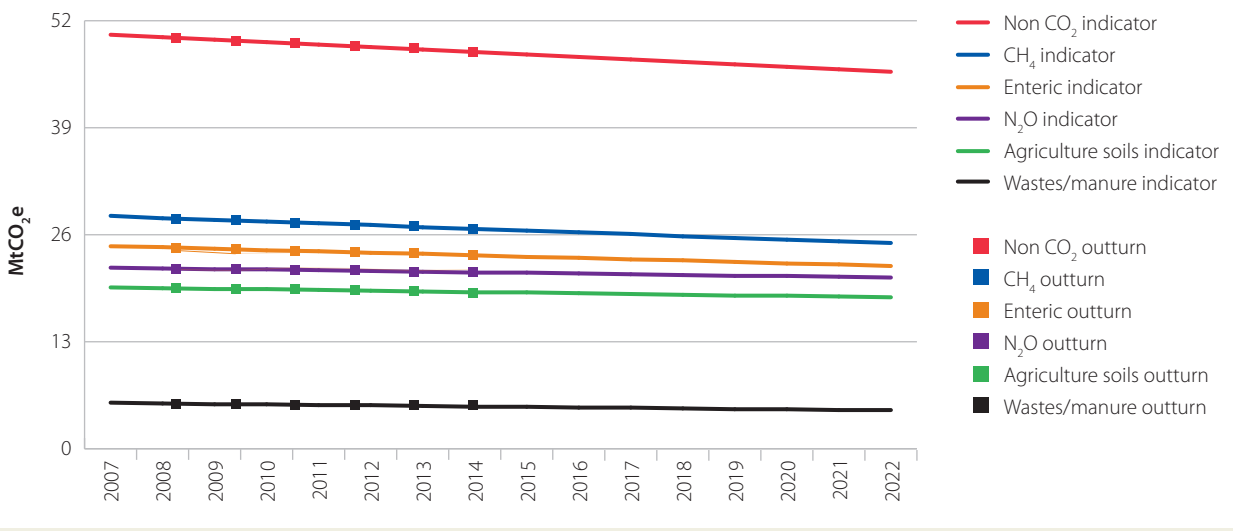
The Government has set an ambition for reducing non-CO_2 emissions in the agriculture sector in England by 3MtCO_2 by 2022 from 2007 levels, which scales up to 4.5 MtCO_2 for the UK. In order to track progress against this ambition, we set indicators for total non-CO_2 emissions, and trajectories for reducing emissions by gas and source (Figure 5.7).

These show that emissions in 2013 were broadly on track against the trajectories:

- Emissions from enteric fermentation and methane were on track.
- Emissions from agricultural soils and nitrous oxide were slightly above the indicator, although this is within the range of uncertainty of the estimates.

Overall, our assessment for 2013 suggests that agricultural emissions are broadly on track against our indicators. If the slight levelling off of nitrous oxide emissions persists in the future, further steps will be needed to ensure carbon budgets are met. The new Smart Inventory will provide greater certainty in monitoring progress.

Figure 5.7. Progress against indicators for agriculture to end of the third budget period



Source: NAEI ((2015), CCC calculations based on LCTP ambition.

3. The policy framework

Industry-led approach (GHG Action Plan)

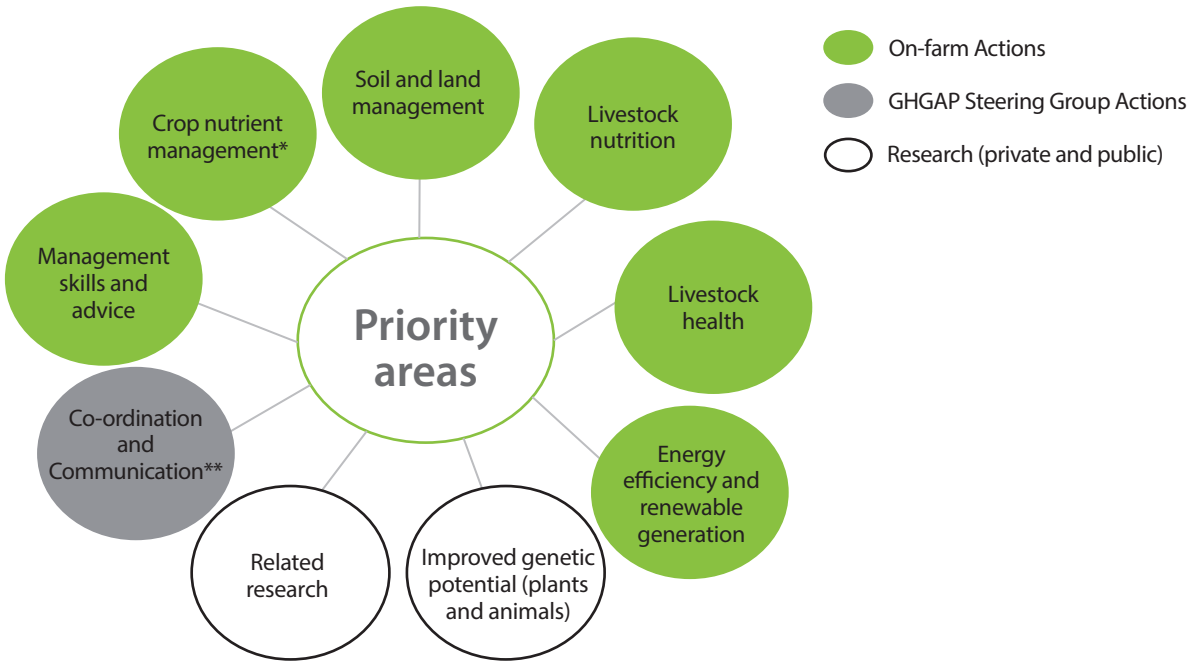
The Government's ambition for a 3 MtCO_2 reduction in non-CO_2 emissions in agriculture in England is being delivered through a voluntary, industry-led approach as set out in its Action Plan. The plan is being delivered in three phases, the first of which was achieved in 2012. The Plan is currently in its second phase which is intended to promote improvements in farming practices in seven priority areas (Figure 5.8).

As reported in previous Progress Reports, it is difficult to evaluate the effectiveness of the industry approach because it is not possible to assess whether progress is due to measures in the Action Plan or to other factors.

In last year's Progress Report, we recommended that industry develop a set of objectives with quantifiable targets in order to allow a proper evaluation of industry action to reduce emissions. Industry has now started work on a set of measures which go some way to address the lack of

evidence. While these may not be able to directly attribute GHG savings to actions taken, they should provide evidence of specific measures that have been taken to engage farmers in more sustainable agricultural practices. It is too early to assess how useful these will be, and we will continue to monitor progress in this area. It will be important to feed this evidence into the 2016 Government review of whether the industry-led approach is delivering the required emissions reductions. If it is not possible to assess the effectiveness of the existing scheme the Government should consider whether a stronger approach is needed.

Figure 5.8. Seven priority areas in the GHG Action Plan



* Manure/slurry/fertiliser/biological fixation management in grassland and arable production systems – supported by arable crop disease management to optimise marketable crop

** includes reporting

Source: Greenhous Gas Action Plan

Agricultural policy is a devolved matter. As in England, the devolved administrations place considerable emphasis on a collaborative approach with the farming industry. To date all the approaches are voluntary, although the Scottish Government has announced its intention to regulate if significant progress is not made. Wales has set a reduction target of 1.5 $MtCO_2e$ by 2020, while the focus in Northern Ireland is to reduce emissions intensity while allowing the sector to grow. Further details on the Devolved Administrations are given in chapter 7. It is important that DECC assess whether action in each of the Nations is consistent with carbon budgets and to push for further actions should this not be the case.

Other policies affecting agriculture

The GHG Action Plan is the only policy directly aimed at reducing GHG emissions in agriculture in England. However, there are a number of other measures at the UK and EU level whose primary objective is not reducing GHG emissions, but which will impact on future emissions from UK agriculture.

Agri-tech strategy

In 2013 the Government published an Agri-tech strategy which aims to improve the productivity, sustainability and competitiveness of the agricultural sector. Two key strands of the strategy are the Agri-Tech Catalyst programme and the Centres for Agricultural Innovation:

- Through its Agri-Tech catalyst fund, the Government is providing £70 million to fund businesses and researchers to develop agricultural technology, and innovative and sustainable solutions to global agricultural challenges. It is expecting to fund around 50 projects by the end of the first two rounds of funding. This should accelerate the commercialisation of agricultural research, with longer term benefits to sector productivity and sustainability (Box 5.2).
- This year, the Government awarded funding for the first Centre for Agricultural Innovation to the Centre for Agri-Informatics and Sustainability Metrics. This will be a 'big data' centre, a key component of which will be to analyse and disseminate data to businesses and researchers working across the whole food chain.

It is important that Defra tracks progress of projects being funded and evaluates the impact of the strategy on longer-term productivity and sustainability of agriculture.

Box 5.2. Examples of projects receiving funding from the Agri-tech catalyst

The following are examples of projects that have been awarded funding through the Agri-tech catalyst fund:

- Improved breeding programmes through advanced pollination technology.
- Evaluating a proxy test for feed conversion efficiency for beef cattle.
- Innovate the next generation of pig breeding using DNA sequence data.
- Novel macrocyclic lactose compounds for crop and livestock protection providing better effectiveness to pest resistance.
- Exploring the use of genomic technologies to reduce mastitis in meat sheep.
- Engineering resistance to disease in pigs, particularly the influenza virus, with the aim of reducing the carbon footprint of pork production.

These should contribute to improvement in the longer-term sustainability of agriculture.

Source: : Agri-tech-catalyst

Anaerobic digestion (AD)

Renewable generation is one of the abatement measures included in the GHG Action Plan, and there is an ambition for saving 0.55 $MtCO_2e$ by 2020 through AD. The deployment of small-scale plant (up to 500 Kw capacity) more than doubled in 2014 in advance of the degression of the Feed-in-tariff (FiT). The tariff was reduced by almost 30%, with rates falling to 11.2p/Kwh for plant capacity of 250 Kw or less and to 10.4p/Kwh for plants with capacity of between 250-500 Kw. We will consider the impact of the degression on AD deployment in next year's Progress Report.

The Government is conducting a review of FiTs later this year, which will consider tariff banding and the wider economic and environmental impacts[1] of maize for bioenergy production. We welcome this review, which should consider the scope for cost-effective support for all scales of AD using sustainable feedstocks.

1 Defra (2015), Risks and opportunities of current and future maize production (SCF0405).

Countryside productivity scheme

The Countryside productivity scheme, launched in March 2015, aims to help farmers invest in specific equipment and innovative technology to improve productivity and sustainability in farming. The £5 million scheme, funded under the Rural Development Programme for England, provides grants of between £35,000 and £1 million towards a 40% reduction in costs of investments in innovative equipment for arable and livestock farms:

- For livestock farmers, the scheme covers technologies to improve animal health, LED lighting for housing and recycling of heat from waste emissions.
- For arable and horticultural farms, funds can be used towards the cost of more efficient slurry injections equipment, remote crop sensing and crop robotics.

Applications for grants will be based, among other criteria, on their ability to deliver GHG reductions and to adapt to a changing climate. The scheme should therefore promote emission reduction in conjunction with raising productivity.

The EU's National Emissions Ceiling (NEC) directive

The National Emissions Ceiling directive, introduced in 2010, sets limits on four pollutants responsible for acidification, eutrophication and ground-level ozone pollution (sulphur dioxide, nitrogen oxides, volatile organic compounds and ammonia). The EU is further considering the inclusion of methane emissions, with a proposed target for a 33% reduction by 2030 on 2005 levels across the region, although not all of this would necessarily fall on the agriculture sector.

For agriculture, which accounted for 48% of methane emissions in the UK in 2013, this would imply better management of manures, which could have a complementary benefit of tackling ammonia emissions. Defra are currently undertaking work to assess the implications of this proposal, especially with regard to identifying measures to reduce methane emissions. It is important that this review considers the feasibility and cost-effectiveness of such measures, which could play a role in delivering our future abatement scenarios.

4. Forward look

In last year's Progress Report, our assessment was that all of the potential emissions savings from agriculture that could help meet the second, third and fourth carbon budgets were at risk.

For this year's report, our analysis has been updated to take account of DECC's latest 'no policy' baseline projections[2], but our overall assessment remains unchanged (Figure 5.9).

- Savings of 3 $MtCO_2e$ for England are at risk due to the voluntary nature of the GHG Action Plan and the difficulties in assessing its effectiveness in terms of reducing emissions.
- Further savings are at risk in the 2020s due to the policy gap, with no commitment by Government to implement policy options beyond 2022.

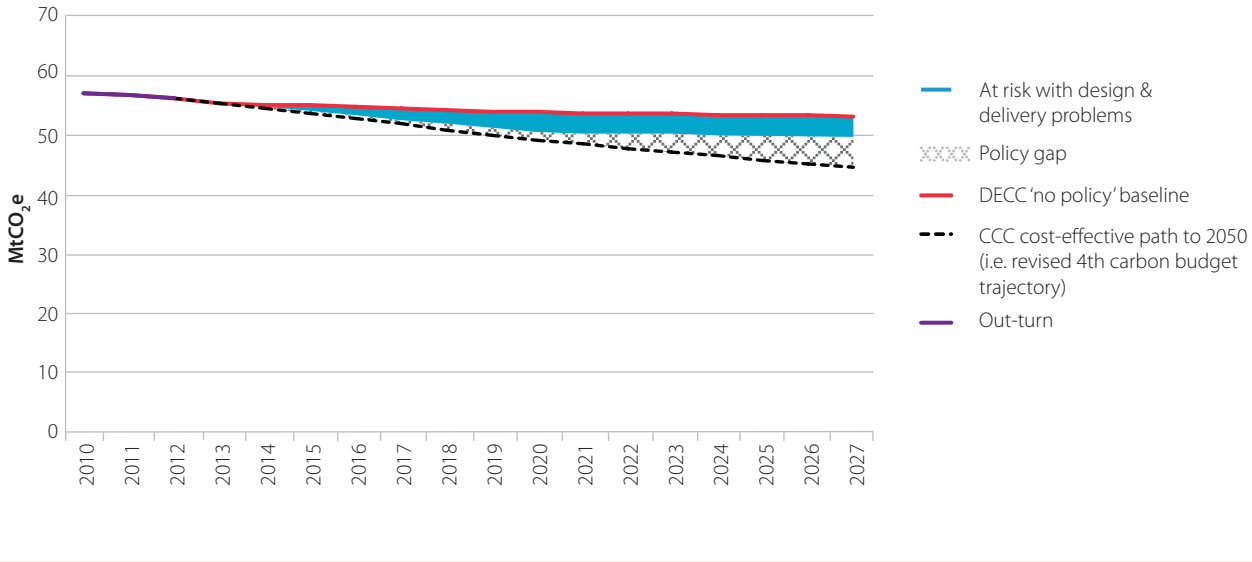
This sector will represent an increasing proportion of total emissions as other sectors decarbonise more quickly. Preparation for deeper cuts will be needed over the period through the fourth carbon budget in order to keep the sector on track to the 2050 target. This should start with better measurement of emissions through the Smart Inventory and identification of cost-effective and feasible abatement options.

2 DECC (2014) Updated Emissions Projections. Available at: www.gov.uk

We have commissioned research to update our assessment of such options which will feed into our recommendations for the fifth carbon budget. This will include a qualitative assessment of the potential for emissions reductions from dietary change. This recognises the need to identify further reduction opportunities in the longer-term through changes in consumer behaviour both in terms of diet change and reducing food waste.

Many of the measures set out in the Adaptation Progress Report also work towards improving agricultural productivity which, if implemented, set a strong basis for helping to meet future carbon budgets. These include improving soil organic matter, soil conservation methods, reducing the risks associated with pests and diseases and improved flood management. Further details are given in Chapter 5 in the Adaptation Progress Report.

Figure 5.9. Assesment of current and planned policies: Agriculture



Source: DECC (2014), Updated Emissions Projections & CCC calculations.
Note: All data is consistent with UEP 2014; outturn values will therefore differ from latest provisional emissions estimates.

5. Land use, land use change and forestry (LULUCF)

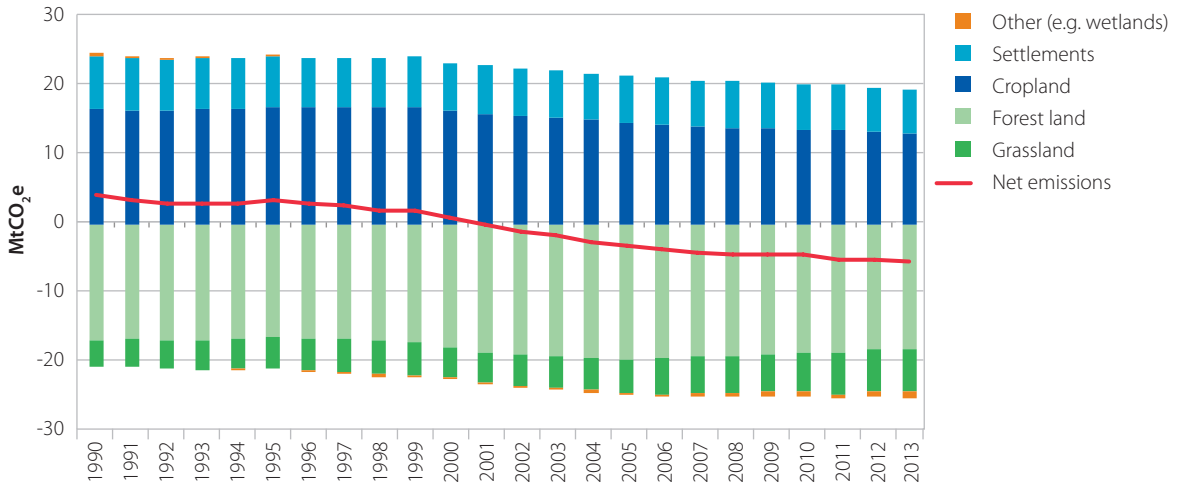
This section considers emissions in the LULUCF sector which covers many land types in the natural world, for example forests, wetlands and grasslands. Many of these are important for societal well-being in terms of the biodiversity, landscapes and ecosystems they provide as well as valuable goods and services such as clean air and water. Plans to improve the natural environment are set out in Chapter 6 of the Adaptation Progress Report.

Emission trends

The LULUCF sector's net carbon sink increased by 6% (equivalent to 0.3 $MtCO_2e$) to 5.3 $MtCO_2e$ in 2013 (Figure 5.10). This was driven by:

- A 1% increase in the net absorption rates of grassland that remains as grassland; and
- A 1% reduction in emissions arising from cropland.

Figure 5.10. LULUCF emissions and removals (1990-2013)



Source: NAEI (2015).

Opportunities to reduce LULUCF emissions

A range of options can be used to increase carbon sequestration and reduce the release of emissions in the sector. These are focused on the expansion of woodland cover and reducing losses from degraded peatland. In addition to mitigating emissions, there are positive links to efforts to adapt to climate change. For example, restoring degraded peatlands also improves water quality, while the expansion of woodland cover provides ecological networks that help biodiversity shift their ranges and distributions in order to keep pace with changes in climate. Further details are given in the Adaptation Progress Report.

Forestry

Woodland accounts for around 13% of total UK land area, which is below the EU average of 44%. Coverage has fallen, reflecting a 20-year reduction in tree planting rates, which by 2010 had declined by 85% compared to levels in 1989. On this basis, we recommended that the rate of tree planting should be increased by an additional 10,000 hectares annually between 2015 and 2030 (or 20,000 ha/pa in total) in order to deliver 1 $MtCO_2$ of carbon savings by 2030.

England and the DAs have all set out plans to increase woodland creation which, if achieved, would be close to our recommendation. Progress to date however, has been short of the ambition, with UK tree planting rates reaching 10,300 hectares in the year to end March 2015. Consideration is needed about whether the balance of effort between each country's contribution towards meeting the overall UK ambition remains appropriate.

Although there are schemes in place that could provide some momentum (Box 5.3), it is essential that England and the DAs put in place plans to meet the targets. The plans should take into account the type of trees being planted given future climate conditions (see the Adaptation Progress Report). In contrast to the DAs, England is committed to private sector investment delivering the ambition. However, there is still an important role for Government to play as an enabler and Defra should be developing work on this (e.g. on new ways to encourage growth and addressing barriers).

Box 5.3. Woodland creation and preservation schemes

While Pillar II of the Common Agricultural Policy (CAP) is an important source of finance for the creation of woodland cover for England and the DAs, there are also a number of other schemes looking to support more tree planting and forest management:

- **Rural Development Programme (RDP) funding:** Under Pillar II of the CAP, funding under the RDP (2014-2020) for England will be provided for the planting of 14,000 hectares of woodland. Similar incentives also exist in each of the DA's Rural Development Programmes. For example, in Northern Ireland, the RDP will fund up to five hectares of woodland expansion as part of the Environmental Farming Scheme. In Scotland, livestock farmers will receive a grant of up to £3,600 per hectare to plant up to 400 trees per hectare on sheep grazing land, while still being able to receive Pillar I payments.
- **Durham pilot study:** One of the barriers identified by landowners is the perceived regulatory burden associated with obtaining permission for planting more than five hectares of woodland (or more than two hectares in sensitive landscape). The Durham pilot will explore whether the framework regulating woodland creation can be improved by, for example, clarifying where a full Environmental Statement is required. The project will include identifying appropriate areas for large-scale woodland creation in the country, where there is likely to be less significant environmental impact (and an opportunity for a positive impact) if UK Forestry Standard requirements are adhered to. The project is expected to conclude later this year, and could result in non-legislative changes to the regulatory framework.
- **'Grown in Britain'** was established in 2013 to increase British timber production and supply. It aims to stimulate the market for British timber, and to encourage investment in woodland creation and management schemes. By creating market-led demand for British timber, it aims to increase the amount of woodland in management and to help protect the wider environment.
- **'Roots to prosperity'** is an action plan for the growth and development of the forestry sector in northern England and is supported by a broad range of industry and public sector stakeholders. It aims to promote good forestry management, increase timber supply and promote economic growth.

Source: Defra, http://www.growninbritain.org/, Confor

Peat for horticultural use

The use of peat for horticultural purposes is the main driver behind the extraction of lowland peat in the UK. In 2013 peat extraction accounted for 0.3 $MtCO_2e$. Defra is committed to a voluntary phase out of its use in the horticulture sector in England by 2030. This will also cover imports, which account for around two-thirds of peat demand.

This ambition is being overseen by the Growing Media Panel, which was established in 2013. Defra has been working with industry to develop a tool to inform the environmental sustainability of growing media ingredients, which are alternatives to peat. The tool will assess, amongst other things, the energy use, water use, and habitat and biodiversity of the raw material of the peat alternative to ensure that reducing peat use in horticulture does not lead to an increase in the use of other raw materials that are less responsibly sourced.

The policy will be reviewed in the second half of this year to assess whether the target remains appropriate.

Upland peat and peat restoration

In last year's Progress Report, we recommended that the LULUCF inventory should include net emissions from uplands and all lowland peatlands, and that policy be strengthened to encourage further restoration. We welcome progress on this:

- Defra is currently reviewing the draft final results of a five-year project on how best to restore drained blanket bog peat in the uplands to achieve the biggest emissions impact by maximising CO_2 sequestration and reducing methane loss. The final results will be published later this year.
- Defra, in partnership with the International Union of Conservation Nature (ICUN), is developing a Peatland Carbon Code, which is a voluntary standard for peatland restoration (Box 5.4). The CCC Adaptation Sub-Committee in its 2013 report[3] identified the development of such a code as a key priority to deliver additional private investment in restorative measures.
- Natural England has been working with key landowners to produce a blanket bog restoration strategy. This aims to develop a common understanding and shared commitment amongst landowners, statutory bodies, and wildlife charities, to achieve blanket bog restoration that delivers multiple outcomes (see Chapter 6 of the Adaptation Progress Report for more detail).

Box 5.4. The Peatland Carbon Code

The UK Peatland Carbon Code is designed to encourage private investment in the restoration of degraded peatlands by addressing the financial barriers to land managers, both in terms of the capital outlay and forgone revenue from existing activities. One such activity is commercial grouse shooting, whereby the burning of moorland heather to create the best conditions for the birds has the effect of drying out the top layer of the peat resulting in carbon losses.

The Code is currently in draft format:

- A two-year pilot stage was launched in 2013 by the ICUN, and it is likely to conclude later this year with an independent evaluation before next steps can be agreed. The focus of the pilot has been on refining the code and the evidence base in addition to piloting the processes involved.
- Guidance is being developed on quantifying the climate and other benefits (e.g. water quality and biodiversity) of restoration, which will be published later this year.
- It is intended that the Code will eventually attract private companies to invest in restoration while contributing towards corporate social responsibility objectives. Feedback from potential sponsors and those with potential restoration sites have been sought during the pilot in order to ascertain the level of interest.

Source: ICUN UK

3 CCC (2013) Adaptation Sub-Committee Progress Report.

6. Summary

The current industry-led approach to reducing emissions in the agriculture sector relies heavily on behaviour change, which also delivers cost-savings to the farmer. However, low-carbon investment and the development of future options and innovation will be needed for deeper reductions in emissions associated with our longer term cost-effective path.

- **Low-carbon investment.** The shift to a more sustainable agriculture system will require investment in a range of new equipment, buildings and processes, which is already being undertaken by the private sector. The support provided by FiTs for on-farm anaerobic digestion and the grants provided through the Countryside Productivity Scheme are welcomed. We are currently updating the agriculture sector Marginal Abatement Cost Curves (MACC) which will highlight cost-effective investments that could deliver further abatement. In the forestry sector, investment will be required to address financial barriers to woodland creation. For example, the UK Woodland Carbon Code enables landowners to recover the costs of planting trees by receiving up-front payment from participating businesses.
- **Developing future options and innovation.** Innovation and R&D around more resilient crops, animal health, better breeding programmes and new generation farming practices will be needed to deliver a more sustainable agricultural system in the future. The Agri-tech strategy will play a key role in driving innovation in this sector, which government should closely monitor and evaluate. In addition, work on updating the MACC will provide a qualitative assessment of further options beyond the fifth carbon budget up to 2050
- **Low-carbon choices.** The current approach to delivering emission reductions in agriculture through the GHG Action Plan relies heavily on farmers adopting more efficient and sustainable agricultural practices (e.g. efficient use of fertiliser). The Centres for Agricultural Innovation currently being funded by Government will help disseminate information about best practice and could also help drive more sustainable agricultural practices. In the longer-term, changes in consumer behaviour (e.g. diet change and waste reduction) will be important for delivering further emissions reduction in agriculture.

The agriculture sector will represent an increasing proportion of total emissions as other sectors decarbonise more quickly. Achieving emissions reduction will become more important for contributing towards carbon budgets. It is therefore imperative that work to roll-out the Smart Inventory next year is not delayed any further in order to improve the accuracy in measuring emissions and the abatement potential from current farming practices. Reducing emissions will also deliver a range of co-benefits to the natural environment and agriculture as we adapt to a changing climate.

Chapter 6: Progress reducing emissions from waste and F-gases

1. Waste and F-gas emission trends and drivers
2. Opportunities to reduce waste and F-gas emissions
3. Policy progress
4. Summary

Key messages and recommendations

Waste and F-gas emissions account for 7% of total UK greenhouse gases. Waste emissions are predominantly methane emissions which arise due to the decomposition of biodegradable waste in landfill sites in the absence of oxygen. F-gases are used in various applications, mainly as coolants in air conditioning and refrigeration, and are typically released through leakage.

Waste and F-gas emission data lags other sectors by a year due to the longer time required to collate non-CO_2 emissions data. In this chapter, we assess waste and F-gas emissions over the period 2009-2012, 2013 outturn data, as well as policy progress to unlock abatement potential.

Waste management is a devolved issue, with England and each of the devolved administrations developing waste strategies and legislating waste measures. We assess the waste policy progress to date for each UK nation.

Waste emissions

- Waste emissions decreased by 14% in 2013, following an annual average 10% decrease over the period 2009-2012. In total, waste emissions fell by 67% from 1990 to 2013. These reductions have mainly been due to reduced biological waste going to landfill, investment in methane capture technology and improved management at landfill sites.
- There is further abatement potential by reducing waste throughout the supply chain, preventing biological waste going to landfill, ensuring that this can be diverted to be used in productive ways (e.g. anaerobic digestion units) and increasing methane capture at landfill sites.

F-gas emissions

- F-gas emissions fell by 0.1% in 2013, following an annual average increase of 2% over the period 2009-2012. This deceleration in growth is most likely due to the impact of EU regulation.
- The new 2015 EU F-gas regulation aims to cut HFCs by 71% in 2030, ban on the use of certain F-gases in specific applications and strengthen leakage checking.

Our key recommendations for Defra and the devolved administrations are:

Ahead of 2016 Progress Report

- **Find opportunities to exceed regulatory minimums on F-gas abatement:** including clearly assessing and addressing barriers where evidence suggests cost-effective abatement above minimum standards.

Ahead of 2017 Progress Report

- **Scotland, England, Wales and Northern Ireland to set out approaches to increase methane capture rates:** as a devolved matter, each nation should set out specific actions and clear milestones.
- **Reduce biodegradable waste to landfill:** each nation should set out specific actions and clear milestones – including England – to further reduce biodegradable waste to landfill.

We set out the analysis that underpins these conclusions in four sections.

1. Waste and F-gas emission trends and drivers
2. Opportunities to reduce waste and F-gas emissions
3. Policy progress
4. Summary

1. Waste and F-gas emission trends and drivers

Waste and F-gas emission data lags other sectors by a year, due to the longer time required to collate non-CO_2 emissions data. In this chapter, we focus on the latest information which shows that waste and F-gas emissions totalled 40 $MtCO_2e$ in 2013, accounting for over 7% of total UK greenhouse gas (GHG) emissions.

(a) Waste emission trends

Waste emission estimates in the inventory have changed significantly over recent years, in particular in relation to the amount of biodegradable waste going to landfill and levels of methane capture (Box 6.1). As a result, the emissions reported here cannot be easily compared with those reported in our 2014 Progress Report.

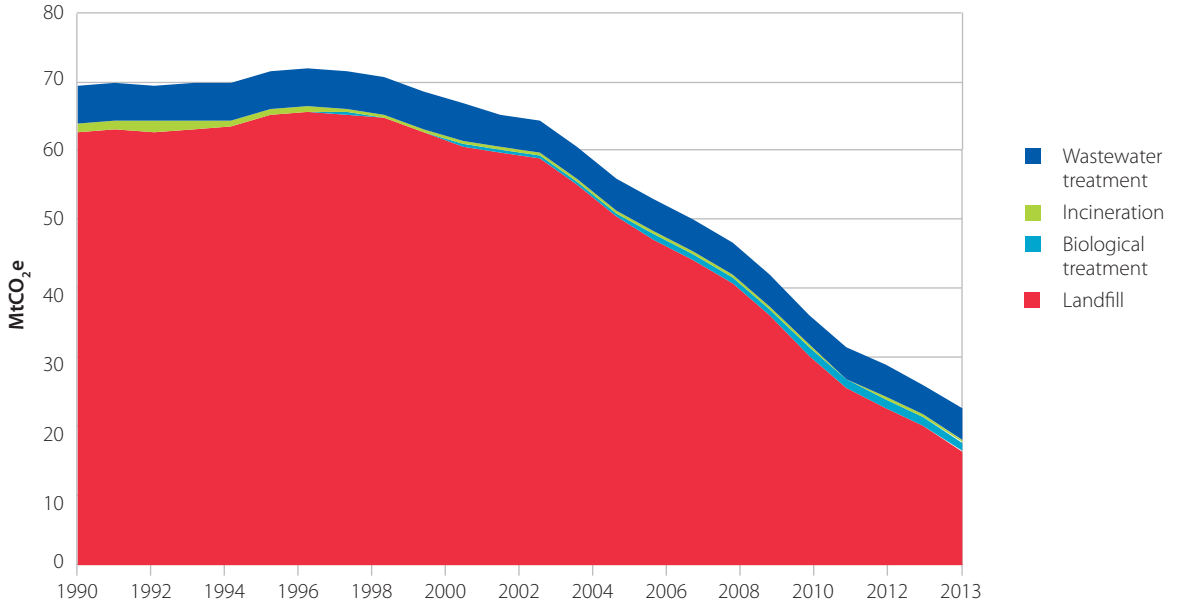
Waste emissions were 23 $MtCO_2e$ in 2013 and accounted for almost 4% of total UK GHG emissions. Waste emissions are predominantly methane emissions which arise due to the decomposition of biodegradable waste in landfill sites in the absence of oxygen. Emissions also arise due to wastewater treatment, biological treatment and incineration of wastes.

Waste emissions fell by 14% in 2013, following an annual average 10% decrease over the period 2009-2012. Waste emissions have fallen by 67% since 1990 (Figure 6.1). These reductions have almost entirely come from declining methane emissions from landfill:

- **Landfill emissions**. 74% of waste emissions and are entirely methane. Landfill emissions fell by 19% in 2013, following an annual average 13% decrease over the period 2009-2012. This fall has been due to reductions in biodegradable waste going to landfill, investment in methane capture technology and improved management at landfill sites (Box 6.1)
- **Wastewater treatment emissions**. 19% of waste emissions and are mainly methane with some nitrous oxide (N_2O). Wastewater treatment emissions have remained broadly flat over 2009-2013.
- **Biological treatment emissions**. 6% of waste emissions and are a mixture of methane and nitrous oxide from composting and anaerobic digestion. Biological treatment emissions increased by 6% in 2013, following an annual average 6% increase over the period 2009-2012.
- **Incineration (without energy recovery) emissions**. 1% of waste emissions and are mainly CO_2. Incineration emissions increased by 1%, following an annual average 3% decrease over the period 2009-2012.

Given their dominance, we focus on methane emissions from landfill.

Figure 6.1. GHG emissions from waste by source (1990-2013, $MtCO_2e$)



Source: NAEI GHG inventory

Waste emission drivers – methane from landfill

Landfill methane emissions are not directly measured, but calculated based on: the quantity of biodegradable waste sent to landfill, assumptions on the properties of waste streams such as methane yield and decay rates[1], and the amount of methane captured at landfill sites:

- **Biodegradable waste.** Waste Reduction Action Programme (WRAP) data suggests that avoidable household food and drink waste has fallen by 15% between 2007 and 2012, from 8.3 to 7 million tonnes.[2] Reductions in waste have been driven by waste prevention and resource efficiency campaigns at local level, voluntary responsibility deals and the recession.
- **Biodegradable waste sent to landfill.** Estimates suggest that the amount of landfilled biodegradable waste reduced by 3% in 2013, following an annual average 7% decrease over the period 2009-2012. Biodegradable waste sent to landfill in 2013 has fallen by 70% since 1990 (Figure B6.1).
- **Methane yield and decay rate.** There is an imperfect understanding of the amount of methane emitted from various waste streams and over how many years it is emitted. Field and experimental observations exhibit wide variation (reflecting differences in how materials are mixed together, which affects moisture content and access of waste streams to oxygen). The yield and decay rate are also affected by real landfill conditions, which differ between and within sites. The Government has estimated that uncertainties over methane yield and decay rates mean that methane emissions from landfill could be 70% greater or lower than currently recorded in the inventory.
- **Methane captured at landfill sites.** The proportion of methane that is flared to CO_2 or used for energy generation, rather than emitted is estimated to average 61% in 2013, rising from 45% in 2009 (Figure B6.1).

Overall, estimated landfill methane emissions have fallen by 74% between 1990 and 2013.

1 Quantity of methane emitted and over how many years the as different types of waste degrade.
2 *Household Food and Drink Waste in the United Kingdom 2012*. Available at: http://www.wrap.org.uk/

Box 6.1. Biodegradable waste, proportion of methane captured at landfill sites and methane emissions from landfill (1990-2013)

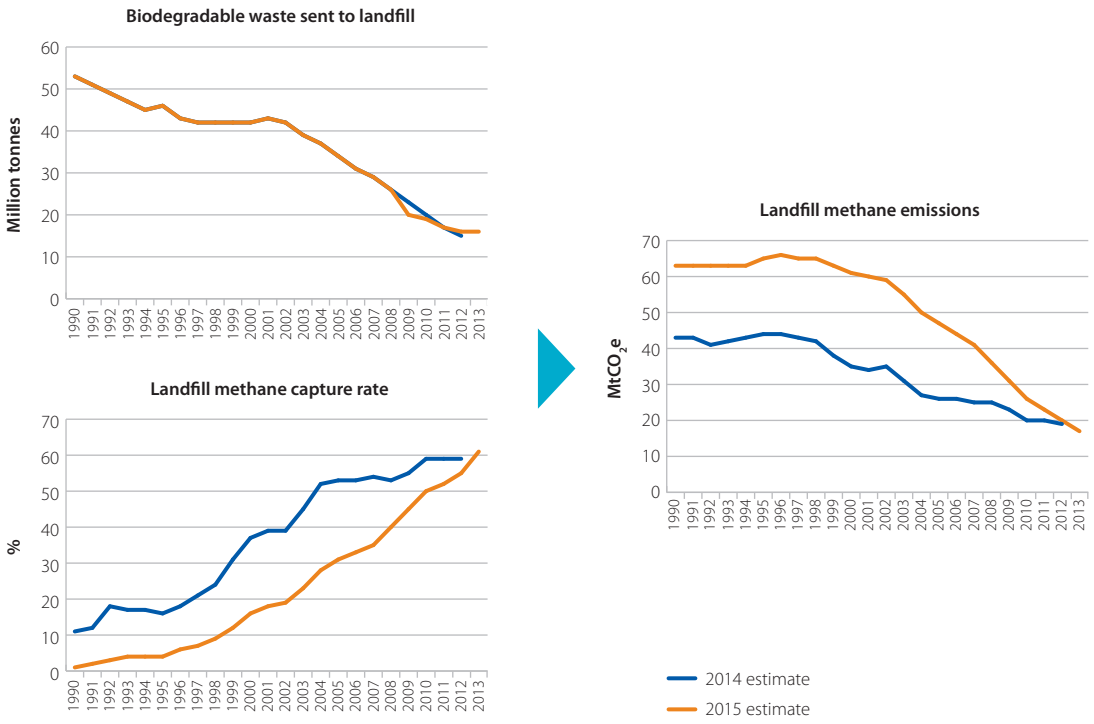
Defra has recently published the results of several studies to improve the accuracy of emissions estimates, including the proportion of biological waste going to landfill, the decomposition rates of waste streams and methane emissions from landfill.

The main factors that have affected historic methane landfill emissions are:

- **Landfill gas combustion in flares based on site-specific data only**. Based on a UNFCCC requirement to use site-specific data only rather than estimated values. This has reduced the estimate of the collection of methane for combustion in flares, and thus increased methane emissions from 1990.
- **Increase in assumed gas engine efficiency from 1998 onwards**. Based on Golder Associates 'Review of methane emissions modelling', which found that landfill power generators have become more efficient over time and thus consume less methane than previously assumed. This change has increased the estimate of methane emissions from 1998.
- **Increase in waste decomposition rates**. Also based on the Golder review, this change raised landfill emissions up to 2005, but has reduced them from 2007.

Defra is continuing to work on better measurement of methane emissions from landfill, in close collaboration with the Environment Agency, Manchester University, and the Technical University of Denmark. This will lead to more robust inventory modelling and present opportunities to improve management of landfill sites.

Figure B6.1. GHG Biodegradable waste, proportion of methane captured at landfill sites and methane emissions from landfill (1990-2013)



Source: National Atmospheric Emissions Inventory (NAEI), MELMod and DECC.
Notes: Biodegradable waste and landfill methane capture do not equal landfill methane emissions. Emissions also depend on methane yield from waste.

Source: NAEI GHG inventory, MELMod and DECC
Notes: Golder Associates (2014) Review of Methane Emissions Modelling. Available at: http://randd.defra.gov.uk/

(b) F-gas emission trends

F-gas emissions were 17 $MtCO_2e$ in 2013 and accounted for 3% of total UK GHG emissions. The majority of emissions were the result of gas leakage of HFCs used in refrigeration and air conditioning as a substitute for ozone-depleting substances. Other F-gases are from diverse sources, such as the use of metered dose inhalers, aerosols and fire-fighting equipment.

F-gas emissions arise from three types of fluorinated gases; hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF_6). They are emitted in very small amounts but have high global warming potentials (between 140 and 23,900 times that of CO_2) and long atmospheric lifetimes.

- **HFC emissions** represent the largest proportion of F-gases (95%) and come mainly from refrigeration and air conditioning products, aerosols and foams, metered dose inhalers and fire extinguishers. HFCs are emitted during the manufacture, lifetime and disposal of these products.
- **PFC emissions** come mostly from electronics and sporting goods manufacture and as fugitive emissions from halocarbon production.
- **SF_6 emissions** result mainly from the use of electrical insulation, as well as other industrial activities, such as magnesium casting, and military applications.

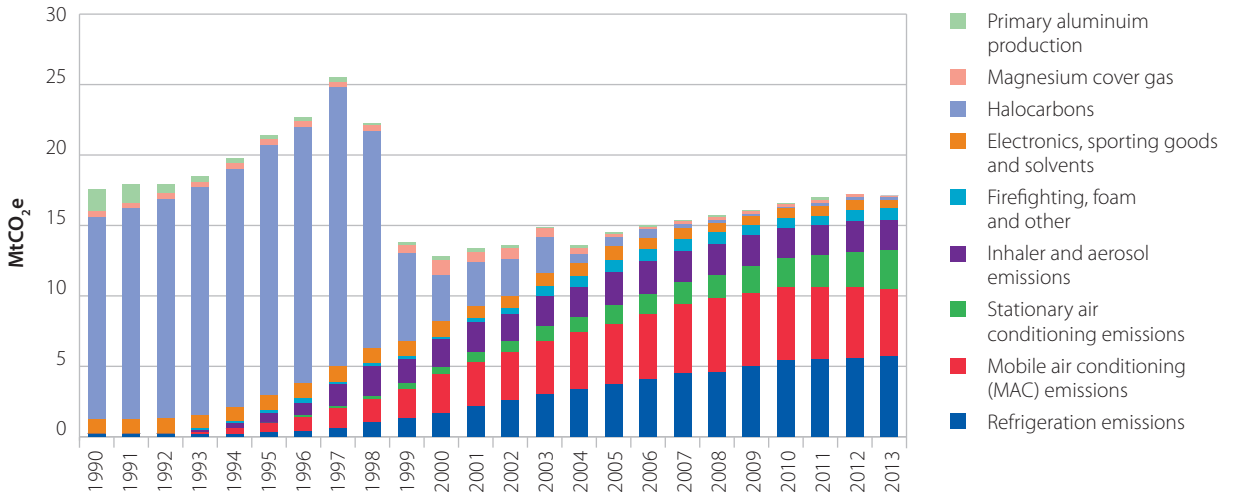
Between 1997 and 1999, emissions dropped significantly as abatement technologies were fitted at production facilities (Figure 6.2). Since 2000, F-gases have been slowly rising again, mainly as a result of increasing demand for air conditioning and refrigeration products.

F-gas emissions fell by 0.1% in 2013, following an annual average increase of 2% over the period 2009-2012. Changes in demand for refrigeration and air conditioning have been the main factors responsible for these emission trends:

- **Refrigeration emissions**. The main source of F-gases increased by 1% in 2013, following an annual average 4% increase over the period 2009-2012, driven by rising demand for refrigeration products. The 2006 EU F-gas regulation is likely to be the main driver of this deceleration in emission growth as it aims at replacing high GWP F-gases with lower GWP refrigerants and reducing the leakage.
- **Mobile air conditioning (MAC) emissions**. Fell by 4% in 2013, following an annual average 2% decrease over the period 2009-2012. The EU Mobile Air Conditioning (MAC) directive is likely the main reason for the reduction in emissions as it restricts the use of F-gases in new cars.
- **Stationary air conditioning emissions**. Rose by 7% in 2013, following an annual average 10% increase over the period 2009-2012. This is mainly driven by increasing use, but these emissions are covered under the new 2015 EU regulation to reduce F-gas emissions.

Overall, while the emissions from refrigeration and stationary air conditioning increased in 2013, the growth has been lower than in previous years. This is likely to have been driven by EU regulation.

Figure 6.2. GHG emissions from F-gases by source (1990-2013, $MtCO_2e$)



Source: NAEI GHG inventory

2. Opportunities to reduce waste and F-gas emissions

a. Opportunities to reduce waste emissions

In our 2012 Progress Report we discussed in detail the potential opportunities to reduce waste emissions. Due to their potent greenhouse gas impact, opportunities focus on reducing methane emissions from landfill:

- **Waste prevention**. Emissions can be further reduced through waste prevention, which also offers substantial upstream environmental and economic gains associated with resource efficiency.
- **Diversion of biodegradable waste from landfill**. There is potential to go significantly further in diverting biodegradable waste away from landfill and towards recycling, composting, anaerobic digestion (AD), mechanical biological treatment (MBT), and incineration with energy recovery.
- **Landfill methane capture**. Methane capture at modern landfill sites is over 80% and can reach as high as 90%. These sites will play a bigger role as legacy emissions from older (and less efficient) landfill sites decline.

Our indicators reflect scenarios where biodegradable waste sent to landfill is reduced at least in line with the UK Government's projections, and potentially reduced close to zero by 2020. This continues the approach we first set out in our 2012 Progress Report (Table 6.1).

Biodegradable waste sent to landfill has fallen in line with our indicator and methane capture rates have continued to rise (although from a different 2012 starting position, Table 6.1). We will review these indicators in our *Fifth Carbon Budget Advice* later this year.

Table 6.1. Progress against the Committee's waste indicators (% change from 2007)					
	Budget 2 (2013-2017)	**Budget 3 (2018-2022)**	**Budget 4 (2023-2027)**	**2013 indicative**	**2013 Outturn**
Biodegradable waste to landfill	-38% to -84%	-39% to -97%	-39% to -97%	-32% to -41%	-45%
Methane captured at landfill	Rising above 2012 rate of 59%				61%
Source: Defra, CCC analysis					

b. Opportunities to reduce F-gas emissions

In our 2014 Progress Report, we considered the potential for further reduction in remaining F-gases. A 2010 AEA study for Defra showed evidence on lower GWP alternatives to HFCs.[3] Some of these alternatives are in development and some are already commercially available:

- **Refrigeration and air conditioning** can use existing hydrocarbons as well as CO_2 and Hydrofluoroolefins (HFOs) which are in development.
- **Metered dose inhalers** can in many cases be replaced with dry powder inhalers, which have been a known technology for over 20 years and are widely used in some other countries.
- **HFOs in aerosols**, while not widely used in the UK, are already being used as a replacement for HFCs in the EU, requiring small modifications to equipment only.

The new 2015 EU F-gas Regulation aims to cut HFCs by 71% by 2030, introduce new bans on the use of certain F-gases in specific applications, and strengthen leak checking.

3. Policy progress

(a) Policy progress to reduce waste emissions

Success in reducing landfill emissions has focused on reducing waste, diverting waste from landfill and capturing the methane from landfill sites. Waste reduction has occurred through a combination of information and voluntary programmes. Action is being taken at EU, national, devolved administration and local authority levels. We briefly summarise each below.

EU Directives

The 1999 EU Landfill Directive required a 50% reduction in biodegradable municipal waste (BMW) landfilled in the UK by 2013 relative to 1995 levels of BMW production, and requires a 65% reduction by 2020. Estimates for 2012 suggest that BMW sent to landfill has fallen by 71% against the baseline, and so is currently outperforming the targets set. There are a number of other waste-related EU Directive targets for which the UK also outperforming or in line to meet (Table 6.2).

3 AEA (2010) *HFC consumption and emissions forecasting.* Available at www.gov.uk.

Table 6.2. EU Directive targets and UK performance to date		
EU Directive	**Target**	**UK 2012 progress**
Biodegradable municipal waste landfilled	From 1995, 50% reduction by 2013 and 65% by 2020	71%
Recycling of waste from households	50% by 2020	44%
Recovery of non-hazardous construction and demolition waste	70% by 2020	87%
Recycling or recovery of packaging waste	60% by 2012	69%

Source: Defra

In our 2014 Progress Report, we discussed the EU Commission's plan to present a comprehensive review of waste-related directives and a single coherent framework through to 2030, aimed at turning Europe into a more circular economy. [4] It had an aim to create half a million new jobs, while making Europe more competitive and reducing demand for costly scarce resources. The plan was expected to include targets to recycle 70% of municipal waste and 80% of packaging waste by 2030, and ban recyclable waste in landfill as of 2025.

The Commission has decided not to proceed with these plans. Instead, it now intends to present a new, more ambitious circular economy package late in 2015 which will aim at transforming Europe into a more competitive resource-efficient economy, addressing a range of economic sectors, including waste. We will monitor developments and report on the package in our 2016 Progress Report.

National waste emission policies

Waste management is a devolved issue, with England and each of the devolved administrations developing waste strategies and legislating waste measures. We first consider progress in policies affecting the whole of the UK, then progress for the individual nations against the devolved targets (Table 6.3).

UK-wide policy

In order to achieve current targets under the EU Directive, the UK introduced the Landfill Tax in 1996. This imposes a charge on landfill operators for each tonne of waste landfilled, creating an incentive to reduce the waste sent to landfill either through waste prevention or diverting waste to other treatments (recycling, composting, recovery, and reuse). The tax has been increased from its initial rate of £7 per tonne in 1996 to £82.60/t in 2015/16. As of April 2015, Scotland has acquired responsibility for setting its own landfill tax and Wales will follow in 2018.

There are a number of voluntary programmes aimed at reducing packaging and food waste managed by Waste & Resources Action Programme (WRAP), which has set a number of targets to reduce waste both in food production, groceries and household use. While not all targets have been met, there has been overall success in many of the programmes (Box 6.2).

4 A circular economy is an alternative to a traditional linear economy (make, use, dispose) in which we keep resources in use for as long as possible, extract the maximum value from them whilst in use, then recover and regenerate products and materials at the end of each service life.

Box 6.2. Waste & Resources Action Programme (WRAP)

WRAP is a registered charity that works with businesses, UK Governments and the EU to help deliver their policies on waste prevention and resource efficiency:

- **Love Food Hate Waste Programme**. Encourages voluntary reductions in food waste in households. The programme, introduced in 2007, has had good success on reducing avoidable household food waste by 21%, saving UK consumers almost £13 billion over the five years to 2012.
- **Courtauld Commitment**. A set of voluntary responsibility deals to 2015 to improve resource efficiency in the grocery retail sector by preventing supply chain, packaging and food waste.
  - Progress to date has been positive, exceeding some targets and narrowly missing others despite growth in the grocery sector. From 2005-2013, almost 3 million tonnes of waste has been prevented, with a monetary value of £5 billion and saving over 7 $MtCO_2e$. From 2013-2015, WRAP hopes to prevent an additional 1 billion tonnes of waste, equating to 3 $MtCO_2e$.
  - WRAP has started preparing a new set of agreements to reduce waste through to 2025 and will announce a formal proposition in 2015.
- **Hospitality and Food Service Agreement**. Launched in 2012 with the aim to:
  - Cut food and packaging waste by 5% by 2015. In 2013, there had been a cut of 2.5%.
  - Increase food and packaging waste that is being recycled, sent to AD, or composted to 70% by 2015. In 2013, this had increased by 7% points to 54%.

Source: http://www.wrap.org.uk/

Capture of methane at landfill sites has significantly increased from an average rate of 1% in 1990 to 61% in 2013 (Figure B6.2). This reflects investment driven by a combination of permit conditions and financial incentives for capturing methane from landfill and anaerobic digestion (e.g. under the Renewables Obligation, Feed-in-Tariffs, and Renewable Heat Incentive).

Later in 2015, we are expecting results from ACUMEN, a three year project to demonstrate technologies and practices to increase methane emission capture in closed and historic landfill sites (Box 6.3). Given the emission legacy of waste going to landfill, it is important to ensure this impact is minimised through greater methane capture. We recommend widespread use and support for of greater capture technology across the UK where cost-effective, based on results from project ACUMEN.

Box 6.3. Project ACUMEN

ACUMEN is a partnership project funded by the EU, Defra and the other participating organisations, and staffed by the Environment Agency, local councils and technology companies.

ACUMEN aims to demonstrate new techniques and technologies to improve the capture and use of methane from closed and historic landfills.

The project is installing and operating a range of new techniques at demonstration landfills. The aim is to show technologies that can work on the full range of closed landfills. The techniques demonstrated include small scale gas engines (8 - 150 kilowatts), a novel low-calorific gas flare and an active biological oxidation technique. The six demonstration sites range from 5 to 40 hectares in size, and between 20 and 50 years in age.

ACUMEN will also assess the costs and benefits of each demonstration project to see which options best suits certain categories of closed landfill. The aim is to provide a range of techniques to landfill owners to help them assess the options for managing methane at their sites and technical guidance in order to replicate the demonstrations at their own landfills.

The project began in September 2012, and will finish in September 2015. We will report on findings from this project in our 2016 Progress Report.

England

In our 2014 Progress Report, we reported the launch of the '*Waste Prevention Programme*' (WPP) for England to drive waste further up the waste hierarchy by helping businesses and households realise cost savings through waste prevention and resource efficiency. Progress over the last year includes:

- In December 2014, Defra published a summary update of progress on the main government actions set out in the WPP, which included 10 projects announced by WRAP receiving funding from the '*Innovation in Waste Prevention Fund*'.[5]
- WRAP are also developing a web-based postcode locator to provide a practical tool to enable householders to find their local re-use and repair services, and a household Waste Prevention Hub for local authorities to help monitor the benefits of waste prevention activity.

However, while the WPP sets in place useful policies to support waste prevention and plans for indicators, unlike the devolved administrations, there are no targets or milestones in England to evaluate progress other than those from WRAP or EU Directives. There are also no further increases planned for the landfill tax in real terms which may slow down progress on reducing landfill emissions.

Since our 2012 Progress Report we have recommended specific strategies to minimise biological waste going to landfill and widespread separate food waste collection. According to a report by Eunomia, there are net benefits from banning sorted biodegradable waste from landfill, such as paper/card. The timing and sequencing of the bans is important in order to set up the adequate supply chains and infrastructure.[6] The Government has responded that priority should be placed on waste prevention to reduce biodegradable waste sent to landfill, that it did not believe landfill bans were the best way to achieve this goal, and it is for local authorities to decide on provision of separate collection of food waste.[7]

5 Defra. Waste prevention programme for England "One year on" newsletter December 2014. Available at: https://www.gov.uk/

6 WRAP (2012) Landfill Bans: Feasibility Research: *The environmental, economic and practical impacts of landfill bans or restrictions: research to determine feasibility.* Available at http://www.wrap.org.uk/

7 Meeting Carbon Budgets – 2014 Progress Report to Parliament. Government Response to the Sixth Annual Progress Report of the Committee on Climate Change. Available at: https://www.gov.uk/

The Government's 2011 *'Anaerobic Digestion (AD) Strategy and Action Plan for England'* includes a £10 million loan fund to support new AD capacity, and an innovation fund to bring down costs of AD, identify potential sources of waste feedstock, and develop markets for digestate (an AD by-product). Since its launch in June 2011, the number of AD plants has increased from 54 to 140 plants by September 2014. These measures are a positive step towards a long term and sustainable circular economy. They need to feed into overall strategies for reducing methane emissions.

We recommend that Defra should publish, by early 2016: specific actions and clear milestones to further reduce biodegradable waste to landfill and improve methane capture rates at landfill sites. We will review action on this in our 2017 Progress Report.

Scotland

The Scottish Government launched Scotland's first *'Zero Waste Plan'* in June 2010. This includes a number of policies and targets (Table 6.3):[8]

- **Waste sent to landfill.** Scotland's proportion of waste going to landfill increased to 40% in 2012, and so is not in line with plans to reduce the proportion to 5% by 2025. However, total waste collected decreased in 2012, and the tonnage of waste sent to landfill fell by 3.5% to 4.5 million tonnes. From 2015, the Scottish Parliament will have new financial powers on disposals to landfill, following on from the Landfill Tax (Scotland) Act 2014. The Scottish tax is set 10% higher than the UK rate for the first three years.
- **Food and other biodegradable waste.** Scotland is planning to roll out separate food waste collections from 2016 and implement a ban on biodegradable municipal waste going to landfill by 2021.
- **Household waste recycled, composted or reused.** Scotland missed its 2013 interim target of 50%, with estimates suggesting that 43% of household waste was recycled, composted or reused. However, 9 out of 32 of Scotland's councils met the 50% target. There should be an improvement in 2014 when new measures under the Waste (Scotland) Regulations 2012 were introduced. These include bans for various materials sent to landfill from 2014, and requirements for councils to provide recycling services to all households.

In the '*Zero Waste Plan*', Scotland has set a plan to reduce the environmental impact of waste and move towards a circular economy. We recommend that Scotland publish by early 2016: specific actions and clear milestones on how it intends to meet its biodegradable municipal waste going to landfill targets and improve methane capture rates. We will review action on this in our 2017 Progress Report

Wales

In Wales, the reduction in waste emissions follows the introduction of a number of levers encompassing regulatory mechanisms, waste prevention and improvements at landfill. In June 2010, Wales published '*Towards Zero Waste*', an overarching waste strategy, and set statutory targets for waste going to landfill and recycling targets for municipal waste. The Welsh Government is aiming for a circular economy approach to waste, with the aim that by 2050 nothing that could be recycled or re-used is sent to landfill:

- **Municipal waste recycling.** Wales met its 52% waste recycling 2012/13 target; in 2013/14 this rose to 54.3%. This was also the highest recycling figure in the UK and 4th in Europe.
- **Landfill waste.** The Landfill Gas Capture Climate Change Project has decreased emissions (3,400 tonnes of methane and over 60,000 tonnes of CO_2 equivalent). As of 2018, Wales will acquire

8 Scotland's Zero Waste Plan. Available at: http://www.gov.scot/

responsibility for setting its own landfill tax and there is an aspiration for no additional municipal waste landfilled from 2025 as an interim step to zero waste by 2050.

- **Food waste collection.** Data collected from WRAP indicates that 99% of households in Wales now have a separate food waste collection service provided by their local authority, compared to a UK average of 49%.

There are several examples of how Wales' approach to waste has been successful (Box 6.4). This has been helped by continued support groups of local authorities that are working together through the Waste Infrastructure Programme to develop sustainable long term solutions for food waste management and residual (black bag) waste management.

We recommend that Wales should publish by early 2016; specific actions and clear milestones to further reduce biodegradable waste to landfill and improve methane capture rates at landfill sites. We will review action on this in our 2017 Progress Report.

Box 6.4. Successes in Wales' approaches to waste

In Swansea, the number of black bags placed out for collection around the city has reduced more than 25% in 12 months. The reduction has been achieved following the introduction of a three-bag limit, '*Keep it to 3*', by Swansea Council in April 2014. Recycling rates for 2013/14 were 52.8%, up nearly five percentage points from the previous year.

Bridgend was the second worst Welsh local authority for recycling in 2010/11 with 31% of waste recycled. However, it is now in the top six with 56.5% of waste recycled in 2013/14. The change was due to an overhaul in its waste strategy: who runs the service locally, how materials are collected and recycled, and what residents have to do. Residents are given two black boxes and a hessian bag for items to recycle and a brown container for food waste. Recycling is collected every week and other residual waste on a fortnight basis. The scheme is saving the council more than £1 million a year, not including the savings in reduced waste sent to landfill..

Northern Ireland

The '*Northern Ireland Waste Management Strategy*' was published in December 2013 and set various additional targets alongside Waste Regulations (Northern Ireland) 2011:

- **Food Waste Regulations.** These came into force in February 2015, banning landfilling of food waste once collected. The regulations provide for the separate collection and subsequent treatment of food waste and require district councils to provide food waste bins for households. It also places a duty on food businesses from producing in excess of 5kg of food waste per week.
- **Household recycling/reuse.** A target of 50% by 2020, with a proposal to increase the rate to 60%.

Progress has been made with a ban on food waste going to landfill and targets for waste/material recycling and recovery across the economy. We recommend that Northern Ireland should publish by early 2016: specific actions and clear milestones to further reduce biodegradable waste to landfill and improve methane capture rates at landfill sites. We also recommend that Northern Ireland evaluate the impact of the food waste ban. We will review action on this in our 2017 Progress Report.

Table 6.3. Waste targets and progress			
Devolved Administration	**Targets**	**Progress**	**On track**
Scotland	Reduce waste arising by 7% by 2017 and 15% by 2025 against 2011 baseline	In 2012 total waste arising fell by 14%	Yes
	70 % of household waste to be recycled/ composted/reused by 2025, with interim targets for 2013 (50%) and 2020 (60%)	42% in 2013	No
	Recycling 70% of all waste (including commercial and industrial) by 2025	41.5% in 2012	Yes
	Reducing the proportion of total waste sent to landfill to a maximum of 5% of all waste by 2025	In 2012 40% waste sent to landfill, up 5% points from 2011	No
Wales	Municipal waste recycling targets for local authorities: 2012/13 – 52% 2015/16 – 58% 2019/20 – 64% 2024/25 – 70%	52.3% in 2012/13 54.3% in 2013/14	Yes
	27% reduction in waste by 2025 compared to 2006/7, "zero waste" by 2050 i.e. prevented, reused or recycled/composted.	1% reduction in commercial waste by 2012/13 5.5% increase in industrial waste by 2012/13 14% reduction in household waste by 2012/13	Yes
	Construction and demolition waste re-use, recycling and recovery - 90% by 2025	87% in 2012	Yes
Northern Ireland	Household waste recycled/recovered: 2015 – 45% 2020 – 50% 90% of construction and demolition wastes to be subject to material recovery by 2020	40.6% in 2013/14	Yes
Source: SEPA (2014), Welsh Government (2014), NIEA (2015).			

(b) Policy progress to reduce F-gas emissions

Progress in the EU

Two EU policies are currently in place to reduce F-gas emissions: the Mobile Air Conditioning (MAC) Directive and EU F-gas Regulation. While the former focuses on air conditioning in cars and vans, the latter focuses on the cross-cutting use of F-gases:

- The MAC directive came into force in 2011. It prohibits the use of F-gases with a GWP more than 150 times higher than CO_2 in air conditioning units in new types of cars and vans introduced from 2011 and in all new cars and vans produced from 2017.

- The EU 2015 F-gas regulation replaced 2006 EU regulation and applies from 1 January 2015. This regulation introduces a number of new measures together with strengthening of existing measures:
  - It reduces the quantities of HFCs that producers and importers are allowed to place on the EU market. The reduction starts with the initial cap in 2015 based on the annual average of the quantities in the market between 2009 and 2012. Producers will receive maximum emission quotas based on their previous performance. The allowed emissions will be reduced sequentially, starting with a 7% cut in 2016 and reaching a 79% cut by 2030. Some HFCs applications are exempted: use of HFCs in military equipment, semiconductor manufacturing sector, metered dose inhalers and feedstock. These exemptions represented at least 5% of total UK HFCs emissions in 2013.
  - For new equipment, the regulation introduces a series of bans on the use of F-gases covering cross-cutting areas. In addition to bans that were originally stated in 2006 regulation, new bans include:
    - Domestic refrigerators and freezers with GWP above 150 from 2015,
    - Refrigerators and freezers for commercial use with GWP above 2,500, from 2020, followed by a ban in 2022 for use of HFCs with GWP above 150,
    - Air conditioning systems containing less than 3kg of refrigerant with GWP above 750, from 2025.
  - For existing equipment, there is a ban on using HFCs with a GWP above 2,500 for the maintenance and servicing of existing refrigeration equipment from 2020.
  - There is some strengthening of existing obligations related to leak checking and repairs, F-gases recovery and technician training.

The EU 2015 regulation focuses mainly on reducing GHG emissions from the use of HFCs with some areas being exempted. The PFCs and SF_6 gases are not subject to the phase out but are likely to be affected by other parts of the regulation. As yet, it is not possible to assess the effect of the new regulation on UK F-gas emissions. DECC is planning to model the impact later this year and we will examine this further in our 2016 Progress Report.

Progress in the UK

The EU 2015 F-gas regulation has been in force since January 2015 as it is directly applicable in the UK. The Government has consulted on a domestic statutory instrument that would allow the enforcement and penalty provisions of the new regulation. This new enforcement regulation has been in force since March 2015, including the following:

- Powers for customs officers to impound unlawfully imported material.
- Powers for the enforcement bodies, such as the Environment Agency, to issue compliance notices for failure to comply with the requirements of the EU regulation.
- Appointment of the bodies which certify companies and train individuals to handle F-gases.

We will review the effectiveness of the regulation in future progress reports.

Some other countries in the EU have gone beyond the current legislation (Technical Annex 6). The UK should examine where there are opportunities to find cost-effective abatement beyond the regulatory minimums and pursue options to deliver that.

4. Summary

(a) Waste

There has been good progress in reducing GHG emissions from wastes, with biodegradable waste going to landfill reducing and new methane capturing technologies lessening its emission impact. However, the biodegradable waste going to landfill today will still be emitting GHG emissions in years to come. Action needs be taken at every step along the waste chain including prevention, recycling, recovery, collection & disposal and landfill management.

Action is required in three key areas:

- **Low-carbon investment**. Investment in methane capturing technology has been one of the main causes of the fall in emissions, stimulated by permit regulations and financial incentives. Waste can be used as an energy source that can reduce demand for other fuels in other sectors. The number of anaerobic digestion units has nearly tripled in the UK since 2011, and continued policy support is vital to their growth. For biological waste already in landfill, the publication of project ACUMEN provides a suitable point to consider future action to increase methane capture at closed landfill sites.
- **Developing future options and innovation**. Finding new ways to improve product design or resource use within supply chains can prevent waste from occurring and save money for businesses and households. Where waste is inevitable innovations, such as results of the three year study in project ACUMEN and more detailed methane emission measurement, will improve landfill management and reduce emissions.
- **Low-carbon choices**. Attitudes and behaviour towards resources and what we consider waste will be essential to the innovation and investment highlighted above. They run all the way through the waste hierarchy, in reusing resources where we can, separating and collecting for use in other sectors, disposing as little as possible in landfill and then ensuring we minimise its environmental impact.

(b) F-gases

Unlike other emissions, F-gases emissions have increased over the last 15 years. New EU regulation on F-gases should reverse this trend over time. To ensure progress is made, action is needed in the following areas:

- **Low-carbon investment**. The EU 2015 F-gas legislation will require new investment in sectors affected by the phase down and new bans. For example, the European Commission (EC) impact assessment found that:[9]
  - The overall barrier preventing the switch to low-carbon technologies was the higher initial investments needed.
  - Looking at operators investing in new equipment, centralised systems of commercial refrigeration would incur highest costs, followed by bus air conditioning systems and single-split room air conditioning.
  - As for companies servicing F-gas equipment, the use of low-GWP alternatives will likely require initial investments in training as the new substances may be more flammable and used at higher pressures.

9 European Commission *Impact Assessment (2012)*. Available at http://ec.europa.eu/clima/policies/f-gas/legislation/documentation_en.htm

- **Developing future options and innovation**. The new legislation could drive innovation of UK F-gases producers in the areas of main focus, such as domestic and commercial refrigeration or air conditioning (RAC) products:
  - For instance, Denmark has introduced a series of taxes and bans on F-gases since 2000, resulting in an overall fall in F-gas emissions coupled with a substantial increase in natural refrigerants in RAC equipment.
  - It is probable that the areas exempted from the phase-down (e.g. metered dose inhalers) will not see sufficient levels of innovation in driving the GHG emissions down over the coming years.
- **Low-carbon choices**. The strengthening of obligations on leak checking, repairs, recovery and training will need behavioural changes from those installing or servicing the equipment using F-gases:
  - The legislation requires employers to ensure employees are properly certified for leak checking, installation, servicing or recovery of equipment.
  - The use of alternative technologies using high pressure or flammable substances will need to introduce new ways of maintaining the equipment.
  - There appear to be significant cultural barriers around the use of natural refrigerants as alternatives for F-gases.[10] These include a lack of awareness and acceptance or misconceptions about the natural refrigerants solutions.

Waste and F-gases are two relatively small sectors for GHG emissions. However, absolute emission reductions may be easier and more cost effective than in some other sectors.

10 Shecco (2012). GUIDE 2012: *Natural refrigerants – market growth for Europe*. Available at http://guide.shecco.com/

Chapter 7: Devolved administrations

1. Emission trends and progress towards targets
2. Power sector
3. Buildings
4. Industry
5. Transport
6. Agriculture and land use
7. Waste
8. Forward look
9. Summary

Key messages and recommendations

The devolved administrations have an important role to play in achieving the UK's carbon budgets. Emissions data broken down for each devolved administration is produced one year later than the UK data. In this chapter we use the recently published data for 2013, unlike the rest of the Progress Report which is based on 2014 data.

Emissions in Scotland, Wales and Northern Ireland account for 22% of UK emissions (9%, 9%, and 4% respectively in 2013, the latest year for which data is available), while they account for 16% of the UK's population and 13% of GDP.

They have each adopted their own ambitious targets for reducing emissions. Scotland has passed its own Climate Change Act and has legislated annual targets, while in Wales and Northern Ireland targets have been set by the devolved governments. In Wales, the proposed Environment Act (2016) provides for reduction targets and carbon budgets.

They have (fully or partially) devolved powers[1] in a number of areas relevant to carbon reductions, with powers varying by nation. Key areas of devolved powers include transport demand-side measures, energy efficiency, agriculture and land use, and waste. It is expected more powers will be devolved. The devolved administrations also have an important role implementing UK policy (such as renewable energy deployment[2]) through the provision of additional incentives and their approach in areas such as planning consents.

The devolved administrations are often leading the UK with innovative policies and effective implementation. Increasingly, examples of good practice and lessons about what works are being shared among the UK nations.

In this chapter, we highlight progress towards emission reductions in each main sector and highlight a number of areas of good practice.

Our key messages are:

Emissions:

- In 2013, emissions fell in Scotland by 3.8%, rose in Wales by 10.3% and remained approximately unchanged in Northern Ireland, compared to a reduction of 2.4% across the UK. In Scotland, emissions reduced in the power, transport and waste sectors. The large emissions increase in Wales was primarily due to a 54% increase in emissions at the Port Talbot steelworks. However, non-traded sector emissions, where the Welsh Government has more devolved powers, decreased 1%.
- Scotland is leading the UK in emission reductions with a 35% reduction since 1990, compared to 12% in Wales, 16% in Northern Ireland and 30% at a UK level.
- The devolved administrations have their own targets to reduce emissions. Scotland, although leading emission reductions, has failed to meet its first four statutory annual targets, which have been set separately to the UK carbon budgets. Inventory changes beyond the Scottish Government's control have made the Scottish annual targets increasingly difficult to achieve as they are set on an absolute basis. However, Scotland is on track to meet its target to reduce emissions 42% by 2020. Wales' progress to meeting a 40% reduction by 2020 and Northern Ireland's progress to meeting a 35% reduction by 2025 are currently falling short of the reductions required.

1 Technical Annex 7 – Devolved administrations, Table 7.1.
2 Energy is completely devolved in Northern Ireland.

Key messages and recommendations

Progress:

- In some policy areas the devolved administrations lead the UK with stronger targets and additional allocated funding. This is particularly notable in residential energy efficiency and programmes to reduce emissions from waste.
- *Energy efficiency and fuel poverty*: the devolved administrations operate tax-payer funded schemes to tackle fuel poverty in addition to the supplier obligations. These often focus on area-based delivery, working with local authorities.
- *Waste*: Ambitious household waste recycling targets have been set in the devolved administrations. Wales met its target for 52% of household waste to be recycled in 2012/2013, although Scotland missed its second, 50%, target in 2013. Northern Ireland is progressing towards its 2015 target of 45%. By contrast, England does not have a target and recycled 44% of waste in 2013.
- The devolved administrations are also making good progress in renewable electricity capacity, accounting for 40% of the UK's total capacity in 2014. However, progress in renewable heat deployment is slow and targets are not being met.

Recommendations:

Stronger action will be required in key areas in order to meet future targets:

Scotland: The Committee produces a stand-alone annual Progress Report for the Scottish Government based on extensive analysis of progress in Scotland against its own climate targets.[3] The most recent report was published in March 2015 and included a number of recommendations. The key recommendations were:

- **Consider further action to facilitate heat networks:** for example obliging local authorities to connect to existing local networks and requiring consideration of network heat in new developments.
- **Evaluate current energy efficiency schemes:** focus particularly on area-based schemes to better understand the most effective way to implement supplier obligations once they become devolved.
- **Improve evidence on agricultural abatement:** to include what has worked under "Farming for a Better Climate" and whether its measures have been taken up beyond the focus farms.

Wales:

- **Develop a heat strategy:** build on UK evidence and approach to develop clear heat strategy for Wales including a renewable heat target.
- **Prepare for higher ambition required of industry:** plan ways to reduce industry emissions, including consideration of voluntary partnership agreements with industry[4] and encouraging innovative solutions.

3 CCC (2015) *Reducing emissions in Scotland 2015 Progress Report* http://www.theccc.org.uk/wp-content/uploads/2015/01/Scotland-report-v6-WEB.pdf

4 The Scottish Government has recently published a new heat strategy which we will examine in our March 2016 Progress Report.

5 Voluntary agreements are ways through which governments and an organisation can explore opportunities for reducing environment and heritage impacts in ways that create prosperity and well-being.

Key messages and recommendations

- **Address non-financial barriers for electric vehicles:** including further measures which could be implemented such as parking, use of priority lanes, raising awareness and public procurement.
- **Meet tree planting targets:** consider whether further measures are needed to ensure tree planting targets are met, and develop approach jointly with stakeholders and other DAs.

Northern Ireland:

- **Consider further action to facilitate heat networks:** for example obliging local authorities to connect to existing local networks and requiring consideration of network heat in new developments.
- **Improve monitoring of agricultural emissions:** following Defra's delivery of the Smart inventory, put in place local monitoring and process for acting on its findings.
- **Address non-financial barriers for electric vehicles:** including further measures which could be implemented such as parking, use of priority lanes, raising awareness and public procurement.

We set out the analysis that underpins these points in 9 sections:

1. Emission trends and progress towards targets
2. Power sector
3. Buildings
4. Industry
5. Transport
6. Agriculture and land use
7. Waste
8. Forward look
9. Summary

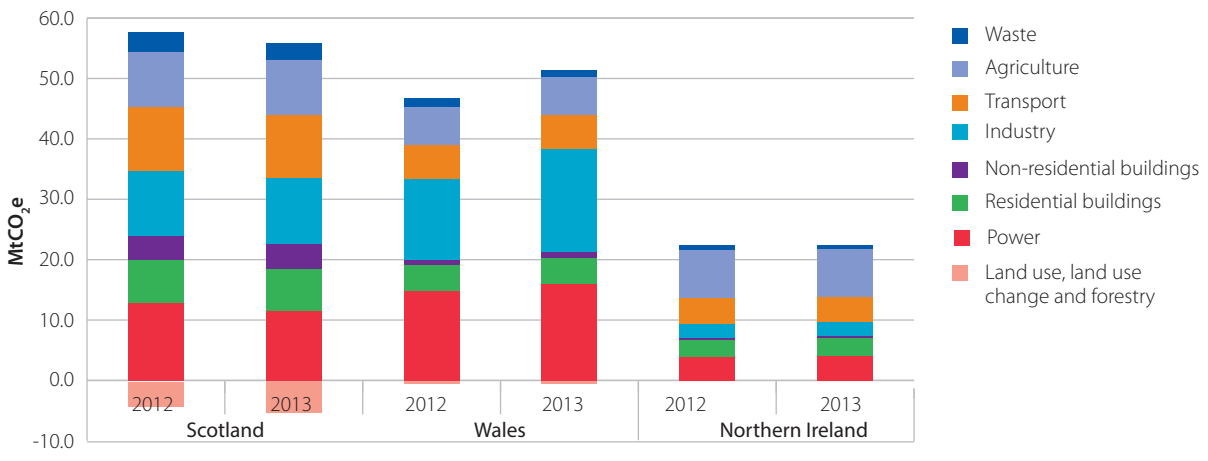
1. Emission trends and progress towards targets

The latest UK emissions data considered elsewhere in this report are for 2014, but the latest data available for the devolved administrations are for 2013. We focus in this section on analysis of the change in emissions from 2012 to 2013[6], as well as an overview of average annual emission changes since the recession (2009-2013).

UK-wide, greenhouse gas emissions decreased 2.4% between 2012 and 2013, with an average decrease of 1.0% per year between 2009 and 2013 (Overview Chapter). In the devolved administrations (Figure 7.1), Scottish emissions fell further in 2012 (3.8%) with an average decrease of 2% per year between 2009 and 2013, while Wales' emissions increased (10.3%) with an average increase of 3% per year between 2009 and 2013. Northern Ireland emissions remained broadly the same (a 0.05% increase).

Scotland, Wales and Northern Ireland account for 22% of UK emissions (9%, 9% and 4% respectively) in 2013 (Table 7.1) while they account for 16% of the UK's population and 13% of GDP.

Figure 7.1. Greenhouse gas emissions in devolved administrations by sector (2012 and 2013)



Source: NAEI (2015).
Note: Emissions are presented here before accounting for trading in the EU ETS, and do not include emissions from international aviation and shipping

In **Scotland**, total emissions fell to 50.6 $MtCO_2e$ due to a switch from coal to low-carbon fuels in power generation. Emissions since 1990 have fallen 35.3%, the largest reduction in the UK. However, Scotland missed its legislated target in 2013[7]. Revisions to the inventory since the Scottish targets were set in 2010 have made achieving the annual targets more challenging. In 2013:

- There were strong falls in emissions from the waste (15.7%) and power (10.8%) sectors, whilst the emissions sink from land use, land use change and forestry (LULUCF) increased by 3.4% .
- There were increases in emissions in non-residential buildings (3.3%), and small increases in industry (0.1%) and agriculture (0.3%).
- Scotland's targets are set on a net basis- taking gross emissions (including international aviation and shipping) and then adjusting to take account of sales and purchases in the EU ETS. For 2013, the Scottish target was 47.976 $MtCO_2e$ compared to a Net Scottish Emissions Account of 49.7 $MtCO_2e$. As a result, Scotland missed its legislated annual target for the fourth successive year.

6 Unless stated emissions data do not account for trading in the EU ETS and do not include emissions from international aviation and shipping.
7 Scotland's targets account for trading in the EU ETS and include international aviation and shipping.

  - Scotland's 42% reduction by 2020 target is within reach. In 2013, emissions (including international aviation and shipping and adjusting for trading in EU ETS) reduced by 38.4% compared to 1990.
  - The latest revisions to the inventory have added 5 $MtCO_2e$ to baseline emissions and 2 $MtCO_2e$ to 2012 emissions, with at least that much in every other year since the baseline year. Although emission estimates have been adjusted, the annual targets are absolute and fixed in legislation.

- In **Wales, total** emissions rose to 50.8 $MtCO_2e$ driven by a marked rise in emissions from industry (27.9%) and power (8.4%). This reflected an increase in emissions from steelworks in Wales and a change from gas to coal in power generation. However, non-traded sector emissions, where the Welsh Government has more devolved powers, decreased 1% in 2013. Wales has set an annual emission reduction targets and a 2020 reduction target which is now more challenging to achieve:
  - Wales has a target to reduce greenhouse gas emissions by 40% from 1990 levels by 2020. In 2013, emissions were 12% lower than in 1990 (compared to 30% for the UK). On the basis of progress to date, the 40% target by 2020 is likely to be missed. There has been significant progress across a number of sectors (e.g. waste and non-residential buildings) but emissions from the power sector have increased by 42% since 1990. This partly reflects the importance of individual power and industry installations at a devolved level (e.g. changes in production at Tata Steelworks in Port Talbot can have a large impact on emissions in Wales).
  - Wales has a cumulative target to reduce annual emissions by 3% (against 2006-2010 baseline) in areas of devolved responsibility: transport, resource efficiency and waste, business, residential, agriculture and related land use, and public sector. In 2012 (the second target year), Wales achieved a 10% reduction against the baseline. Even though overall greenhouse gas emissions increased in 2013, this target is likely to have been achieved again given the reduction in non-traded sector emissions in 2013 and given the out performance against the 2012 target. The Welsh Government will publish its assessment of performance in 2013 later in 2015.
- In **Northern Ireland**, emissions in 2013 remained around the same as 2012 levels (a slight 0.05% increase). Northern Ireland's emission reduction target is lower than the Scottish and Welsh targets, reflecting the larger share of emission from difficult to reduce sectors (in particular agriculture).
  - Emissions in 2013 were 22.4 $MtCO_2e$. Emissions rose in the power (4.7%), residential (3.0%) and industry (3.2%) sectors reflecting an increased demand for heating with colder temperatures at the beginning of the year and a switch from gas to coal for power generation.
  - Emissions fell in the waste (13.3%), non-residential buildings (5.2%), and transport (1.2%) sectors. The land use, land use change and forestry (LULUCF) sector, which is a net emitter in Northern Ireland, has also decreased by 7.2% since 2012.
  - Northern Ireland has a target to reduce emissions by at least 35% compared to 1990 levels by 2025. In 2013, emissions in Northern Ireland were 16% below their 1990 levels. According to projections of emissions from the Northern Ireland Executive, this progress is falling short of what is required in order to meet the 2025 target.

Overall, emissions rose 2.3% collectively in the devolved administrations in 2013. The differing rates of reduction and rises across the countries in part reflect the relative importance of different sectors (Figure 7.2) at the devolved level.

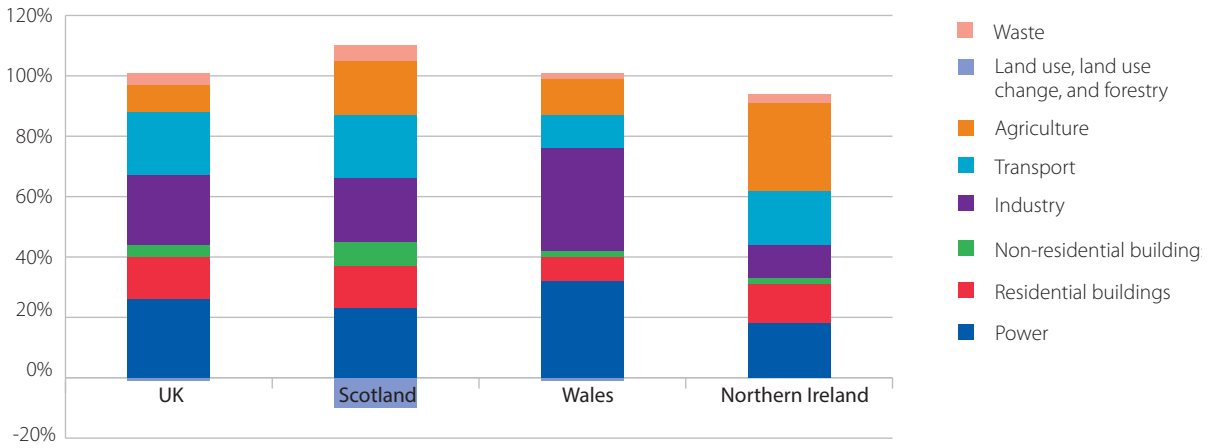
Emissions fell sharply for the UK as a whole in 2014 (Overview Chapter). Data for the devolved administrations are not yet available, but the trends in other areas (e.g. above average temperatures, increase in use of renewables, roll-out of energy efficiency, and GDP growth) suggest the reduction in emissions is likely to be similar in the nations.

Table 7.1. Devolved administrations' emission targets and progress

	Targets/milestones – reductions from 1990 baseline	% of UK emissions	Emissions change 1990-2013	Average annual emission change 2009-2013
Scotland	42% by 2020 (inc. IA&S)	9%	35.3% reduction 38.4% reduction including International aviation and shipping and accounting for EU ETS	2% reduction
Wales	40% by 2020	9%	12.1% reduction	3% increase
Northern Ireland	35% by 2025	4%	16.0% reduction	0%
UK	34% by 2020	-	30.2% reduction	1% reduction

Source: NAEI (2015)
Note: The latest UK emissions data considered elsewhere in this report are for 2014, but the latest data available for the devolved administrations are for 2013. This data (unless stated) does not account for trading in the EU ETS and does not include international aviation and shipping.

Figure 7.2. Greenhouse gas emissions in the devolved administrations by sector contributions (2013)



Source: DECC (2014).

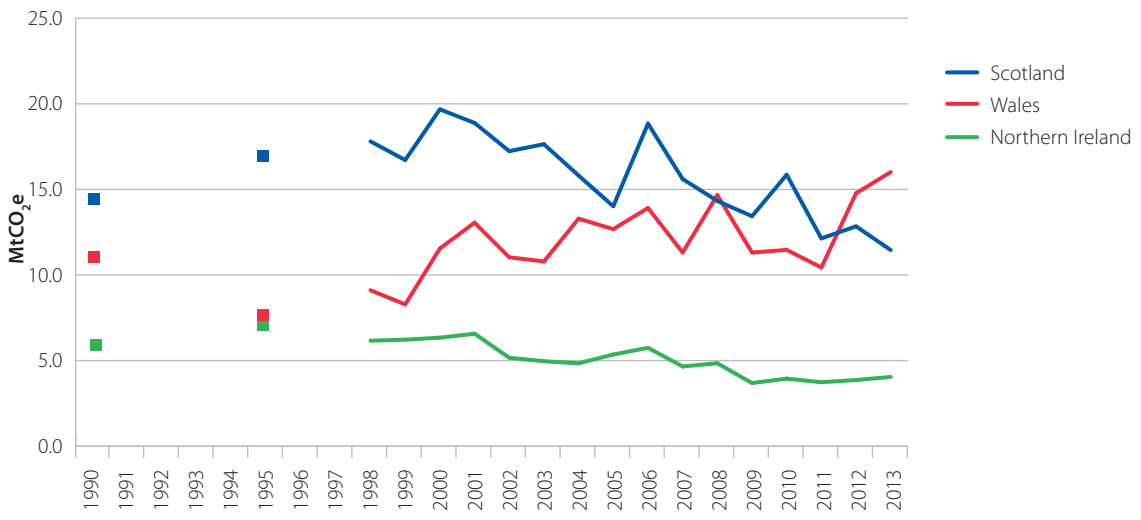
2. Power sector

(a) Emissions and electricity generation trends

Power sector emissions fell in Scotland in 2013, in line with a fall in England and the UK as a whole, but rose in Wales and Northern Ireland (Figure 7.3) due to changes in the fuel mix (Figure 7.4).

- In **Scotland**, emissions fell 10.8% in 2013 with an average annual decrease of 3.1% between 2009 and 2013. Power sector emissions account for 23% of total Scottish emissions. They have fallen 23% since 1990 levels.
- In **Wales**, emissions rose 8.4% with an average annual rise of 7.2% between 2009 and 2013. Power sector emissions account for 32% of total Welsh emissions, and are 42% higher than 1990 levels.
- In **Northern Ireland**, emissions rose 4.7% with an average annual rise of 1.9% between 2009 and 2013; however emissions are 24% less than 1990 levels. The sector accounts for a 13% share of total Northern Irish emissions.

Figure 7.3. Power sector emissions in Scotland, Wales and Northern Ireland (1990-2013)

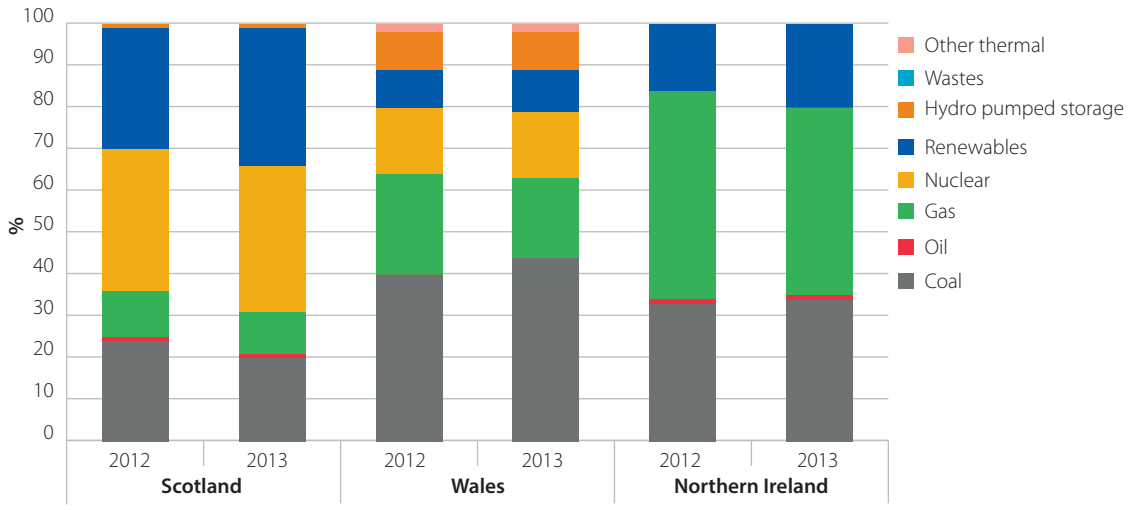


Source: NAEI (2015).
Note: No inventory data are available for devolved adminstrations for 1991-1994 or 1996-1997

Table 7.2 highlights the changes to emissions and power generation between 2012 and 2013. Emissions fell in Scotland despite generation increasing 5%. This is due to a decrease in carbon-intensive fuels for generation such as coal (9% fall), with the closure of Cockenzie power-station in early 2013, and a rise in renewables (16%) and nuclear (8%).

In Wales and Northern Ireland, there was a rise (9% and 30% respectively) in renewable generation. However, there were also increases (6% and 10% respectively) in coal generation, perhaps reflecting fuel-switching due to increased gas prices and reduced coal prices. Coal is now the main fuel used to generate electricity in Wales.

Figure 7.4. Proportion of generation by fuel type in Scotland, Wales and Northern Ireland (2012 and 2013)



Source: DECC (2014).

Table 7.2. Power sector emission and generation changes (2012-2013)

DA	Emissions	Overall electricity generation	Renewable generation	Nuclear generation	Coal generation	Gas generation
Scotland	-11%	+ 5%	+ 2.4 TWh (16%)	+ 1.5 TWh (8%)	- 1 TWh(-9%)	- 0.2 TWh (-3%)
Wales	+8%	- 1%	+ 0.2 TWh (9%)	+ 0.2 TWh (4%)	+ 0.7 TWh (6%)	- 1.3 TWh (-21%)
Northern Ireland	+5%	+ 5%	+ 0.4 TWh (30%)	N/A	+ 0.2 TWh (10%)	- 0.2 TWh (-5%)

Source: NAEI (2015), DECC (2014)

At the UK level, emissions fell 7% in the power sector between 2012 and 2013, with an average annual decrease of 0.6% between 2009 and 2013. This reflects a fall in demand for electricity and a reduction in the carbon intensity of electricity supply. While Scotland saw a stronger fall in emissions than at the UK level, the increase in emissions from the power sector in Wales and Northern Ireland was in contrast to the UK trends. This highlights the larger impact of individual installations at the devolved level, with the closure or change in production of one plant able to significantly affect the overall picture.

(b) Progress and policy on renewable electricity

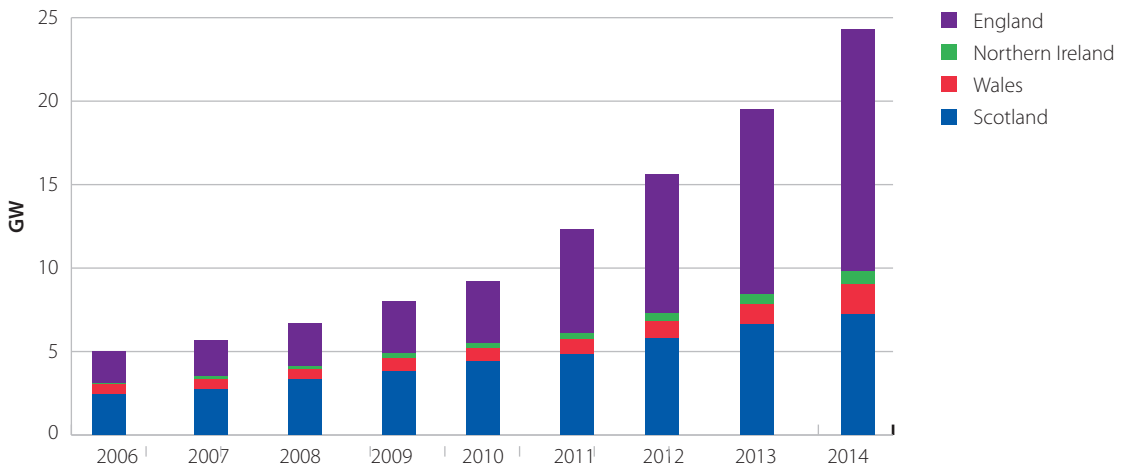
There has been ongoing progress in the deployment of renewable electricity across the devolved administrations (Figure 7.5), which in 2014 together accounted for 40% of UK renewables capacity. The devolved administrations each have targets or milestones for renewables (Table 7.3):

Table 7.3. Renewables targets and progress

DA	Renewables target	Progress in 2014	On track
Scotland	Equivalent of at least 100% of gross electricity consumption to be delivered from renewables by 2020.	7.2 GW installed capacity, 10% increase from 2013. Generation from renewables was equivalent to 49.6% of Scotland's gross electricity consumption. This was an increase from 44.4% in 2013 and means the 2015 interim target of 50% is very likely to be met. In 2014, Scottish generation accounted for 30% of total UK generation.	Yes
Wales	Aspiration totalling 22.5 GW of installed capacity from different renewable energy technologies by 2020/2025[7] Technical Advice Note (TAN) on Renewable Energy 2005 target of 7,000 GWh per year by renewable electricity by 2020.	1.8 GW installed capacity, 53% increase from 2013. In 2014 generation from renewables was 3,400 GWh, a 29% increase from 2013.	Renewable Energy technologies aspirations – not on track. TAN target – on track.
Northern Ireland	Meet 40% of electricity consumption from renewable sources by 2020, with interim targets for 20% in 2015.	0.8 GW installed capacity, 17% increase from 2013. Generation from renewables was equivalent to 19.0% of Northern Ireland's gross electricity consumption in 2013/2014. This was an increase from 17% in 2012/2013. The 2015 interim target is likely to be met.	Currently yes, however future capacity looks uncertain.

Source: DECC (2015), Scottish Government (2015), DETINI (2014).

Figure 7.5. Renewable deployment in the UK (2006-2014)



Source: DECC (2015).

8 Welsh Government (2010) *A Low Carbon Revolution* http://www.mng.org.uk/gh/resources/100315energystatementen.pdf

- In **Scotland**, the Government is on track to meet its 2020 target. The average rate of deployment from 2015 onwards will need to increase to 1.4GW per year to bring the total capacity to between 14 and 16 GW. This is higher than the maximum achieved in any year to date. However, if the projects which are currently under construction or consented (8.9 GW) are built, then this capacity will be achieved and the target met.

  Alongside the Renewables Obligation (RO) and Contracts for Difference (CfD), (Chapter 1) Scotland has additional smaller-scale instruments to finance renewable projects which contribute to meeting renewable targets. These include the Renewable Energy Infrastructure and Innovation Fund and the Highlands and Islands Enterprise investment fund (£18.8 million funding for 2014-2016). They have contributed to success in deploying locally and community owned renewable energy.

- In **Wales**, large infrastructure planning is a reserved matter, so decisions over projects greater than 50 MW are decided by the UK Planning Inspectorate. The Silk commission on devolution in Wales recommended that powers over large-scale energy consents (between 50 MW and 350 MW in size) become devolved to the Welsh Government by 2020. Small-scale developments can be decided upon locally, with funding provided through the GB Feed in Tariff (FiT).

  – Wales does not have targets for renewable capacity but has an aspiration for 22.5 GW by 2025. In order to achieve this aspiration, a further 20.7 GW capacity will need to be installed through a variety of technologies. The number of projects in the pipeline currently is not sufficient and the ambition is unlikely to be achieved.

  – The Technical Advice Note (TAN) 8[9] target to produce 7,000 GWh from renewables by 2020 is likely to be met. A further 1.9 GW of capacity will be required by 2020. As of March 2015, there are 1.4 GW of projects in the pipeline, either consented or under construction, and a further 1.1 GW submitted for planning consideration.

  – The Government is currently considering a CfD for a tidal lagoon in Swansea Bay, with 320 MW installed capacity (Box 7.1). Plans for further lagoons (e.g. Colwyn Bay in North Wales) have the potential to deliver low-carbon power for the UK. We will examine the role of tidal lagoons in more detail in our 5th Carbon Budget advice which will be published by December 2015.

- In **Northern Ireland,** the success of renewable electricity development has, according to Department of Enterprise, Trade and Investment (DETI),[10] been due to the support provided by the Northern Ireland Renewables Obligation (NIRO) which operates in tandem with funding from GB-wide schemes. It is estimated that to meet the 40% 2020 target, installed capacity will need to be between 1.5 and 1.8 GW, an increase of at least 0.7 GW from 2014 capacity. In 2014:

  – Solar PV capacity in Northern Ireland has increased 120% and is expected to rise further as the cost of installation continues to reduce;

  – Currently, onshore wind dominates renewable energy capacity, and there are no offshore wind farms. In 2014, 92% of renewable electricity generated was from onshore wind. A number of onshore planning applications are currently in the pipeline.

9 Technical Advice Notes are advice to developers and decision-makers. TAN 8 in Wales is one which provides guidance on land use planning with relation to renewable energy and sets a target for renewable generation.

10 DETI (2010) Energy *A Strategic Framework for Northern Ireland* http://www.detini.gov.uk/strategic_energy_framework__sef_2010_-3.pdf

– In order to achieve a 40% target, at least 600 MW of offshore energy will be needed.[11] In 2014, it was announced that the developers of the First Flight Wind project off the east coast of Northern Ireland were abandoning plans for a 600 MW wind farm due to an unfavourable regulatory process and insufficient development incentives.

Box 7.1. Swansea Tidal Lagoon

Tidal power could be an energy opportunity for the UK. The proposed 320 MW six-mile horseshoe-shaped sea wall scheme in Swansea Bay could generate around 500 GWh of electricity per year, enough to power almost 120,000 homes. It would capture incoming and outgoing tides behind the sea wall and use the weight of the water to power turbines. The scheme could also lead to construction jobs and a new assembly plant in south Wales for under-water turbines.

The cost of generation from the Swansea project will be high (the company are asking for £168 per MWh generated), but the developers have plans for five subsequent lagoons which they believe will produce electricity more cheaply (£90-£95 per MWh). Three of the other proposed lagoons sites are in Wales: Cardiff, Newport and Colwyn Bay. The other two are in Bridgwater in Somerset and West Cumbria.

The project was granted planning permission in June 2015. Negotiations are currently taking place with DECC to establish whether a Contract for Difference for Swansea Bay Tidal Lagoon project is affordable and value for money.

The RO and NIRO are being replaced by CfDs for large-scale renewable power generation. The CfD is a competitive scheme and it cannot be known in advance what proportion of contracts will be allocated to each nation. Under CfD's, least cost projects are contracted but if those are not in the devolved administrations then it is harder to provide targeted funding for specific projects. For example Outer Moray Firth failed to secure a contract in the first CfD auctions in February 2015, but can bid into subsequent auctions. Northern Ireland is currently not part of the GB small-scale Feed-In-Tariff and following planned closure of the NIRO, DETI is in discussions with DECC on how they can be integrated into the FIT. A review will be finalised by the end of 2015.

Scotland is leading the devolved administrations in terms of deployment of renewable power capacity and meeting their ambitious targets. Northern Ireland is making progress in solar PV and Wales is at the forefront of tidal lagoons. However, more could be done in Northern Ireland and Wales to ensure their own targets are met and contributions are made towards wider EU and UK targets. The devolved administrations should continue to learn from each other and make use of the powers and capacities available for promoting and demonstrating renewable energy, signifying commitment to investments and undertaking a mediating role between stakeholders.

3. Buildings

(a) Emissions from residential buildings

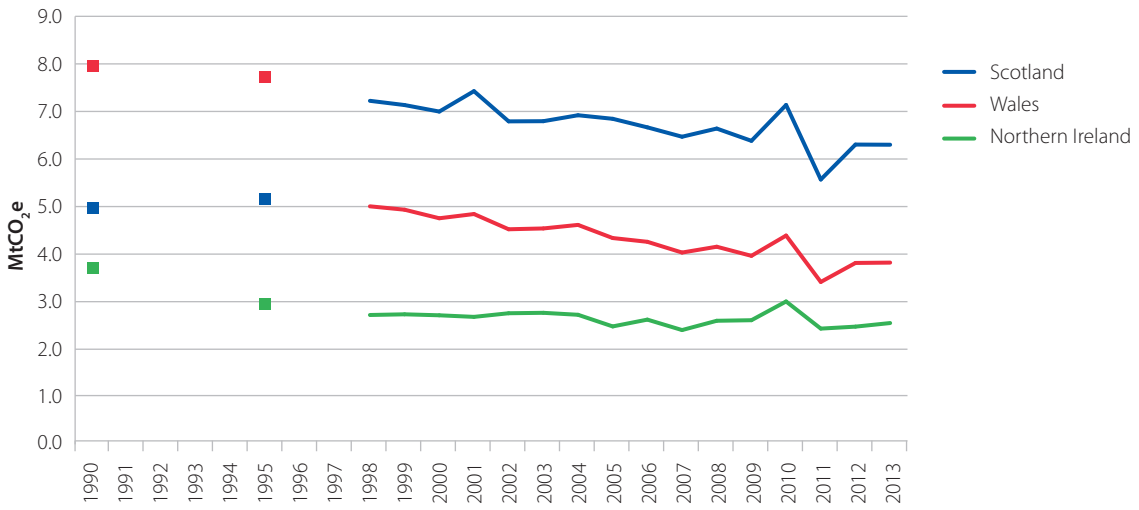
Direct residential emissions remained the same in Scotland in 2013 compared to 2012, but rose in Wales and Northern Ireland (Figure 7.6). This was similar to the overall UK trend (0.4% increase in 2013) and reflects an increase in the demand for heating during 2013 due to colder than average temperatures early in the year.

- In **Scotland,** emissions from residential buildings remained the same as in 2012. Emissions were 14% of all emissions and 13% lower than 1990 levels. Between 2009 and 2013 emissions decreased on average 0.3% per year.

11 DETI (2011) *Draft Onshore Renewable Electricity Action Plan 2011-2020* http://www.nigridenergysea.co.uk/wp-content/uploads/2011/10/Draft-OREAP-Oct-2011.pdf

- In **Wales**, emissions from residential buildings rose 0.2% but decreased 0.7% per year on average between 2009 and 2013. Emissions were 9% of total Welsh emissions and 16% lower than 1990 levels.
- Emissions from residential buildings in **Northern Ireland** rose 3% in 2013, but decreased 0.5% per year on average between 2009 and 2013. The sector accounted for 13% of total emissions in 2013, and emissions were 25% lower than in 1990.

Figure 7.6. Residential emissions in Scotland, Wales and Northern Ireland (1990-2013)



Source: NAEI (2015).
Note: No inventory data are available for devolved adminstrations for 1991-1994 or 1996-1997

(b) Low-carbon heat

Scotland and Northern Ireland each have targets for renewable heat (Table 7.4); Wales currently has no heat strategy or heat targets.

Table 7.4. Low-carbon heat targets and progress

DA	Target	Progress in 2013	On track
Scotland	Source 11% of heat demand from renewable sources by 2020, and a largely decarbonised heat sector by 2050. Interim target of 3.5% in 2012.	In 2013, 0.66 GW operational with an output of 2.9 TWh. The latest estimate of heat demand is for 2012 when renewable heat generation equated to 3% of Scotland non-electrical heat demand.	No
Wales	-	-	-
Northern Ireland	4% of total heat consumption to be provided by renewable sources by 2015 and 10% by 2020.	In October 2014, 0.3 TWh of renewable heat was operational. Latest data on consumption is for 2010 when renewable heat generation equated to 1.7% of demand.	No

Source: Energy Saving Trust (2014), DECC (2014), DETI (2014)

In **Scotland**, the 2020 target does not look likely to be met. The current pipeline of projects is not sufficient to produce 11% of non-electrical heat demand from renewables in 2020. There is also uncertainty over the 65 MW Markinch Biomass CHP Plant in Fife, currently the largest biomass plant in the UK, as the paper mill supplied with heat from the scheme fell into administration in April 2015.

In **Wales**, data from a baseline study of renewable energy[12] showed that in 2012, there was almost 60MW of renewable heat capacity in Wales, with a potential to generate 166 GWh of heat per year. This equates to 0.3% of heat demand in Wales.

In **Northern Ireland**, targets are also off-track. Local biomass supply is very limited. Biogas from Northern Ireland's extensive farming industry, however, could be developed further.

The main renewable heat scheme in the UK is the Renewable Heat Incentive (RHI). It is GB-wide, and provides payments to those who generate and use renewable energy to heat their buildings. Both Scotland and Wales have performed well compared to the GB-average in terms of installations under the RHI:

- The non-domestic scheme has run since November 2011 and focuses on the industrial and commercial sectors. By March 2015, the scheme had supported around 2,100 MW of installed capacity, of which 21% was in Scotland and 9% in Wales. These are greater proportions than would be expected based on a GVA share (8% and 3% respectively).
- The domestic scheme was launched in April 2014. By March 2015, the scheme had supported over 30,600 accreditations, of which 19% were in Scotland and 7% in Wales. These are higher proportions than would be expected from shares of the GB housing stock (9% and 5%, respectively) but does reflect Scotland and Wales' larger share of off-grid homes.

To support the development of low-carbon heat in Northern Ireland, the Executive has introduced its own RHI and Renewable Heat Premium Payment (RHPP) schemes. These operate in the same way as they do at a GB level:

- The RHPP scheme was launched in May 2012 for domestic customers as an interim measure for households in advance of a full domestic RHI scheme. By October 2014, it had provided £2.7 million of funding and incentivised 1,100 renewable heat installations with an installed capacity of 20MW
- The RHI scheme was launched for non-domestic customers in November 2012. Up to October 2014, there were 295 applications and 171 accredited installations with an installed capacity of 18MW.

Scotland also has its own policies to encourage the uptake of renewable heat:

- The Scottish Government published a Heat Policy Statement (HPS) in June 2015, setting out its approach to working towards decarbonising the heat system. It designates energy efficiency as a National Infrastructure Priority, with Scotland's Energy Efficiency Programme (SEEP) providing support to all buildings. The statement also includes a target for district heating, to have 1.5TWh of heat by 2020 and 40,000 homes connected by 2020. Funding includes:
  - The District Heating Loan Fund which provides loans of up to £400,000 per project for low-carbon and renewable technologies. There is a further £8 million of funding for the scheme between 2014 and 2016;
  - The Home Energy Scotland Renewables Loan scheme which provides interest free loans up to £10,000 for renewable heat installations for owner occupiers. In 2013-2014 660 loans were awarded, totalling £4 million.
  - The Low Carbon Infrastructure Transition Programme (LCITP), launched in March 2015, with £76 million over the first three years, to provide tailored development support for established and start-up infrastructure projects, including heat, across private, public and community sectors.

12 Welsh Government (2014) *Low Carbon Energy Generation in Wales* http://gov.wales/docs/desh/publications/140605low-carbon-baseline-survey-en.pdf

We will examine the implementation of the Heat Statement commitments in our 2016 Scottish Progress Report and assess to what extend they meet the recommendations we made in our March 2016 Scottish Progress Report.

We recommended that Scotland should consider further action to facilitate heat networks, for example through the equivalent of the Heat Networks Delivery Unit, requiring consideration of district heating in new developments; and obliging local authorities to connect to existing heat networks where technically possible to provide anchor loads. The same recommendations apply to Northern Ireland. For Wales, we recommend that the Welsh Government develop a heat strategy and set a renewable heat target to encourage uptake.

(c) Fuel poverty and progress in energy efficiency policy

Fuel poverty is a partially devolved issue, with each devolved administration having its own targets (Table 7.5). The devolved administrations continue to use the 10% definition[13], rather than the Low Income High Cost (LIHC) measure used in England.

A number of characteristics make reducing fuel poverty more of a challenge in the devolved administrations: lower average incomes; higher average energy costs due to housing stock characteristics with more houses not on the gas grid; and a greater proportion of energy inefficient properties.

Table 7.5. Proportion of households in fuel poverty in the UK using the '10% definition'

	Targets/milestones	2012	2013	On track
England	Fuel poor should live in homes of EPC rating C or better by 2030	12%	12%	-
Scotland	No one living in fuel poverty by 2016	35%	39%	No
Wales	Eradicate fuel poverty by 2018	30%	n/a	No
Northern Ireland	Eradicate fuel poverty by 2016	42%	n/a	No

Source: DECC (2015)

Energy efficiency policy is well developed and more comprehensive in the devolved administrations than in England. The main energy efficiency schemes, the Green Deal and Energy Company Obligation (ECO) are GB-wide (Chapter 2), but Scotland and Wales have devolved powers to develop their own schemes. Scotland and Wales have been successful in leveraging funding from the ECO, taking a higher share of the measures than their housing stock (Table 7.6). In Northern Ireland, energy efficiency is fully devolved and the Executive has developed similar supplier schemes to the GB ones, as well as their own additional policies.

13 A household is said to be in fuel poverty if it needs to spend more than 10% of its income on fuel to maintain an adequate level of warmth (typically defined as 21 degrees for the main living area and 18 degrees for other occupied rooms). Under the LIHC definition, a household is considered to be fuel poor if they have required fuel costs that are above average (the national median level) and were they to spend that amount, they would be left with a residual income below the official poverty line.

Table 7.6. Provisional numbers of ECO and Green Deal measures and proportion of GB total

DA	Total ECO measures delivered (January 2013 to December 2014)	Green Deal Cashback (Wales – up to March 2014)	Green Deal Home Improvement Fund (Wales from June 2014 until March 2015)	Green Homes Cashback Phase 2 (Scotland from June 2014 to February 2015)
Scotland (9% of GB housing stock)	150,633 measures (11.6% GB total)	N/A	N/A	3,991 measures installed 3,305 vouchers paid totalling £8.3M
Wales (5% of GB housing stock)	66,156 measures (5.1% GB total)	626 vouchers (4.3% England and Wales total)	2,149 vouchers (16.6% England and Wales total)	N/A

Source: DECC (2015), Energy Saving Trust (2015)
Note: Households can have more than one measure installed.

Fuel poverty targets are not being met and fuel poverty remains high in the devolved administrations, with a rise seen in Scotland in 2013, compared to numbers broadly flat in England.[14] The UK Government and the devolved governments will need to do more. The administrations would benefit from learning from each other about what works and is cost-effective. Current schemes and funding available include:

In **Scotland**:

- The Home Energy Efficiency Programme (HEEPS) has been in operation since April 2013 and prioritises fuel poor and vulnerable households. Funding in 2015/2016 will be £119 million. The scheme includes the Affordable Warmth Scheme, Area-based schemes (Box 7.2) and the Energy Assistance Scheme:
  - Alongside funding for physical measures, the Scottish Government also funds Home Energy Scotland to provide free and impartial advice on appropriate schemes.
  - HEEPS has provided continuity and certainty in the face of UK government changes to ECO in 2014. However, funding timescales have been challenging and eligibility for the programme means households cannot also make use of ECO funding.
- In April 2015, the Scottish Government announced more funding to tackle the rise in fuel poverty. A £224 million scheme will open in September 2015 and will target the funds at installing insulation, heating and low-carbon or renewable measures in up to 238,000 fuel poor households. The contract has been awarded across six different regions to spread delivery costs and ensure it reaches those rural households otherwise hard to reach. There are also plans to devolve the implementation of the ECO in the future.
- The Scottish Government has also provided additional funding (£15 million) to encourage the uptake of its Green Homes Cashback scheme, although the scheme has now closed for new applications.

The Scottish Government should carry out an evaluation of current energy efficiency programmes (especially the area-based schemes) to help determine the best way to implement supplier obligations as they become devolved.

14 Technical Annex 7 – Devolved administrations, Figure 7.1.

In **Wales**:

- The Welsh Government has matched ECO funding with an extra £35 million which local authorities can apply for based on the deprivation index and type of household. Promoting ECO through local authorities appears to have gained the trust of communities. However, due to initial delays with funding from the Welsh Government and changes in ECO, the amount of energy efficiency funding in Wales is now expected to be less than half than previously expected for 2015/2016.
- There are two other main schemes in Wales:
  - Nest, run by British Gas on behalf of the Welsh Government, has £20 million per year of funding and provides eligible households with energy efficiency improvements, whole house retrofits and call centre advice. It targets those with an energy efficiency rating of F or G, and since 2011 has improved over 15,000 homes.
  - Arbed is an area based scheme (Box 7.2) focused on deprived areas of Wales. The second phase ran from 2012 to June 2015 with £45 million funding from the EU and Welsh Government.
- Current investment is insufficient given the scale of the problem. Estimates in the 2014 Bevan report[15] on fuel poverty suggest that it would take 78 years for the Welsh Government's Nest programme to reach each and every home affected by fuel poverty in Wales. Costs to go further would be substantial. A report by Energy Saving Trust for WWF Cymru[16] proposed bringing the worst performing houses up to energy rating D. This would reduce the number of fuel poor homes by 40%, with an estimated cost of £2.1 billion. The Well-being of Future Generations Act (legislated April 2015), with clear mechanisms for reducing carbon emissions and tackling fuel poverty in Wales, should encourage government agencies to work together to deliver more effective fuel poverty schemes. We will examine its impacts in future Progress Reports.

In **Northern Ireland:**

- The Sustainable Energy Programme is a supplier obligation scheme similar to the ECO. It is intended to run until March 2016 to bridge the gap while Northern Ireland Energy Bill provisions on energy efficiency are being considered. Up to 2013, the scheme delivered 132,000 measures to priority domestic households and 3,900 to non-priority domestic.17 The majority (80%) of funding is targeted at vulnerable households. The other 20% of funding is available for schemes that target non-priority domestic households and the non-domestic sector.
- The Warm Homes Scheme has a target to install energy efficiency improvements in 9,000 homes per year. However the Northern Ireland Executive is moving away from this self-referral approach, as the majority of people in need of help do not self-refer. Affordable Warmth, an area-based scheme, is being implemented in 2015 after a successful pilot.

Wales and Northern Ireland would benefit from up-to-date house condition surveys in order to monitor effectively the uptake of energy efficiency measures.

15 Beven Foundation (2014) *Rethinking poverty – implications for actions* http://41ydvd1cuyvlonsm03mpf21pub.wpengine.netdna-cdn.com//wp-content/uploads/2014/11/Rethinking-Poverty-Final.pdf
16 WWF (2012) *Cutting carbon emissions in Welsh homes* http://assets.wwf.org.uk/downloads/cutting_carbon_emissions_in_welsh_homes.pdf
17 Utility Regulator (2014) *Northern Ireland Sustainable Energy Programme* http://www.uregni.gov.uk/uploads/publications/NISEP_notification_paper_2.pdf

Box 7.2. Area-based energy efficiency schemes in Scotland and Wales

The UK Government could learn from the implementation and success of area-based schemes in Scotland and Wales:

HEEPS: Area-Based Scheme is a Scottish scheme delivered by local authorities which prioritises delivery in fuel poor areas. £60 million of funding is available for 2014/2015, with the majority being split between the 32 councils and the remainder being made available to local authorities to develop larger-scale schemes. In 2013/14, almost, 25,000 energy efficiency measures were delivered (around 15,000 in the private sector and the remainder in social rented sector stock, mostly focused on solid wall insulation). The Scottish scheme has been important in developing local skill sets.

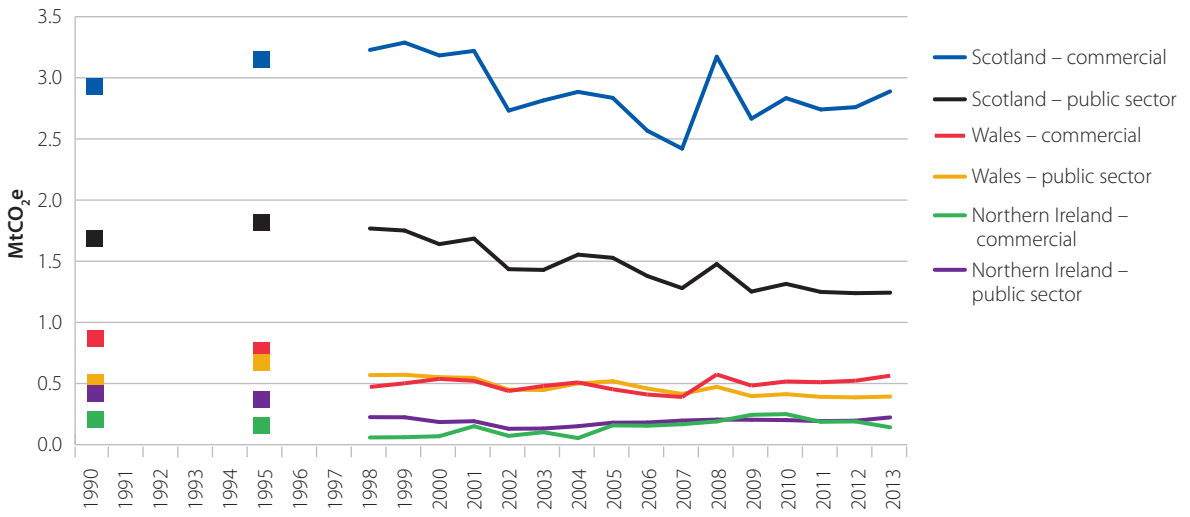
Arbed is a £45 million project which set a target to improve energy efficiency in a minimum of 4,800 homes across Wales by the end of 2015, as well as to reduce greenhouse gas emissions by a minimum of 11.6ktCO_2. The scheme is part-funded by the EU and part by the Welsh Government. Figures for installations are currently unavailable but the Welsh Government considers the scheme to be very successful. The scheme is aimed at whole house retrofits and also encourages homeowners, landlords and local authorities to apply for other measures not covered by Arbed. Once measures have been fitted, follow up 'packs' are sent to households to encourage behaviour change. An evaluation on a sample of households is expected to be published later in 2015, along with a Cardiff University study on the health benefits and NHS savings. The next Arbed scheme will up-scale what has previously been achieved, with more innovative ideas for materials and processes.

(d) Emissions from non-residential buildings

Emissions from non-residential buildings rose in Scotland and Wales in 2013 consistent with a rise in emissions at a UK level. However, emissions fell in Northern Ireland (Figure 7.7).

- In **Scotland**, emissions from non-residential buildings increased by 3%, with emissions from commercial buildings increasing by almost 5% and those from the public sector increasing slightly (0.3%). Emissions rose 1% per year on average between 2009 and 2013. The non-residential buildings sector accounted for 8% of total Scottish emissions in 2013.
- In **Wales**, emissions from non-residential buildings also rose by 5%, although it is a very small sector, accounting for 2% of total emissions in 2013. Between 2009 and 2013, emissions rose on average nearly 2% per year. Emissions from commercial buildings rose nearly 8% and those from public sector increased nearly 2%.
- **In Northern Ireland**, emissions from non-residential buildings decreased by 5%, with an average annual decrease of 4% between 2009 and 2013. Emissions from the commercial sector decreased nearly 25%, whilst those from the public sector increased nearly 14%. The non-residential buildings sector accounted for just 2% of emissions in Northern Ireland in 2013.

Figure 7.7. Emissions from non-residential buildings in Scotland, Wales and Northern Ireland (1990-2013)



Source: NAEI (2015).
Note: No inventory data are available for devolved adminstrations for 1991-1994 or 1996-1997

While England, Scotland and Wales do not have any separate energy efficiency programmes specifically targeted towards non-residential buildings, the Sustainable Energy Programme in Northern Ireland also covers commercial buildings.

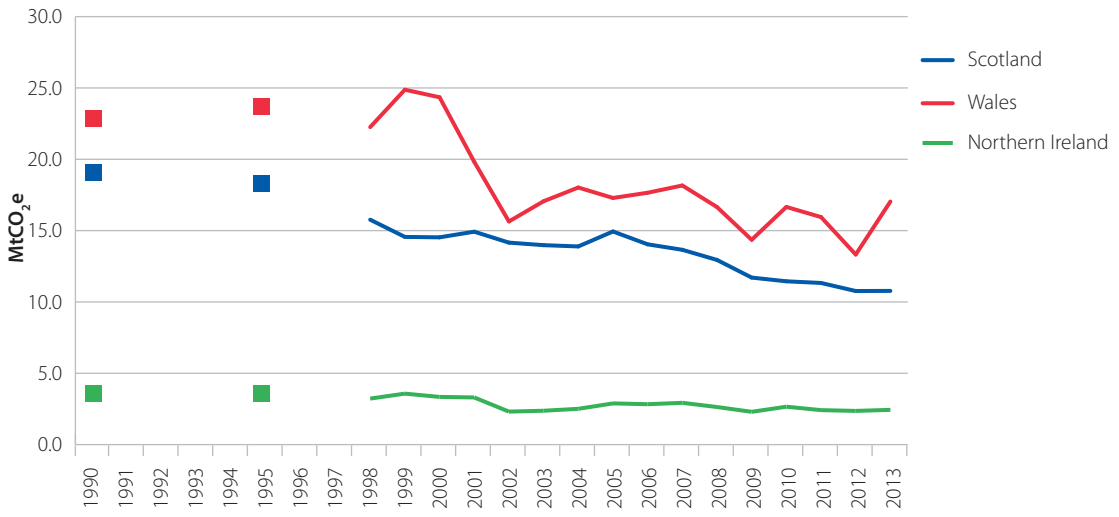
It is important for public sector organisations to help to deliver emission reductions and support the development of skills and suppliers. The Scottish Government has proposed that from November 2015, Scottish public bodies should be required to report yearly on emissions, savings from carbon projects, as well as renewable energy generation and consumption. This duty could be useful as monitoring and reporting of emissions is an essential first step in understanding energy use (Chapter 2).

4. Industry

Emissions from industry rose across the devolved administrations from 2012 to 2013 (Figure 7.8). As at the UK level, where direct emissions rose 1% despite production continuing to fall. This was due to a shift towards more carbon-intensive outputs in iron and steel.

- In **Scotland**, emissions from industry rose only slightly (0.1%) in 2013, with an average annual decrease of 1.6% between 2009 and 2013. Emissions from the sector accounted for 21% of total Scottish emissions and have decreased 44% since 1990.
- In **Wales**, emissions from industry rose nearly 28% in 2013 to 17 $MtCO_2e$, similar to levels in 2008. Between 2009 and 2013 emissions rose on average 3.5% per year. However, emissions are still 25% lower than 1990 levels. In 2013, industry emissions were 34% of total Welsh emissions.
- Emissions from industry in **Northern Ireland** accounted for 11% of total emissions in 2013 and rose by 3%. Emissions between 2009 and 2013 rose on average by 1% per year; however they are 31% less than in 1990.

Figure 7.8. Industry emissions in Scotland, Wales and Northern Ireland (1990-2013)



Source: NAEI (2015).
Note: No inventory data are available for devolved adminstrations for 1991-1994 or 1996-1997

Industry makes up a particularly large portion of total emissions in Wales, with 46% of the emissions in 2013 from Port Talbot steelworks. Emissions from Port Talbot increased significantly in 2013.

- Port Neath Talbot local authority in Wales where Tata steelworks is located was the UK's third-highest local authority CO_2 emitter in 2012[18] and its emissions in 2013 accounted for 15% of total Welsh CO_2 emissions (compared to 4.6% of Wales' population living there).
- In 2013, EU ETS verified emissions for Port Talbot steelworks were 54% greater than in 2012. This followed two years of decreasing emissions.
- The steelworks is one of the largest in the UK. One of its blast furnaces was reopened in 2013 which is likely to have increased production and contributed to greater emissions.

Tata Steel has made a commitment to become more energy efficient **in Wales**. Energy efficiency and carbon reduction schemes include:

- In April 2010, Tata Steel commissioned a £60 million energy efficiency scheme involving the capture and re-use of gas from the Basic Oxygen Steelmaking plant. This will be followed up by a £50 million scheme to re-use waste heat. Tata is also involved in the development of Hlsarna smelting technology, with a demonstration plant planned in the Netherlands, which could reduce energy and emissions by a further 20% from the steel making process.
- Tata has been investigating the use of CO_2 utilisation through algae and is continuing to develop products and solutions that will help its customers reduce their carbon footprint.

While these actions will reduce emissions from the steelworks, Port Talbot is not located near any planned CCS infrastructure and will not be able to take advantage of this abatement potential as other UK large steelworks could.

The devolved administrations have little control over industrial policies for emission reductions as these are largely reserved and operate at the UK/EU level (Chapter 3). Policies include the EU ETS, CRC Energy Efficiency Scheme, Climate Change Levy and Climate Change Agreements (CCAs), and the Renewable Heat Incentive (RHI). The Green Investment Bank also operates across the UK.

18 The latest data available for local authorities CO_2 emissions is 2012. 2013 data will be released later in 2015.

The devolved administrations all offer interest-free loans for small and medium-sized enterprises (SMEs) for energy efficiency or resource efficiency projects:

- The Resource Efficient **Scotland** advice service provides support to businesses; third sector and public sector organisations to reduce costs by implementing resource efficiencies in energy, raw materials, water and waste management. It offers loans for resource efficient projects and for renewable energy projects.
- The Carbon Trust offers government funded interest free loans to SMEs for carbon savings and energy efficiency projects in **Wales** and **Northern Ireland**.

Other noteworthy initiatives include a partnership approach in Northern Ireland. In March 2015, a voluntary Prosperity Agreement was signed between Northern Ireland Environment Agency and Lafarge Tarmac (Northern Ireland's only cement plant), which will allow the innovative use of waste-derived fuels to secure jobs, prosperity and better environment outcomes in Cookstown. Cement manufacturing is one of the most carbon-intensive manufacturing processes and Lafarge Tarmac's commitment to reduce emissions by 10% over 4 years, as well as increasing the use of alternative fuels, is an important step forward. The agreement is a good example of joint working between regulators and industry.

Given the importance of energy-intensive industry for emission reduction, it will be particularly important for the Welsh Government to develop plans for future, larger abatement requirements in areas under their devolved powers.

5. Transport

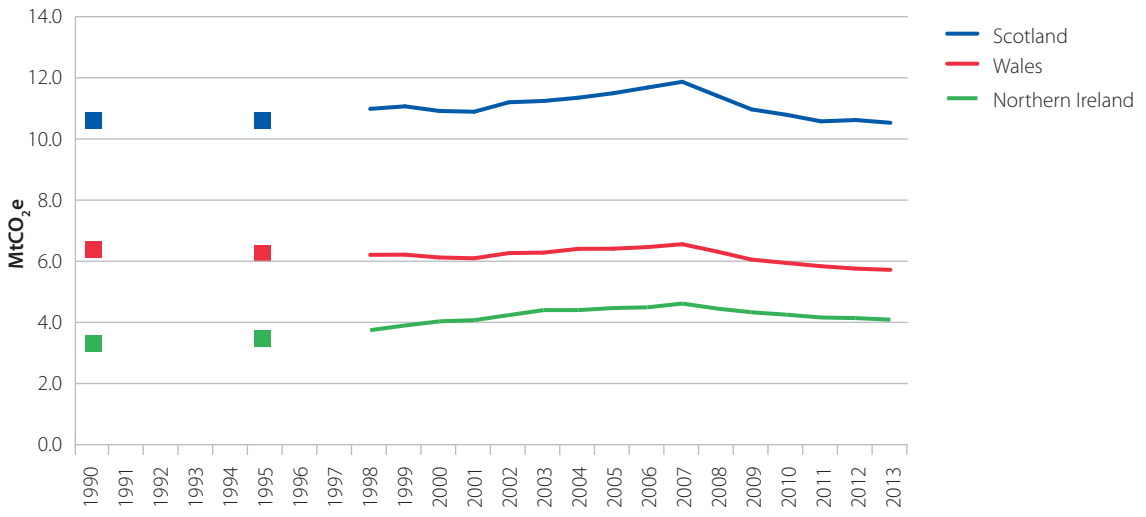
Within the transport sector road transport is mostly reserved in all the devolved administrations, though demand-side provisions such as road maintenance, cycling, bus policies and bus provisions are devolved. As part of the devolution settlement, Scotland is likely to get additional powers to set speed limits.

(a) Emissions trends and drivers

Emissions from transport fell across the devolved administration from 2012 to 2013 (Figure 7.9).

- In **Scotland**, transport emissions fell nearly 1%, although they were broadly unchanged from 1990 levels. Transport emissions account for 21% of total emissions in Scotland in 2013, in line with the UK.
- In **Wales**, the transport sector accounts for a smaller share (11%) of overall emissions. Emissions from transport also fell nearly 1% in 2013 and are 6% lower than in 1990.
- In **Northern Ireland**, transport emissions fell 1% in 2013 but were 22% higher than in 1990. Emissions from the sector took an 18% share of overall Northern Irish emissions in 2013. The increase in emissions since 1990 largely reflects an increase in car ownership rates in Northern Ireland, which are now comparable with the UK average. Northern Ireland has the highest share of emissions from rural driving at 63%, compared with 55% in Wales, 50% in Scotland and 40% across the UK as a whole in 2013.

Figure 7.9. Transport emissions in Scotland, Wales and Northern Ireland (1990-2013)



Source: NAEI (2015).
Note: No inventory data are available for devolved adminstrations for 1991-1994 or 1996-1997

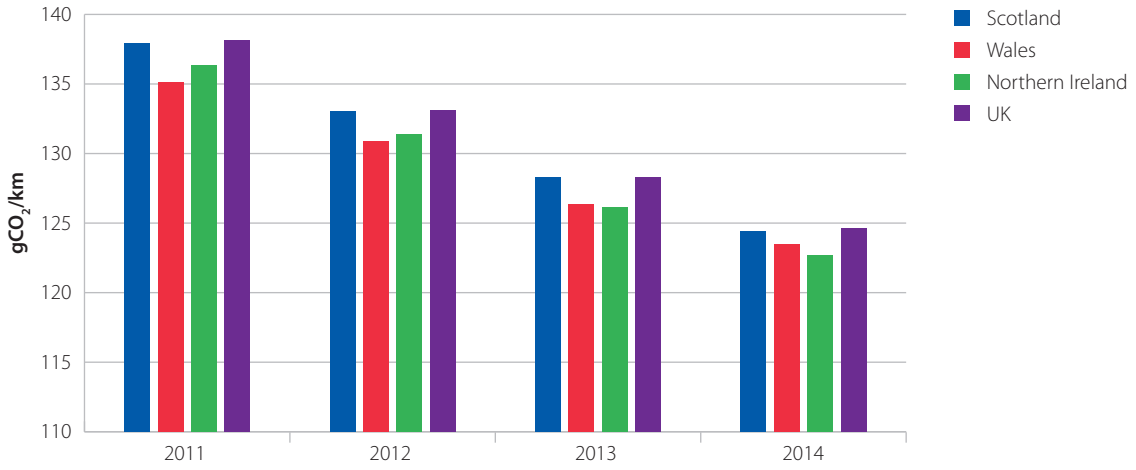
The reduction in emissions from the transport sector is primarily due to an increase in new car efficiency in 2013 and 2014, despite increases in annual vehicle kms across the devolved administrations (Table 7.7). The efficiency of new cars is driven by EU legislation; however, there has been some variation in progress towards achieving the EU's 2020 target of 95 gCO_2/km in 2020 (Figure 7.10).

Table 7.7. Change in vehicle kms in 2013 and new car efficiency 2014

DA	Road traffic	Heavy Good Vehicles	Car Vehicles	New car efficiency 2014	Target for 95 gCO_2/km by 2020 on track
Scotland	0.7% increase	0.9% increase	0.1% increase	124.4 gCO_2/km (3% decrease from 2013)	Yes – although behind Wales and Northern Ireland. Scotland is in line with UK average
Wales	1.0% increase	0.9% increase	0.5% increase	123.5 gCO_2/km (2% decrease from 2013)	Yes
Northern Ireland	2.0% increase	No change	3% increase	122.7 gCO_2/km (3% decrease from 2013)	Yes – best efficiency in UK

Source: Scottish Government (2015), Department for transport (2015), DRDNI (2014), The Society of Motoring Manufacturing and Traders Limited (2015)

Figure 7.10. New car efficiency in Scotland, Wales, Northern Ireland and the UK (2011-2014)



Source: The Society of Motor Manufacturers and Traders (2015).

(b) Progress developing electric vehicles markets

There has been an increase in electric vehicle (EV) sales at the UK level since 2010, although this is from a low base and has been largely driven by sales in England which represented 87% of the total UK market in 2014. Sales of electric vehicles in Scotland accounted for 7.5% of UK sales in 2014, with Wales taking nearly 3% and Northern Ireland 2%. These shares were lower than the proportion of overall vehicle sales for Scotland and Wales (9% and 4% respectively), but the share of electric vehicles sales in Northern Ireland was in line with its share of overall vehicles sales.

Scotland and Northern Ireland have continued to make progress developing infrastructure and markets for electric vehicles following on from Plugged in Places funding from Department for Transport (DfT):

- At the end of January 2015, there were around 850 public charging points across **Scotland**, approximately 40 of them being rapid. The Scottish Government has committed £2 million between 2014 and 2015 to support work across low-carbon vehicles, while Transport Scotland have been awarded £600,000 funding for 2014/15. Research[19] has shown that out of five councils in the UK with the highest number of EVs in their fleet, four are in Scotland. Dundee Council had the highest number of EVs (38) following an active programme of replacing diesel pool cars. The Dundee area also has over 30 charging points.
- **In Wales**, there has been less of a push for the EV market, partly as it was not a pilot area for Plugged in Places scheme. There are however over 100 charging points across Wales.
- The ecar project in **Northern Ireland** has installed electric vehicle charging infrastructure and offers grants to electric vehicle owners to install charging points in their homes or workplaces. The scheme also engages in marketing activities. There are 334 charging points available at 174 different locations. In 2013/2014 the usage of these increased by 790%, and usage in 2014/2015 is expected to increase further.

Barriers to EVs, both financial and non-financial, remain. These include costs, range anxiety, and lack of information. We recommend new, low-cost approaches to financing; on-street residential charge

19 2020 Climate Group News (2015) *Scottish councils leading way on electric vehicles adoption* http://www.2020climategroup.org.uk/news/scottish-councils-leading-way-electric-vehicle-adoption/

points; softer time-limited measures such as access to bus lanes and parking spaces; and raising awareness through public procurement.

(c) Changing travel behaviour

The main lever to influence emission reductions from transport in the devolved administrations relates to infrastructure and service provision, actions to improve transport planning and the support of behaviour change:

- The Smarter Choices Smarter Places (SCSP) pilot programme in **Scotland** has been a success in terms of outcomes. Following an evaluation of the pilot, £5 million of funding has been announced for 2015/16 for the behavioural change aspects of the programme to be rolled out across Scotland. This is a one year funded programme; however as behaviour change is recognised as a long-term process, there is a desire to secure further funding to continue the programme beyond March 2016. £20 million of funding has been allocated for 2014/15 and 2015/16 to Sustrans Community Links Programme for exemplar projects that facilitate the use of cycling and walking for commuting. In addition, a further £7 million of funding has been allocated for 2014/15 for walking and cycling infrastructure.
- The Active Travel (**Wales)** Act 2013 makes it a legal requirement for local authorities in Wales to map and plan for suitable routes for active travel, and to build and improve their infrastructure for walking and cycling every year. For 2014/15, £5 million of funding has been announced for the Safe routes in Communities programme with an addition £400,000 for two schools in Bridgend. Wales also has a Bus Services Support Grant, providing £25 million towards services in 2014/15, and has established a Bus Advisory Group to inform future decisions. In March 2015, a consultation closed on a new National Transport Plan which will demonstrate how the Welsh Government will continue to implement the Wales Transport Strategy. The Welsh Government should demonstrate leadership and consistency in the promotion of sustainable travel options in the new plan.
- In **Northern Ireland**, the Executive published an active travel strategy in 2013. This includes a number of aspirational targets, including increasing the average distance walked, the average distance cycled and the percentage of trips taken by cycling to be in line with their UK counterparts. There is also a focus on promoting active travel to school-age children to ensure that by 2015, 36% of primary school pupils and 22% of secondary school-age children are walking or cycling to school as their main means of transport. In 2013, 27% of primary and 15% of secondary school children were walking or cycling to school.

The devolved administrations are often at the forefront of behaviour change programmes and these policies and action plans can help them to encourage the use of more sustainable methods of transport. However, to be successful they should ensure infrastructure facilitating sustainable behaviours such as EV charging and cycling provisions are in place and that any future programmes and targets are tailored to their specific country's needs.

6. Agriculture and land use

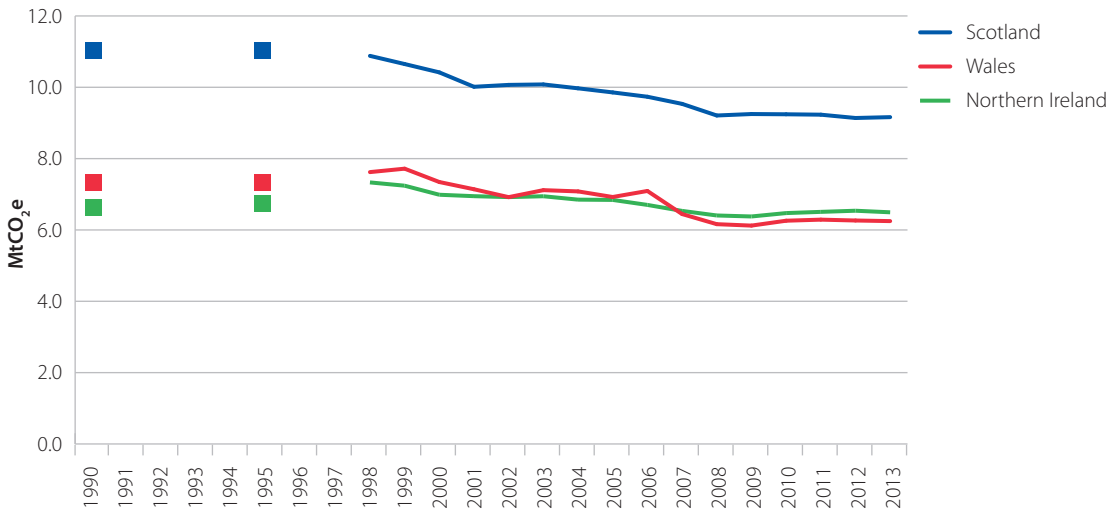
(a) Agriculture emissions and drivers

Emissions from agriculture in Wales and Northern Ireland fell and those in Scotland rose in 2013 (Figure 7.11). There is considerable uncertainty over emissions from agriculture. Work at a UK level is expected to reduce that uncertainty over the coming years with the introduction of the Smart inventory. The level of uncertainty reduces the scope for significant new initiatives at this stage.

Agriculture in the devolved administrations is relatively more important for emissions and the economy than the UK as a whole, this is especially the case for Northern Ireland where emissions were 29% of the total compared to 18% in Scotland, 12% in Wales and 9% at a UK level in 2013.

- In **Scotland**, agricultural emissions rose slightly (0.3%) in 2013 although have reduced 15% since 1990.
- Emissions from agriculture in **Wales** fell slightly (0.3%) in 2013 and were 18% below 1990 levels.
- In **Northern Ireland**, emissions from agriculture fell nearly 1% and are 5% lower than they were in 1990.

Figure 7.11. Agriculture emissions in Scotland, Wales and Northern Ireland (1990-2013)



Source: NAEI (2015).
Note: No inventory data are available for devolved adminstrations for 1991-1994 or 1996-1997

Agricultural policy is a devolved matter. As in England, the devolved administrations place considerable emphasis on a collaborative approach with the farming industry. To date, policy approaches are voluntary, though the Scottish Government has announced its intention to regulate if significant progress is not made:

- **Scotland** has an emissions reduction milestone for agriculture of 1.3 $MtCO_2e$ from 2006 levels by 2020 to help towards a 42% reduction by 2020 in all emissions. In 2013 emissions had reduced 0.6 $MtCO_2e$ since 2006. However, assessment of progress is difficult due to changes in the methodology used to measure agricultural emissions since the target was set. The main initiative in Scotland is Farming for a Better Climate (FFBC):
  - FFBC, designed to encourage voluntary uptake of win-win actions in key actions areas: using energy and fuels efficiency; developing renewable energy; locking carbon into soil and vegetation; optimising application of fertilisers and manures; optimising livestock management and storage of waste. In 2013, there were improvements in the greenhouse gas inventory for agriculture that should include the uptake measures in FFBC.
  - The trial, with four farmers, was successful with the farms demonstrating a 10-12% reduction in carbon emissions. Nine new farms have volunteered to investigate the on-farm benefits from taking a low-carbon approach through FFBC. However, there is at present no monitoring of how many farmers have adopted or aim to adopt measures. We recommend that a survey is carried out to establish whether there has been uptake of FFBC beyond the focus farms and which measures have worked.

- In 2014, the Scottish Government announced that the initiative would receive £0.8 million funding for 2014/2015 and 2015/2016.

- **Wales** has set a reduction target of between 0.6 $MtCO_2e$ (10% below 2008 level) and 1.5 $MtCO_2e$ by 2020 in its 2010 Climate Change Strategy. In 2013, emissions were 0.1 $MtCO_2e$ higher than in 2008. However, assessment of progress is difficult due to changes in the methodology used to measure agricultural emissions since the target was set. Proposed emission reductions are being delivered through programmes such as A Sustainable Future: The Welsh Red Meat Roadmap, Hybu Cig Cymru (Meat Promotion Wales), The Dairy Roadmap for Wales and the Glastir programme.

  - Glastir offers farmers financial support to develop sustainable land management practices. The Welsh Government has commissioned a range of modelling and monitoring activities in order to gauge actual quantification of scheme impacts – the Glastir Monitoring and Evaluation Programme (GMEP).

  - Although actual impacts will not be available to evaluate until late 2016, model simulations of six measures have been tested for their potential climate change mitigation contribution in the first annual report of the Glastir programme.[20] These initial estimations suggest that the six selected measures could reduce greenhouse gas emissions on a farm by farm basis up to 24% and are a positive sign of the potential impact.

- In **Northern Ireland,** the Greenhouse Gas Implementation Partnership (GHGIP) is a collaborative strategy between stakeholders and the Executive. GHGIP encourages implementation of on-farm efficiency measures which will reduce the carbon intensity of local food production. The approach allows the agri-food sector, which is a large contributor to the economy in Northern Ireland, to address its carbon footprint whilst contributing to economic growth by meeting the growing global demand for food. A report on Phase I was launched in March 2014 and highlighted successes, including a £2 million grant to support advance slurry spreading systems to reduce GHS emissions, the development of a carbon calculator, and 1,400 farmers attending training on nutrient management. Phase two of the strategy is under development.

(b) Forestry and land use emissions

The size of the carbon sink from the land use, land change and forestry (LULUCF) sector increased in Wales and Scotland in 2013 (Figure 7.12). In Northern Ireland, the sector was a net emitter in 2013, although emissions have reduced since 2012.

- In **Scotland**, the size of the carbon sink increased 3.4% and reached 5.2 $MtCO_2e$ in 2013. This is a significant increase from 1990, when the sector was emitting 0.1 $MtCO_2e$. Between 2009 and 2013, the average increase of the sink was 5% per year. This reflects increased planting rates and the changing age profile of the trees and their ability to sequester carbon. The carbon sink in Scotland represents 99% of the UKs total LULUCF sink.

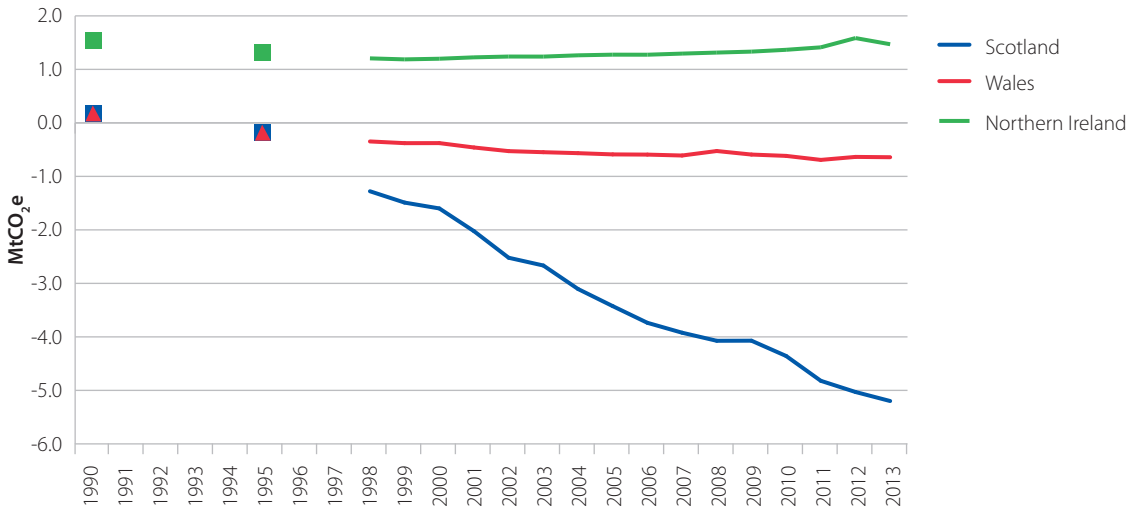
- In **Wales**, the sink increased in 2013, rising to 0.6 $MtCO_2e$. The proportion of land converted to croplands, a source of emissions, has been decreasing since 2000.

- In **Northern Ireland**, the sector was a net emitter in 2013[21], emitting 1.5 $MtCO_2e$. This was a reduction of 0.1 $MtCO_2e$ from 2012 due to an increase in forest fires in 2012 increasing emissions in that year. The largest cause of emissions in the sector is grassland drainage which is unchanged since 1990, land converted to cropland which has been decreasing since 1995, and land converted to settlements which is increasing.

20 Centre for Ecology & Hydrology (2014) *Glastir Monitoring & Evaluation Programme First Year Annual Report* http://gov.wales/docs/drah/publications/140701-gmep-annual-report.pdf

21 According to the 2013 inventory, the LULUCF sector in Northern Ireland has been a net emitter since 1990. Previous inventories showed the sector as a small sink between 1995 and 2011.

Figure 7.12. Emissions from land use, land use change and forestry in Scotland, Wales and Northern Ireland (1990-2013)



Source: NAEI (2015).

Within the forestry sector, the devolved administrations have ambitious targets to increase the rates of tree planting (Table 7.8):

Table 7.8. Afforestation targets and progress

DA	Forestry targets/policy	Progress 2014	On track
Scotland	Plant 10,000 hectares per year, creating 100,000 hectares by 2020	8,300 hectares planted, a 20% increase from 2013 planting rate	No
Wales	Plant 100,000 hectares of new woodland over a 20 year period, equivalent to 5,000 hectares per year	900 hectares planted	No
Northern Ireland	Double the area of forest from 6% in 2012 to 12% in 2056, equivalent to planting 1,700 hectares per year	300 hectares planted	No

Source: Forestry Commission (2015)

- In **Scotland**, planting rates have failed to meet the target set, although rates in 2014 were higher than 2013 (but not as high as 2012 when 9,000 hectares were planted). This has in part been due to poor weather in recent years, and competing land use. Scotland's first Land Use Strategy (2011) is due for review in 2015, with the second strategy due in March 2016. In 2014/2015 and 2015/2016, the Scottish Government has £61m funding available under the Woodland Creation scheme to encourage planting on private land.
- The recent planting rate in **Wales** has increased since 2011 when rates were in the low hundreds of hectares. This was due to the planting part of Glastir programme gaining traction. However, more is required to meet targets. The Welsh Government is supporting action through the Nature Fund which was set up to tackle the continuing decline in biodiversity. The Fund is supporting a total of 20 projects that will take forward a collaborative, innovative approach to achieve sustainable land management at a landscape scale. The projects include tree planting and peat bog restoration. Going forward, the Welsh Government has instigated a review of the Land Use Climate Report (2010):

  - The original report[22] highlighted that the reasons measures to reduce emissions sponsored by the Welsh Government were not taken forward was in part due to lack of clarity (e.g. where to place woodland creation) and a lack of sufficient incentives for farmers and land owners (e.g. for woodland creation and peatland restoration).
  - The review will be used as a key document in shaping the climate interventions of the Wales Rural Development Programme 2014-2020, Glastir and other land-based elements and help prioritise areas for investment and provides an evidence base to develop further actions to cut greenhouse gas emissions and adapt to a changing climate. The main areas for delivery are: improved efficiency of agricultural production; expanding woodland and restoring peatland; and, exploiting opportunities in rural areas for generating renewable energy.

- In **Northern Ireland**, the Rural Development Programme 2014-2020 is worth over £500 million and aims to improve competitiveness in agriculture and forestry, improve the environment and the quality of life in rural areas and diversification of the rural economy. The woodland investment scheme and forest expansion scheme have £800,000 available for 2014-2020.

The devolved administrations should consider whether further action is needed to ensure tree planting targets are met. These could include introducing additional measures to incentivise planting. Any plan or strategies introduced should be developed and delivered jointly with key stakeholders and other nations. Future planting should also include a diverse range of species, as discussed in Chapter 5 of our Adaptation Progress Report.

The LULUCF inventory currently only includes emissions from lowland peat. Emissions related to upland peat and peatland restoration are excluded. However, the IPCC has finalised the methodology for capturing the changes in emissions, focusing on the rewetting and restoration of peatlands since 1990. Inclusion in the inventory by member states is voluntary:

- Peatlands cover approximately 21% of land area in **Scotland**. They account for 60% of the UK's peatlands and 4% of Europe's total peat carbon store. 600,000 hectares of peatlands require restoration in Scotland. By March 2015, 6,500 hectares have been restored, short of the Scottish Government's ambition to restore at least 10,000 hectares by 2015. The Scottish Government has announced £15 million for peatland restoration for 2014/15 and 2015/16. Scotland's 2014 National Peatland Plan sets out proposals for research and awareness-raising.
- In **Wales**, around 25% of the land area is peat. The Resilient Ecosystems Fund[23] has provided £165,000 to restore peatlands in Welsh Water's two reservoirs.
- Peatlands cover 13% of the land area in **Northern Ireland** but store 42% of the country's soil carbon store. Around 80% of Northern Ireland's peatlands have been degraded. Financial support has been given to peatland restoration projects, largely through the Rural Development Programme.

Peatlands in the devolved administrations account for large areas of land. In Chapter 6 of our Adaptation Progress Report, we have identified that too much burning of peatland is being carried out by landowners, even if the land is designated as a site of special scientific interest. The devolved administrations should encourage good practice in heather and grass burning to avoid damage to peatlands. They should also ensure that detailed management plans are produced for restorations.

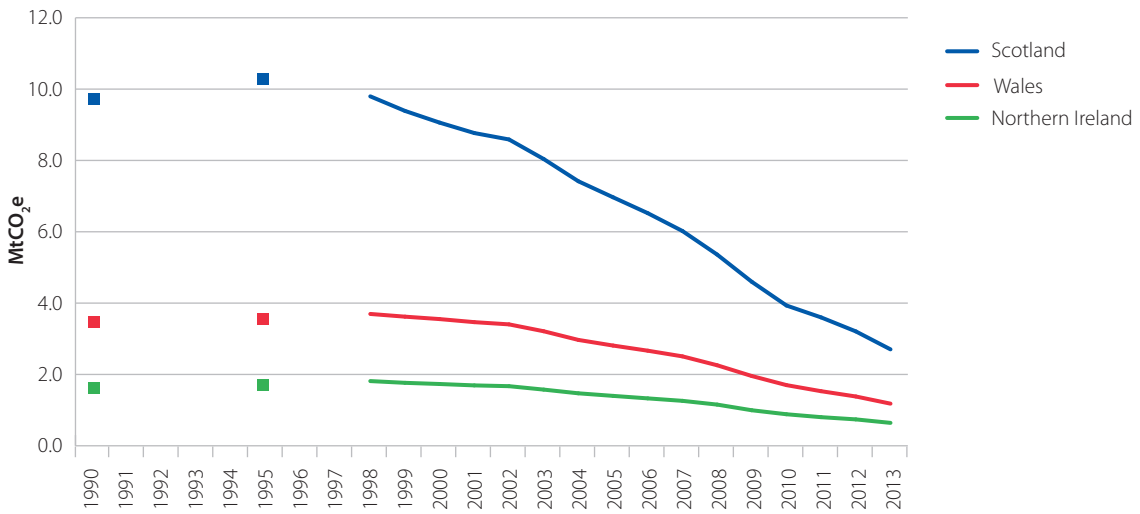
22 ADAS (2014) *Review of Land use Climate Change* http://thecccw.org.uk/wp-content/uploads/2015/02/ADAS-review-of-LUCC-final-report-2014.pdf
23 The scheme was a partnership between Natural Resources Wales, RSPB Cymru, Snowdonia National Park Authority and the National Trust.

7. Waste

Waste is fully devolved to the Scottish and Welsh Governments and Northern Ireland Executive. In 2013, emissions from waste declined across all the devolved administrations (Figure 7.13). They fell nearly 16% in Scotland, 14.5% in Wales, and 13% in Northern Ireland, compared to 14% in England. Waste emissions account for only a small proportion of total emissions of Scotland, Wales and Northern Ireland (5%, 2% and 3% respectively).

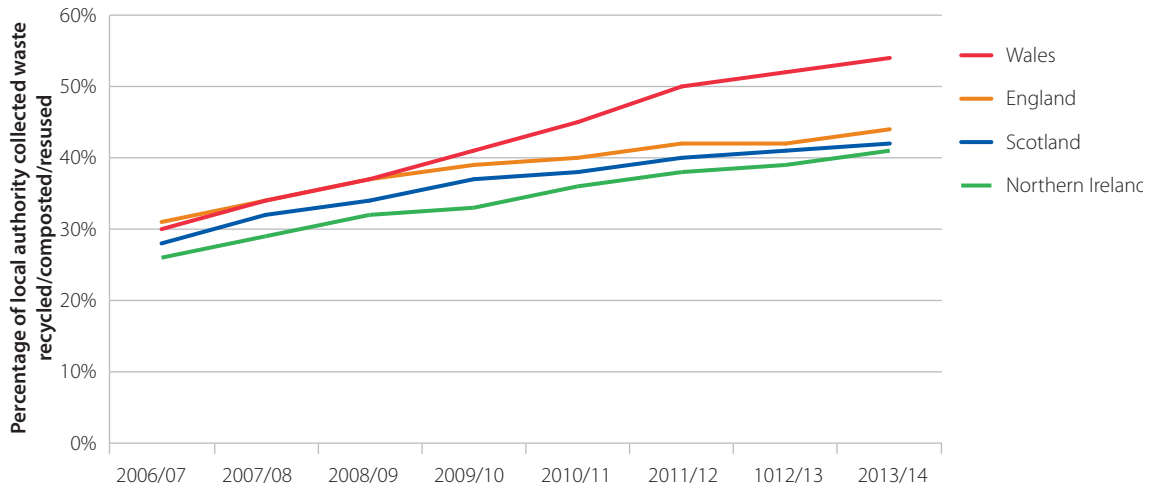
Recycling rates have been improving in recent years (Figure 7.14), with more than 54% of municipal waste sent for recycling/composted/reused in Wales in 2013/14, the highest in the UK and fourth highest in Europe. Scotland and Northern Ireland had recycling rates around the 40% mark and England 44%.

Figure 7.13. Waste emissions in Scotland, Wales and Northern Ireland (1990-2013)



Source: NAEI (2015).
Note: No inventory data are available for devolved adminstrations for 1991-1994 or 1996-1997

Figure 7.14. Recycling rates in Scotland, Wales, Northern Ireland and England (2006/07-2013/14)



Source: Defra, SEPA, Environment Agency Wales, and the Northern Ireland Executive (2015)

We discuss progress in the implementation of devolved waste policies in detail in Chapter 6. Key findings are:

- **Scotland** missed its 2013 interim target of 50% for municipal waste recycled, composted or reused with 43% recycled in 2013. This is likely to improve in 2014 following new measures introduced under the Waste (Scotland) Regulations 2013. Scotland's overall waste sent to landfill increased to 40% in 2012, however, due to the overall tonnage of waste decreasing, the amount send to landfill actually decreased 3.5% to 4.5 million tonnes. Landfill tax will be devolved to Scotland and be set 10% higher than the UK rate for the first three years. We recommend that Scotland publishes a detailed plan on how it intends to meet its targets to reduce biodegradable municipal waste going to landfill, including the cost-effectiveness of planned progressive bans on waste sources.
- Reductions in emissions in **Wales** are due to a number of regulatory targets for municipal recycling and waste going to landfill. In 2013, Wales met its 52% waste recycling 2012/2013 target, in 2013/14 this rose to 54.3% – leading the UK. Landfill tax is likely to be become devolved to Wales in 2018. In Wales, the Government has moved to a circular economy approach with regards to waste. This is an alternative to a linear economy, encouraging resources are kept for as long as possible, extracting maximum value from them while in use, and then recovering and regenerating products and materials at the end of service life. Utilising a circular economy across the UK could provide opportunities for innovation, new business models and elimination of waste.
- Progress has been made in **Northern Ireland** with a ban on food waste going to landfill, targets for waste material recycling and recovery across the economy and a successful first year of the carrier bag levy. We recommend that Northern Ireland evaluate the impact of the food waste ban, and set biodegradable waste prevention and landfill targets.

8. Forward look

Emissions fell in Scotland, rose in Wales and remained roughly the same in Northern Ireland in 2013. Progress against targets remains mixed with future targets being very challenging to achieve.

The devolved administrations each have emission reduction targets that if met would contribute greatly to the UK's ability to meet to the next set of carbon budgets. By 2020, if emissions in the devolved administrations fall in line with their targets, there would be a combined reduction of 39% (~ 64 $MtCO_2e$), 11% of UK emissions in 2013. They each have a report on how emission reduction targets will be met:

- Scotland's second Report of Policies and Proposals[24] (RPP2) sets out how Scotland will be able to meet its own statutory annual targets to 2027 set out in the Climate Change (Scotland) Act 2009 as well as the 42% reduction target to 2020. The report estimates that reductions of 43.3% in 2020 and 57.8% in 2027 could be achieved if they implement all policies and proposals in the report and the EU ambition within the traded sector remains at 20%.
- Wales' Climate Change Strategy[25] outlines the policies and programmes required for meeting the 40% target for reductions from all sectors by 2020 and the 3% annual reduction target (which includes all direct greenhouse gas emissions in Wales, except those from heavy industry and power generation). The Welsh Government has also published an Environment Bill due to be legislated in spring 2016. One of the key parts of the Bill is climate change. The Welsh Government intends to put in place statutory emission reduction targets and carbon budgeting.

24 Scottish Government (2013) *Low carbon Scotland* http://www.gov.scot/Resource/0042/00426134.pdf
25 Welsh Government (2010) *Climate Change Strategy for Wales* http://gov.wales/docs/desh/publications/101006ccstratdeliveryemissionsen.pdf

- Northern Ireland's Greenhouse Gas Emissions Reduction Action Plan[26] sets out how the Programme for Government's 35% reduction target by 2025 target will be met. Northern Ireland's Executive has in the past considered a Climate Change Act and has requested advice from the CCC on the appropriateness of this.[27]

In emission reduction and a number of policy areas, the devolved administrations have set more challenging targets than the UK, with funding in addition to that available from UK/GB-wide policies. This is particularly evident in residential energy efficiency and fuel poverty, waste and agriculture and land use. However, stronger action will be required in key areas in order to meet future targets – both those set at the devolved administration level and UK/EU level.

- Scotland has failed to meet its first four annual targets. This has in part been due to the targets being absolute and therefore being impacted significantly by changes to the inventory. However, Scotland is still on track to meet its 42% reduction compared to 1990 levels by 2020.
- Wales' 3% annual targets are being met. However, progress towards meeting its ambitious 40% reduction target by 2020 has fallen short. Wales has a higher proportion of traded emissions covered by the EU Emissions Trading Scheme (ETS) than the rest of the UK, meaning the 40% target is particularly sensitive to increases in EU-ETS emissions for which the framework is non-devolved.
- In Northern Ireland, the latest projections to 2025 suggest that it will not meet its targets.

Both Wales and Northern Ireland emissions are dominated by specific sectors (agriculture in the case of Northern Ireland, industry in the case of Wales). The Welsh Government will need to consider ways to reduce industry emissions as targets tighten in the future by, for example, considering voluntary agreements with large emitters, and looking at encouraging innovative solutions. Following Defra's delivery of the Smart inventory, Northern Ireland will need to put in place local monitoring and process for acting on its findings.

Further action across all the devolved administrations is required, in particular within energy efficiency programmes, increasing low-carbon heat penetration, encouraging greater uptake of electric vehicles and travel behaviour changes, increasing tree-planting rates and ensuring waste targets are met.

9. Summary

In order to meet the targets outlined above and to contribute to UK carbon budgets, improved policy and additional action is needed in the devolved administrations to drive investment, innovation and low-carbon choices:

- **Low-carbon investment:** To meet carbon budgets, further investment in the devolved administrations will be required. For example, ambitious renewable energy targets require long-term investment and funding streams. Devolved policies can play an important role in supplementing UK policies to drive investment in renewable heat and electricity. Investment incentives are also needed in areas which are fully devolved, such as tree planting (e.g. through sources of public and private funding). The devolved governments will need to extend existing policy approaches and funding commitments into the 2020s.

26 Cross-Departmental Working Group on Greenhouse Gas Emissions (2011) *Northern Ireland Greenhouse Gas Emissions Reduction Action Plan* http://www.doeni.gov.uk/northern_ireland_action_plan_on_greenhouse_gas_emissions_reductions.pdf

27 CCC (2011) *The appropriateness of a Northern Ireland Climate Change Act* http://archive.theccc.org.uk/aws2/Northern%20Ireland%20-%20Annex%20-%20advice%20on%20CC%20Act.pdf

- **Developing future options and innovation**: Innovate UK and research councils operate at a UK-wide level; however the devolved administrations have a role to play and Innovate UK works closely with the governments of, and partners in, Scotland, Wales and Northern Ireland. In Wales, the Government has moved to a circular economy approach with regards to waste. Utilising a circular economy across the UK could provide opportunities for innovation, new business models and elimination of waste. The devolved administrations, especially Scotland, have a number of successful schemes for promoting and incentivising renewable energy innovation, such as the Scottish Infrastructure and Innovation Fund. In the future, these should target a balance and mix of technologies in a range of renewable energies.
- **Low-carbon choices:** The devolved administrations are often at the forefront of piloting behaviour change schemes, such as the Smarter Choices Smarter Places in Scotland and the number of voluntary agriculture programmes. To ensure that consumers are incentivised to choose low-carbon options, there needs to be a continued evaluation of schemes to assess progress and ensure that actions are targeted in priority areas.

Abbreviations

ACUMEN	Assessing, Capturing and Utilising Methane from Expired and Non-operational landfills
AD	Anaerobic Digestion
BEV	Battery Electric Vehicle
BIS	Department for Business, Innovation & Skills
BMW	Biodegradable Municipal Waste
CCAs	Climate Change Agreements
CCC	Committee on Climate Change
CCGT	Combined-Cycle Gas Turbine
CCL	Climate Change Levy
CCS	Carbon Capture and Storage
CCT	Company Car Tax
CERO	Carbon Emission Reduction Obligation
CfD	Contract for Difference
CH_4	Methane
CHP	Combined Heat and Power
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
CPF	Carbon Price Floor
CPS	Carbon Price Support
CRC	CRC Energy Efficiency scheme (previously Carbon Reduction Commitment)
CSCO	Carbon Savings Community Obligation
DCLG	Department for Communities and Local Government
DEC	Display Energy Certificate
DECC	Department for Energy and Climate Change
Defra	Department for Environment, Food and Rural Affairs
DSBR	Demand-Side Balancing Reserve
DSR	Demand-Side Response

DfT	Department for Transport
DUKES	Digest of UK Energy Statistics
EC	European Commission
ECA	Enhanced Capital Allowance
ECO	Energy Company Obligation
EEP	See UEP
EMR	Electricity Market Reform
ENSG	Electricity Network Strategy Group
ENUSIM	Energy End-Use Simulation Model
EPC	Energy Performance Certificate
EPS	Emissions Performance Standard
ESOS	Energy Savings Opportunity Scheme
EU	European Union
EU ETS	European Union Emissions Trading System
EV	Electric vehicle (BEV or PHEV)
FEED	Front-End Engineering Design
F-gases	Fluorinated gases
FIDER	Final Investment Decision Enabling Regime
FTA	Freight Transport Association
GDA	Generic Design Assessment
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GIB	Green Investment Bank
GVA	Gross Value Added
GW	Gigawatts
GWh	Gigawatt hours
GWP	Global Warming Potential
HEFCE	Higher Education Funding Council for England
HFCs	Hydrofluorocarbons
HGV	Heavy goods vehicle
HHCRO	Home Heating Cost Reduction Obligation

HNDU	Heat Networks Delivery Unit
IAS	International Aviation and Shipping
ICAO	International Civil Aviation Organisation
ICE	Internal Combustion Engine
IED	Industrial Emissions Directive
ILUC	Indirect Land Use Change
IMO	International Maritime Organisation
IPCC	Intergovernmental Panel on Climate Change
ITPR	Integrated Transmission & Planning Regime
kW	Kilowatt
kWh	Kilowatt-Hours
LA	Local Authority
LCF	Levy Control Framework
LCPD	Large Combustion Plant Directive
LCRS	Logistics Carbon Reduction Scheme
LIHC	Low Income High Cost
LSTF	Local Sustainable Transport Fund
LULUCF	Land use, land use change and forestry
MAC	Mobile air conditioning
MW	Megawatt
MWh	Megawatt-Hour
N_2O	Nitrous oxide
NAEI	National Atmospheric Emissions Inventory
NEDC	New European Drive Cycle
NER	New Entrants Reserve
NO_x	Oxides of nitrogen
Ofgem	Office of the Gas and Electricity Markets
OLEV	Office for Low Emissions Vehicles
ONS	Office for National Statistics
PFCs	Perfluorocarbons
PHEV	Plug-In Hybrid Electric Vehicle

PM	Particulate Matter
R&D	Research and development
RAC	Refrigeration and air-conditioning
RHI	Renewable Heat Incentive
RO	Renewables Obligation
ROC	Renewables Obligations Certificate
RTFO	Renewable Transport Fuel Obligation
SAP	Standard Assessment Procedure
SF_6	Sulphur Hexafluoride
SMEs	Small and Medium Enterprises
SMMT	Society of Motor Manufacturers and Traders
TW	Terawatts
TWh	Terawatt hours
UEP	DECC's Updated Energy Projections
UK	United Kingdom
ULEV	Ultra-low emission vehicle
VECTO	Vehicle Energy Calculation Tool
VED	Vehicle Excise Duty
WLTP	World Light Duty Test Procedure
WPP	Waste Prevention Programme
WRAP	Waste and Resources Action Programme
ZCH	Zero Carbon Homes

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