Meeting Carbon Budgets – 2012 Progress Report to Parliament

Committee on Climate Change
June 2012

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

Preface

The Committee on Climate Change (the Committee) is an independent statutory body which was established under the Climate Change Act (2008) to advise UK and devolved administration governments on setting and meeting carbon budgets, and preparing for climate change.

Setting carbon budgets

The Climate Change Act established a legally-binding target to reduce the UK's greenhouse gas emissions by at least 80% below 1990 levels by 2050. The Act introduced a system of carbon budgets which provide legally-binding limits on the amount of emissions that may be produced in successive five-year periods, beginning in 2008, and requires the Committee to advise on the level of the budgets.

In December 2008, the Committee provided advice on the level of the first three carbon budgets and the 2050 target. The advice was accepted by the Government and carbon budgets requiring emission reductions by at least 34% below 1990 levels in 2020 were legislated in May 2009.

In December 2010, we set out our advice on the fourth carbon budget, covering the period 2023-27. Our recommended budget requires a 50% reduction in emissions by 2025 relative to 1990 levels. This was accepted by the Government and set in law in June 2011.

Progress meeting carbon budgets

The Climate Change Act requires that we report annually to Parliament on progress in meeting carbon budgets; this is our fourth annual progress report.

Advice requested by Government

The Committee also provides ad hoc advice in response to requests by Government and the devolved administrations, under a process set out in the Climate Change Act. Over the last year we have advised on: implications of including aviation and shipping in carbon budgets and targets and emissions reduction targets in Wales, Northern Ireland and Scotland. We also conducted a review of bioenergy and published our annual progress report on adaptation.

Acknowledgements

The Committee would like to thank:

The team that prepared the analysis for the report: This was led by David Kennedy and Adrian Gault and included: Alice Barrs, Owen Bellamy, Russell Bishop, Ute Collier, Ibukunoluwa Ibitoye , David Joffe, Alex Kazaglis, Ewa Kmietowicz, Sarah Leck, Eric Ling, Laura McNaught, Nina Meddings, Meera Sarda, Stephen Smith, Kavita Srinivasan, Indra Thillainathan and Mike Thompson.

Other members of the Secretariat that contributed to the report: Tara Barker, Kristofer Davies, Sharon Gaisie and Swati Khare-Zodgekar.

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A number of organisations for their support, including AEA, Cambridge Econometrics, DECC, Defra, Department for Transport, Energy Saving Trust, Energy UK, Heating and Hot Water Industry Council, Mineral Wool Insulation Manufacturers Association, National Energy Action, National Grid, National Insulation Association, Northern Ireland Executive, RenewableUK, Rothamsted Research, Scottish Government, Society of Motor Manufacturers and Traders, Tata Steel, UK Green Building Council and the Welsh Government.

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

Contents

Foreword

This is our fourth annual report to Parliament on progress in reducing emissions to meet carbon budgets, as required under the Climate Change Act. In it we consider the extent to which emissions are within budgeted levels, and prospects for meeting future budgets based on an assessment of forward indicators and policy development. We conclude that mild weather was the single biggest driver of emissions reductions in 2011, with falling real income and rising energy prices being important additional factors.

Underlying progress in implementing carbon reduction measures was modest, and stronger performance is needed across all the sectors if we are to meet carbon budgets in the medium and longer term.

This is a legacy of the low level of ambition in policies developed before carbon budgets were set. It is something we anticipated when we set out our indicator framework in 2009. We envisaged a period of new policy development, with an acceleration of the implementation of measures at the end of the first budget period.

The critical point is whether or not we have made sufficient progress developing new policies to address the major challenges that we face across the emitting sectors. We need strong incentives: to drive significantly increased investment in renewable power and heat generation; to support the first nuclear investments and the CCS demonstration programme; to continue to deliver and encourage loft and wall insulation; and to encourage consumer demand for efficient cars and vans using both conventional and electric technologies.

In this report we show that progress has been made, but more is needed, and at a faster pace, to provide confidence in meeting the low-carbon challenge. The strategy for Electricity Market Reform is the right way forward, but lacks clarity and detail. The Green Deal and the Energy Company Obligation will encourage cavity and solid wall insulation, but risks remain and the overall ambition for energy efficiency improvement appears low. Conditions are in place to support electric vehicle market development; the initial consumer response has been cautious, but we must maintain support. Renewable heat policy appears well designed for the commercial sector, but there is a gap for the residential and large industrial sectors.

The Government now needs to build on the progress made; finalising policies to create an investment climate that will allow us to move into the delivery phase.

This calls for political will at a time when questions are being raised about costs and achievability of carbon budgets. These relate to concerns about the pace of international progress towards a new global deal, the implications of shale gas, and costs of investment in low-carbon technologies during the recession, as well as subsequent recovery.

But these concerns do not undermine the case for action, which continues to strengthen. This is not just because there is a legal requirement under the Climate Change Act to formulate policies to meet carbon budgets, but because these policies are economically sensible in an increasingly carbon and resource-constrained world. They offer us the opportunity to be on the front foot, synchronising low-carbon investments with turnover of the capital stock, and bringing our industrial capabilities to bear on the production of goods and services with a long-term future.

Our analysis shows that currently legislated carbon budgets remain achievable, and that associated costs, energy affordability and competitiveness impacts remain manageable. Conversely, a failure to act now will only store up costs and risks for the future. As the Stern Review showed, an investment of 1-2% of GDP will help us avoid costs of 5-20% of GDP in the future.

We hope that this is the last year when we will be highlighting the need for a step change. With the continued development of policies, and response from people and businesses, we should be able to report next year that the pace of delivery has increased.

As always, we would like to thank the Secretariat for their input to this report – they have worked tirelessly in recent months to provide our advice on a range of important issues: the inclusion of aviation and shipping emissions in carbon budgets; the role of local authorities; reviews of bioenergy and shipping; and our assessment of energy bill impacts.

Professor Dame Julia King
Interim Chair,
Committee on Climate Change

The Committee

Professor Dame Julia King (Interim Chair)

Professor Dame Julia King CBE DBE FREng is the interim Chair of the Committee on Climate Change and Vice-Chancellor of Aston University. She led the 'King Review' for HM Treasury in 2007-8 on decarbonising road transport. She was formerly Director of Advanced Engineering for the Rolls-Royce industrial businesses. Julia is one of the UK's Business Ambassadors, supporting UK companies and inward investment in low-carbon technologies.

David Kennedy (Chief Executive)

David Kennedy is the Chief Executive of the Committee on Climate Change. Previously he worked on energy strategy and investment at the World Bank, and the design of infrastructure investment projects at the European Bank for Reconstruction and Development. He has a PhD in economics from the London School of Economics.

Professor Samuel Fankhauser

Professor Samuel Fankhauser is acting Co-Director of the Grantham Research Institute on Climate Change at the London School of Economics and a Director at Vivid Economics. He is a former Deputy Chief Economist of the European Bank for Reconstruction and Development.

Sir Brian Hoskins

Professor Sir Brian Hoskins, CBE, FRS is the Director of the Grantham Institute for Climate Change at Imperial College and Professor of Meteorology at the University of Reading. He is a Royal Society Research Professor and is also a member of the National Science Academies of the USA and China.

Lord John Krebs

Professor Lord Krebs Kt FRS, is currently Principal of Jesus College Oxford. Previously, he held posts at the University of British Columbia, the University of Wales, and Oxford, where he was lecturer in Zoology, 1976-88, and Royal Society Research Professor, 1988-2005. From 1994-1999, he was Chief Executive of the Natural Environment Research Council and, from 2000-2005, Chairman of the Food Standards Agency. He is a member of the U.S. National Academy of Sciences. He is chairman of the House of Lords Science & Technology Select Committee.

Lord Robert May

Professor Lord May of Oxford, OM AC FRS holds a Professorship jointly at Oxford University and Imperial College. He is a Fellow of Merton College, Oxford. He was until recently President of The Royal Society, and before that Chief Scientific Adviser to the UK Government and Head of its Office of Science & Technology.

Professor Jim Skea

Professor Jim Skea is Research Director at UK Energy Research Centre (UKERC) having previously been Director of the Policy Studies Institute (PSI). He led the launch of the Low Carbon Vehicle Partnership and was Director of the Economic and Social Research Council's Global Environmental Change Programme.

Executive summary

Introduction and key messages

This is our fourth annual report to Parliament on progress reducing emissions to meet carbon budgets, as required under the Climate Change Act.

In our first report we set out our approach to measuring progress reducing emissions, based on a set of indicators. The indicators allow us to differentiate between changes in emissions due to the economy and the weather, and underlying progress reducing emissions.

In subsequent reports we identified that emissions fell in 2009 due to the recession, and increased in 2010 due to the cold weather, without which emissions would have been broadly flat. We concluded that underlying progress through the implementation of measures would – if continued – be insufficient to meet future carbon budgets, which require annual emissions reductions of 3%.

We therefore identified the need for a step change in the rate of implementation of measures to achieve carbon budgets. We envisaged that the step change would be driven by new policies developed through the first carbon budget period (2008-2012), and would start at the end of that period. This is reflected in our indicators, which build in a relatively low level of ambition for implementation of measures during the first budget period, with an acceleration into the second carbon budget period (2013-2017).

In this fourth progress report we update our assessment using 2011 data, and we consider progress against policy milestones (e.g. the Electricity Market Reform, the Green Deal) required to drive the step change.

Our main conclusions, which lead us to specific recommendations summarised in Box 1, are:

- **Emissions trends**. Economy-wide greenhouse gas (GHG) emissions fell by 7% in 2011 to 547 $MtCO_2e$. However, 3 percentage points of this fall were due to the mild winter temperatures in 2011, with much of the remainder due to rising energy prices, falling real income and transitory changes in the power generation mix, and only around 0.8 percentage points due to implementation of measures to reduce emissions. This rate of underlying progress is only a quarter of that required to meet future carbon budgets.
- **Progress against indicators**. Although there has been progress against indicators, this is relative to a low level of ambition for the first budget period. Therefore there will be a need to do more across almost the full range of measures. There are major challenges sustaining and increasing the pace of investment in low-carbon power generation, buildings fabric measures and other energy efficiency improvements, renewable heat, electric vehicles, and travel behaviour change. Whereas when we first highlighted the need for a step change there was a lead-time of several years, this has now elapsed. Therefore the step change is needed urgently if we are to remain on track to meeting future carbon budgets. In other words, it is crucial now to move from the policy development phase to delivery.

- **Power sector**. Investment in onshore and offshore wind in 2011 was around one-third of the rate required annually by the end of the decade. There is a healthy project pipeline, but there are a number of barriers which need to be addressed if the pipeline is to be translated into actual investments. There has been slippage in the demonstration programme for carbon capture and storage (CCS), which should now proceed as a matter of urgency. There has been progress towards new nuclear investment, but whether this will proceed remains uncertain. One key driver across these technologies will be the Electricity Market Reform.
- **Buildings**. There has been progress on loft and cavity wall insulation and boiler replacement, but very limited progress on solid wall insulation and uncertainty over the extent to which people are purchasing the most efficient appliances. Going forward, it will be challenging to sustain an extensive loft and cavity wall insulation programme, and to ramp up solid wall insulation.
- **Renewable heat**. The Renewable Heat Incentive (RHI) was introduced in 2011 but currently is only available for non-residential installations. There has been very little uptake of renewable heat in the residential sector, which is problematic given the need to make significant progress here to meet carbon budgets (e.g. analysis for the fourth carbon budget assumes deployment of the order of several million residential heat pumps).
- **Industry**. Energy efficiency improvements may have been implemented in 2011. But much has to be done to make progress on the use of sustainable bioenergy and deployment of CCS.
- **Transport**. There has been good progress on new car emissions, which continue to outperform our indicator, but very limited progress on vans. There is concern that miles travelled increased across modes in 2011 and a risk that emissions will rise as the economy recovers. On electric vehicles, although conditions are in place to support market development, this is yet to happen at any scale and therefore remains a major challenge. A plan for full roll-out of Smarter Choices is required, as is more effort to support eco-driving, where rates of training have been very low.
- **Agriculture**. Although emissions in 2010 were in line with our indicator trajectory, there was an increase of 0.7% relative to 2009. Of particular concern was the increase in the use of fertiliser for crop production even though output fell.
- **Waste**. Emissions from waste fell in 2010, continuing a long-term trend, but there remains scope to go further.

- It will be crucial to develop and implement new policies generally, and specifically to support electricity sector decarbonisation, energy efficiency improvement and investment in residential renewable heat.
  - **Electricity Market Reform (EMR)**. Progress has been made on EMR, most notably through the Government stating this will be based on long-term contracts for low-carbon power generation and submitting enabling legislation for pre-legislative scrutiny. It is important now that a clear carbon objective is set for the EMR (i.e. to achieve carbon intensity of the order of 50 gCO_2/kWh in 2030 through investment in a portfolio of low-carbon technologies), to provide investor confidence that there will be a market for low-carbon technologies built to schedule and cost, and that there will not be a second dash for gas. Specific commitments on minimum levels of less mature technologies should be made subject to cost reductions being achieved. There are also a number of detailed design questions which should be resolved as a matter of urgency so that the EMR can be implemented from 2014.
  - **Green Deal and Energy Company Obligation (ECO)**. The Government has responded to our concerns around initial proposals consulted on in the autumn of 2011. The final design of the Green Deal and the ECO is likely to result in additional installations of cavity wall and loft insulation relative to very low levels under original proposals, as well as the insulation of around a million solid walls. However, incentives for the insulation of easy-to-treat cavity walls and lofts remain weak, and installation numbers projected by DECC remain substantially below our indicator trajectories, resulting in a carbon gap of at least 3 $MtCO_2$. Options to strengthen incentives for loft and cavity wall insulation should be developed. More generally, we will closely monitor the Green Deal and ECO to determine whether they deliver sufficient carbon savings.
  - **Residential renewable heat**. The residential sector is currently covered by a small-scale grant programme which has failed to deliver even against a low level of ambition. Given the importance of developing a residential renewable heat market to build supply chains and consumer acceptance, the Renewable Heat Incentive (RHI) should be made available to the residential sectors as soon as possible. Green Deal finance should also be made available in conjunction with the RHI to cover at least the additional costs of renewable heat investment compared to conventional alternatives. Approaches to address non-financial deployment barriers should be introduced.

Box 1: Summary of recommendations in 2012 progress report

Power

- Urgently resolve financial uncertainty for renewable projects by confirming support levels under the Renewables Obligation.
- Move forward with demonstration of carbon capture and storage (CCS), selecting projects by end-2012 and closing by end-2013; include gas CCS demonstration; develop long-term strategy including commercialisation approach (e.g. support for the next phase of investment following demonstration), storage sites and approach to CO_2 pipeline investment which anticipates future demand.
- Set a clear carbon objective for the Electricity Market Reform (EMR) (i.e. to achieve a carbon intensity of the order of 50 gCO_2/kWh by 2030 through investment in and development of a low-carbon technology portfolio); make commitments on minimum level of investment in less mature technologies subject to cost conditions being met.
- Set out detailed implementing arrangements for EMR by the end of 2012; allow renewable projects to be considered for early eligibility for Contracts for Difference under EMR (along with nuclear and CCS); make EMR support for intermittent generation as close to feed-in tariffs as possible.
- Ensure a major role for the Green Investment Bank in mobilising project finance for offshore wind investment (e.g. to reach around 12 GW by 2020).
- Engage with EU partners to strengthen the carbon price in the EU ETS.

Buildings

- Strengthen incentives for loft and cavity wall insulation prior to launch of the Green Deal in autumn 2012.
- Retain the CRC, but with reduced administrative burden, and redesigned league table to strengthen reputational incentives. Consider scope for rationalisation of policies covering the non-residential sector to one carbon price instrument, in conjunction with league tables and mandatory carbon reporting.
- Start the non-residential Green Deal no later than January 2013.
- Announce ambitious standards for private rented regulation in the non-residential sector by the end of 2013.
- Include the residential sector in the Renewable Heat Incentive (RHI) from summer 2013, make eligible for Green Deal finance in conjunction with the RHI, and introduce approaches to address non-financial barriers.

Industry

- Set out approaches by the end of 2012 (in the forthcoming industry strategy) to increase use of sustainable bioenergy in large industry and to develop and deploy CCS.

Transport

- Consider options to strengthen incentives for purchase of more efficient vans.
- Reverse budget decision on company car tax for electric vehicles.
- Set out, by summer 2013, an approach to fully roll out Smarter Choices nationwide.
- Include eco-driving as a key element in the practical driving test.
- Enforce the current motorway speed limit.

Agriculture

- Develop a robust framework for monitoring changes in farming practice based on survey data by the end of 2012.
- Set out by the end of 2012 triggers for introduction of new policies going beyond the current voluntary approach.

Waste

- Develop specific strategies by the end of 2013 to increase diversion of food, paper and card from landfill.

Data

- Improve the evidence base on energy efficiency of appliances, district heating, surface transport emissions by mode, agriculture emissions, waste emissions.

We set out the analysis that underpins these conclusions in 11 parts:

1. Economy-wide emission trends
2. Non-traded sector emissions
3. Traded sector emissions
4. Progress reducing power sector emissions
5. Progress reducing emissions from buildings
6. Progress reducing emissions from industry
7. Progress reducing transport emissions
8. Progress reducing emissions from agriculture
9. Progress reducing waste emissions
10. Progress reducing emissions in the devolved administrations
11. Current and future funding for implementation of measures

1. Economy-wide emissions trends

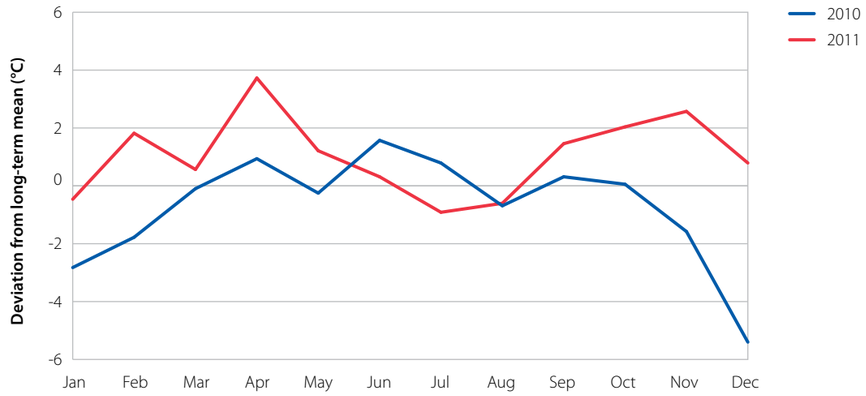
The context for our assessment in this report is one of milder winter temperatures, falling household real income, slightly rising GDP, and rising energy and fuel prices.

- The winter months in 2011 (i.e. January, February and December) were around 4^{0}C warmer than the previous year and there were 27% fewer heating degree days (HDD) over the year (Figure 1).
- GDP grew by only 0.7% in 2011, following growth in 2010 of 2.1%. Within this, manufacturing output grew by 2.0%, while household real disposable income fell by 1.2% (Figure 2).
- Wholesale gas price increases in 2011 resulted in a 9% (7% in real terms) increase in residential gas prices, and an 8% (6% in real terms) increase in residential electricity prices (Figure 3).
- In the transport sector, petrol prices rose by 14% (11% in real terms) and diesel prices rose by 16% (14% in real terms) (Figure 4).

Economy-wide emissions in 2011 fell by 7% to 547 $MtCO_2e$, reflecting reductions in both CO_2 and non-CO_2 emissions (Figure 5).

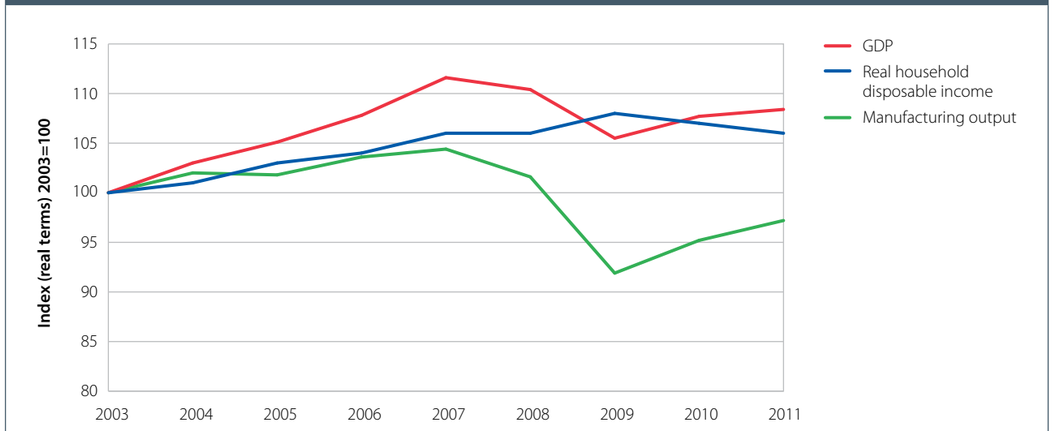
- CO_2 emissions fell by 8% in 2011 to 456 $MtCO_2$, reflecting reduced emissions from buildings, industry and power generation.
- Non-CO_2 emissions fell by 2% to 90 $MtCO_2e$, continuing long-term trends.

Figure 1: Average daily temperature – deviation from long-term mean (2010 and 2011)



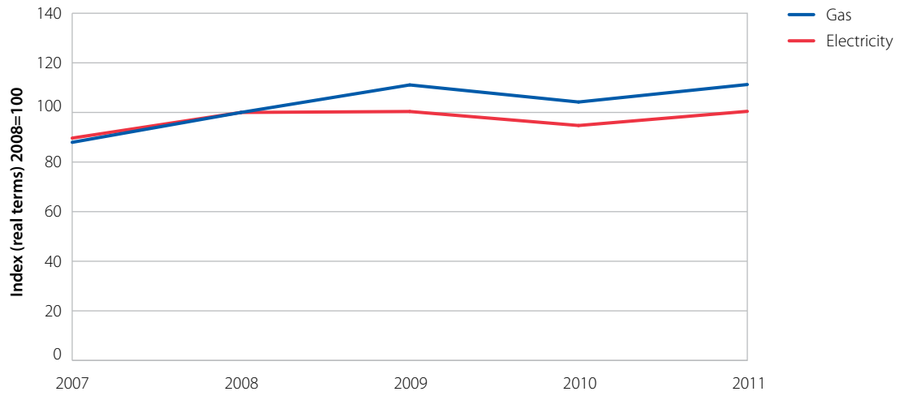
Source: DECC (March 2012) *Quarterly Energy Prices* Table 4.1.2.
Notes: The long-term mean for each month is mean temperature between 1971-2000.

Figure 2: UK Economic Indicators (2003-2011)



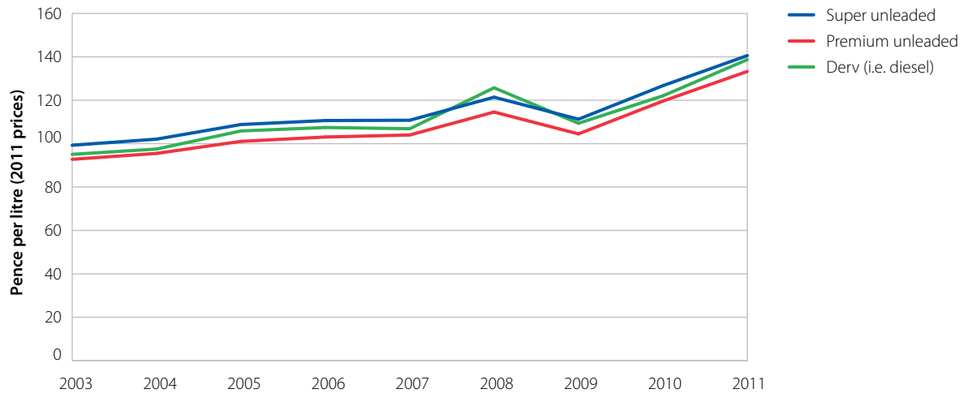
Source: ONS (2012) *Quarterly National Accounts.*

Figure 3: Fuel prices in the residential sector (2007-2011)



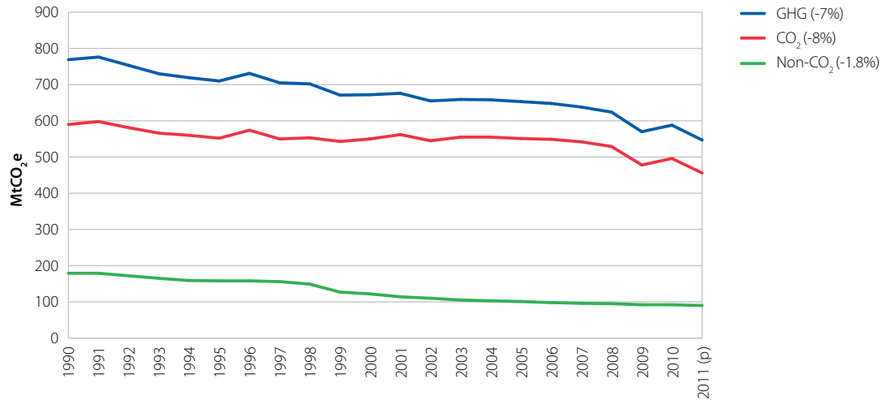
Source: DECC (March 2012) *Quarterly Energy Prices* Tables 2.2.1 and 2.3.1.

Figure 4: Petrol and diesel prices (2003-2011)



Source: DECC (March 2012) *Quarterly Energy Prices* Table 4.1.2.

Figure 5: UK greenhouse gas emissions (1990-2011)



Source: DECC (2012) 2011 *UK greenhouse gas emissions, provisional figures*.

The key emissions driver in 2011 was the milder winter weather which resulted in reduced demand for heat in buildings:

- The emissions reduction after allowing for the weather effect was 4% between 2010 and 2011.
- Emissions reduction due to substitution of nuclear for fossil fuel power generation accounts for only a small part (around 0.4 percentage points) of this 4% reduction.
- Implementation of measures for which we have evidence accounts for emissions reduction of around 0.8 percentage points.
- It is likely that most of the remaining reduction can be attributed to the combination of reduced household real income and increased energy and fuel prices, partially offset by the impact of increased GDP.

Going forward, the key external drivers are likely to be weather, income, and energy and fuel prices:

- On average, winter temperatures can be expected to be slightly lower than in 2011 (e.g. by the 2020s mean winter temperatures across the UK are predicted to be around 5°C[1], compared to 5.4°C in 2011).
- From 2011 to 2020 the OBR projects GDP to grow by 20-25% in real terms, with household incomes also growing but at a slightly slower rate.

1 UK Climate Projections http://ukclimateprojections.defra.gov.uk/

- Fossil fuel prices are highly uncertain, but wholesale gas and electricity prices in DECC's central projection increase to 2020 by 11% and 16% respectively. Retail gas and electricity prices in the residential sector are predicted to increase by 19% and 36% respectively and average petrol prices by 5%.

Combined with falling household income and rising fuel prices, implementation of measures was sufficient to reduce emissions in 2011. However, with stronger income growth in future and limited changes projected in fuel prices, implementation of measures will need to accelerate to deliver the 3% annual emissions reductions required to meet future budgets.

2. Non-traded sector emissions

Non-traded sector emissions primarily comprise direct emissions (i.e. emissions from burning fossil fuels, not from electricity use) from buildings and non-energy-intensive industry, and emissions from surface transport; they comprise around 60% of total UK greenhouse gas emissions.

Non-traded sector emissions in 2011 fell by 7% to 326 $MtCO_2e$, mainly due to mild winter temperatures which reduced demand for heat in buildings

- The non-traded sector emissions reduction between 2010 and 2011 after allowing for the impact of milder winter weather was 2%.
- Implementation of measures to reduce emissions accounts for around 1% of this 2% reduction.
- The remainder of the reduction is likely to be explained by falling real household income, and rising energy prices, resulting in further reduced heat demand. This may have been partially offset by impacts due to increased GDP, and within this, to increased industrial output and increased surface transport demand.

Our indicators of underlying progress reducing emissions set out trajectories for key emissions drivers for each of the major emitting sectors. The indicators incorporate an assumption of some but limited progress implementing measures during the first carbon budget period, reflecting the fact that there is a lead time for development of new and ambitious policies. Going beyond the first budget period, the indicators build in an acceleration in the rate of progress required to meet carbon budgets, and as should be possible given implementation of new policies (Table 1).

Table 1: Required ramp-up in delivery in the non-traded sector

	Annual uptake/improvement		
	Required Budget 1 average	**Required Budget 2 average**	**Required Budget 3 average**
Residential buildings			
Loft insulation (million homes)	0.9	2.1	n/a
Cavity wall insulation (million homes)	0.8	1.4	n/a
Solid wall insulation (homes)	90,000	150,000	220,000
Efficient boilers (millions)	1.0	0.9	0.7
Renewable heat			
Renewable heat penetration (% of heat demand) total	0.1%	0.8%	2.4%
Road transport			
New car emissions intensity (gCO_2/km)	-3.8	-6.0	-5.8
Biofuels penetration (% by vol)	0.7%	0.7%	0.4%
Car drivers undertaking eco-driving training	300,000	320,000	340,000
Electric car sales (PHEV/BEV)	5,000	130,000	450,000

Source: OFGEM (2012) *CERT Update Quarter 15*, DCLG (2012) *Housing statistics – Table 241*, Heating and Hotwater Council (2012), DECC (2012) *Estimates of home insulation levels in Great Britain*, DECC (2011) *DUKES Table 7.7*, SMMT (2012) *New Car CO_2 Report*, SMMT (2012), HMRC (February 2012) *Hydrocarbon Oils Duties Bulletin*, Energy Saving Trust (2012), CCC calculations.

Progress against indicators in 2011 was broadly on track, albeit against the limited ambition in our indicator framework for the first budget period, but with slippage in some key areas (Table 2).

- **Surface transport**. The carbon intensity of new cars was ahead of our indicator trajectory for a third year running, while there was some progress in laying the foundations for electric vehicle market development, but limited progress on measures to encourage consumer behaviour change.
- **Buildings**. There was continued progress on boiler replacement with mixed progress on insulation measures. Loft and cavity wall insulation were broadly on track against our indicator trajectory, but levels of solid wall insulation remained very low.
- **Renewable heat**. In 2010, overall renewable heat penetration was ahead of trajectory based on deployment in the non-residential sectors. Although 2011 data on renewable heat penetration are not yet available, other data (i.e. from the RHI and RHPP) suggest continued progress in the non-residential sectors but very limited progress in the residential sector.

Table 2: Progress against measures in the non-traded sector

	Annual progress†			Cumulative progress‡	
	2010 outturn	**2011 outturn**	**2011* indicator**	**2011* outturn**	**2011* indicator**
Residential buildings					
Loft insulation (millions)	0.5 (CERT professional) + 0.8 (DIY & other)	0.8 (CERT professional) + 0.3 (DIY & other)	0.6	2.4 (CERT professional) + 1.5 (DIY & other)	2.2
Cavity wall insulation (millions)	0.4	0.5	0.6	2.1	2.4
Solid wall insulation	13,000	19,000	120,000	60,000	330,000
Efficient boilers (millions)	1.3	1.3	1.0	4.9	4.0
Renewable heat					
Renewable heat penetration (% of total heat demand)	+0.2%	n/a	0.0%	1.8%	1.2%
Road transport					
New car gCO_2/km	-5.3	-6.1	-4.7	138.1	151.0
Biofuels penetration (% by volume)	+0.7%	-0.1%	+0.6%	3.5%	4.0%
Car drivers trained in eco- training	9,700	8,000	300,000	23,000	885,000
Electric car sales (PHEV/BEV)	170	1,100	8,100	1,300	13,000

Source: OFGEM (2012) *CERT Update Quarter 15*, DCLG (2012) *Housing statistics – Table 241*, Heating and Hotwater Council (2012), DECC (2012) *Estimates of home insulation levels in Great Britain*, DECC (2011) *DUKES Table 7.7*, SMMT (2012) *New Car CO_2 Report*, SMMT (2012), HMRC (February 2012) *Hydrocarbon Oils Duties Bulletin*, Energy Saving Trust (2012), CCC calculations.
Notes: *2010 for renewable heat. †Annual progress represents additional uptake/improvement in 2011 (2010 for renewable heat) relative to the previous year. Cumulative progress represents: for residential building measures, total additional installations between 2007 and 2011; for road transport measures, level achieved in 2011; for renewable heat penetration, level achieved in 2010.

Continuation of the rate of progress on measures achieved in 2011 would be sufficient to meet the first and second carbon budgets, but not the third and fourth budgets (Figure 6):

- Even after allowing for the effect of the milder winter weather in 2011, emissions were below the level of the first carbon budget. This is a result of the significant emissions reduction in 2009 due to the recession.
- The permanent loss of income associated with the recession together with continued progress implementing measures as in 2011 would also be sufficient to meet the second carbon budget.
- However, an acceleration in the rate of progress implementing measures – as set out in our indicator framework – will be required if deeper emissions cuts required to meet the third and fourth carbon budgets are to be achieved.

Therefore the conclusion we have reached in previous reports – that there is a need for a step change in the pace at which measures are implemented – continues to apply. When we first highlighted this need, we recognised there would be a lead time of several years. However, the

Figure 6: Non-traded sector emissions based on continued implementation of measures in 2011 (2007-2027)

Source: NAEI (2012); DECC (2012) *2010 UK Greenhouse gas emissions, provisional figures*; CCC calculations.
Notes: *As proposed in our 2008 report, the Intended budget (2008-2022) corresponds to the UK share of an EU 30% 2020 target. We recommended it should be enacted in the context of a global deal to reduce emissions. **Based on the Baseline scenario from DECC (2011) UEP, net of estimated savings ensuing from continued uptake of measures at the rates seen in 2011, until 2022 or until full potential is realised (e.g. all lofts have been insulated), whichever is sooner. Trajectory has been smoothed.

lead time has now elapsed. The step change in pace of implementation is therefore needed urgently if we are to remain on track to meeting future carbon budgets. Achieving the step change will depend on the effectiveness of policies, which we consider in our sectoral analysis below.

3. Traded sector emissions

UK traded sector emissions

The traded sector includes territorial emissions covered by the EU Emissions Trading Scheme (EU ETS)[2], namely emissions from power generation, energy-intensive industries (e.g. refineries, iron and steel and cement production) and from 2012, emissions from domestic aviation and some non-CO_2 emissions. It accounted for around 40% of total greenhouse gas emissions in the UK in 2011, of which around two-thirds were emissions from the power sector and around one-third from energy-intensive industries.

Under the accounting rules of the Climate Change Act, the traded sector carbon budget is measured according to net emissions (i.e. emissions adjusted for trade in allowances) and should therefore automatically be met. This is because any emissions above the budget will be offset through the purchase of European Union Allowances (EUAs) or offset credits in the EU ETS.

However, it is important that gross emissions (i.e. before adjusting for trade in allowances) in the traded sector are reduced in order that longer-term emissions pathways required under the Climate Change Act remain feasible. For example, we have highlighted the importance of early power sector decarbonisation in the context of meeting the 2050 target to reduce emissions by 80% on 1990 levels.

2 It currently excludes emissions from international aviation

Gross emissions in the traded sector fell by 7% in 2011 to 221 $MtCO_2e$, driven by reductions in both power and industry.

- Power sector emissions reduced 7%, accounting for 4% out of the overall 7% reduction.
- Energy-intensive industry emissions reduced 8%, accounting for the remaining 3% of the overall 7% reduction.

As a result, given the impact of the recession in 2009, traded sector emissions were below the level of the EU ETS cap in 2011, suggesting either that the UK is a net exporter of EUAs or that UK firms are holding EUAs with a view to meeting EU ETS obligations in future periods.

We consider underlying emissions trends in power and industry, and whether these are compatible with meeting carbon budgets, in sections 4 and 6 below.

EU traded sector emissions and wider international action

Traded sector emissions at the EU level have important implications for the UK via the carbon price in the EU ETS.

Traded sector emissions in the EU fell by 2% in 2011, partly offsetting a 3% rise in 2010 (Figure 7).

The consequence of this reduction was that emissions remained below the level of the EU ETS cap in 2011. Given this headroom, and limited effort required to meet the cap in future, the EU ETS price fell to €7/tCO_2 in December 2011, from €14/tCO_2 in 2010. There have been further reductions in the early months of 2012, reaching lows of around €6/tCO_2.

The low carbon price is very problematic, both for the UK and EU, because it will dampen incentives for cost-effective emissions reduction, and because it signals a low level of emissions reduction ambition at the EU level.

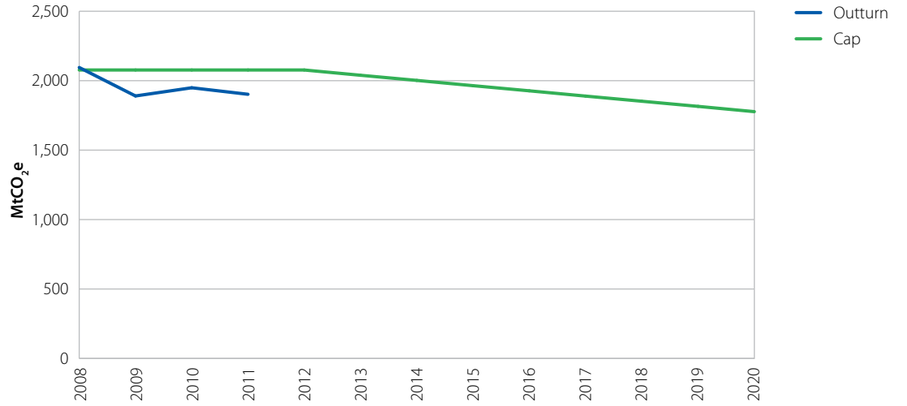
Options for addressing the low carbon price at EU level include:

- Tightening of the existing EU ETS cap to 2020 (e.g. through holding back and retiring EUAs).
- Underpinning the EU ETS carbon price (e.g. through setting a reserve price in auctions of EUAs).
- Agreeing ambitious EU emissions reduction targets for 2030.

The UK should strongly support measures which would increase EU ambition to 2020 and drive up the EU ETS price, strengthening incentives in the UK and putting the EU on a more cost-effective path to achieving its 2050 target.

Increasing EU ambition would also be constructive in the context of international climate negotiations, where progress has been made but significant risks remain:

Figure 7: Emissions within the EU ETS versus cap (2008-2020)



Source: European Commission (April 2012) *Verified emissions data for 2011;* European Commission (22 October 2010) *Commission Decision 2010/364/EU.*
Notes: Excludes international aviation.

- The latest United Nations Conference of the Parties was held in Durban in December 2011. Parties are committed to limiting global warming to 2°C, but noted the significant gap between this objective and the current emissions pledges for 2020. The Durban Platform paves the way for agreement on a new, globally comprehensive deal to be implemented by 2020, although the level of ambition it will set on emissions reduction has yet to be agreed.
- A number of countries and jurisdictions have begun to act through committing to ambitious emission reductions, enacting new legislation and introducing cap-and-trade schemes. These include China, Australia, South Korea and Mexico, as well as the state of California and the province of Quebec.
- The International Energy Agency (IEA) has highlighted the risks in further delaying rapid global action. It concludes that 80% of total CO_2 emissions allowed to 2035 are already "locked in" by existing infrastructure. Without further action before 2017 this will reach 100%, meaning that all subsequent stock would have to be zero-carbon (or high-carbon infrastructure would need to be scrapped prematurely) to be consistent with a 2°C trajectory.

It is also important that the EU starts discussion of a 2030 package including overall ambition, a split of emissions reduction effort between traded and non-traded sectors, and potential sectoral targets (e.g. for new car emissions in 2030). Providing this long-term visibility for investors would address uncertainties relating to the period beyond 2020 which currently undermine the low-carbon investment climate across the EU, and could help strengthen the carbon price alongside other measures.

The UK should pro-actively engage in discussion on the 2030 package in order to put the EU on a cost-effective pathway to meeting its 2050 target and buttress commitments that have already been made here through legislation of the fourth carbon budget.

4. Progress reducing power sector emissions

Power sector emissions reductions

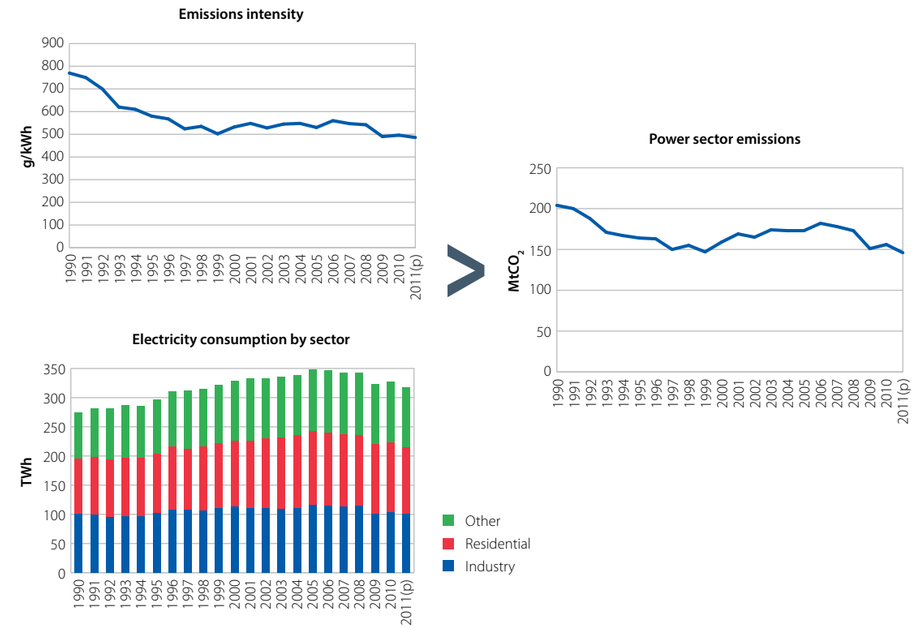
Power sector emissions account for around 27% of UK greenhouse gas emissions. Provisional data for 2011 suggests power emissions fell by 7% from 156 $MtCO_2$ in 2010 to 146 $MtCO_2$. The power sector emissions reduction in 2011 was due to reductions in demand and carbon intensity of generation (Figure 8).

- Demand fell by 4%, largely as a result of falling consumption in the residential (-5%) and industrial sectors (-4%), due to higher average temperatures during 2011. After adjusting for changes in temperature, residential demand fell by around 1%.
- Carbon intensity fell by 2%, from 496 gCO_2/kWh in 2010 to 486 gCO_2/kWh in 2011 due to an increased share of renewables and nuclear generation in the mix.
  - There was a 31% (8 TWh) increase in renewable generation, due to favourable weather conditions for wind and hydro as well as an increase in capacity (2.9 GW).
  - Nuclear generation also increased by 11% (6 TWh), reflecting plants returning to operation after maintenance outages in 2010.
  - Gas generation fell 30% (29 TWh) and coal generation stayed broadly flat, reflecting favourable conditions for coal versus gas over the year.
  - Had there been more fuel switching (i.e. a reduction in coal, rather than gas generation, which a higher carbon price would have helped incentivise) carbon intensity could have fallen by 14%.
- Emissions fell by 7% (10 $MtCO_2$) in 2011. Following an increase in 2010 due to unusually cold weather and temporary nuclear outages, they are now roughly back at their level of 2009 (when temperatures and nuclear generation were at similar levels).

Achievable emissions intensity is the carbon intensity of electricity that would be achievable if power plants were despatched to the grid in order of least emissions rather than least cost, and if they were available to generate as often as in an average year. In 2011, achievable emissions intensity improved by 35g, from 308 gCO_2/kWh in 2010 to 273 gCO_2/kWh. This shows that there is scope to reduce current emissions intensity by over 200g (40%) through fuel switching away from highly carbon-intensive fuel (i.e. coal and oil) to gas.

To assess underlying progress reducing emissions, as opposed to changes driven by fluctuations in demand and nuclear load factors, our indicators focus on investments in low-carbon technologies.

Figure 8: Emissions intensity of electricity supply, electricity demand and CO_2 emissions from the power sector (1990-2011)



Source: CCC calculations, DECC (March 2012) *Energy Trends*, DECC (March 2012) *Provisional 2011 results for UK greenhouse gas emissions and progress towards targets.*
Note: 2011 data are provisional.

Progress against power sector indicators: wind generation

Investment in onshore and offshore wind continued in 2011, but at one-third of the rate required by 2020. Although there is a healthy project pipeline, there are barriers which are preventing consented projects entering construction, and stopping projects moving through planning in a timely manner.

- Investment in offshore wind was in line with our indicators (0.5 GW), but will need to ramp up quickly (e.g. to 1.1 GW per year in 2016, 1.8 GW per year in 2020). Investment in onshore wind increased slightly (to 0.6 GW) but fell short of our indicator trajectory for a second year in a row, and well below the levels required by 2020 (1.5 GW).
- There is already sufficient capacity in the project pipeline to meet our 2020 indicator onshore and our 2017 indicator offshore. However, planning approval rates for onshore capacity have fallen to around 50%, and determination periods remain long. There is also evidence that onshore projects with approval are moving slowly through to construction. This is likely to reflect current uncertainties over support mechanisms and difficulties with radar interference and grid connection; the supply chain appears healthy. We would expect a similar bottleneck for offshore wind unless uncertainties and barriers are addressed.

In order to address these barriers, the Government and regulators should:

- Confirm support for projects under the Renewables Obligation, which has been delayed due to an ongoing debate about support for onshore wind. Any decision to reduce support from the initially proposed level of 0.9 ROCs (Renewable Obligation Certificates) should be made based on a full assessment of investment prospects (e.g. across the distribution of projects in the pipeline). To the extent that lower support would reduce the number of viable projects, an assessment of alternative means for meeting the 2020 renewable energy target should be undertaken.
- Ensure that the planning process appropriately accounts for the benefits of onshore wind, in order to avoid higher levels of investment in more expensive technologies that would have adverse affordability impacts. For example, onshore wind could be as little as half the cost of offshore wind.
- Ensure clarity over the details of support under the Electricity Market Reform (EMR), including a provision for renewable projects to be considered for early eligibility for Contracts for Difference (e.g. in 2013); and design support under EMR for intermittent projects to be as close as possible to feed-in tariffs.
- Explore options to address barriers to finance, such as intervention from the Green Investment Bank (GIB).
- Continue to work with industry, the Ministry of Defence and others to address radar interference strategically and collaboratively.
- Bring forward the grid connection dates for projects and confirm final arrangements for transmission pricing.

Given appropriate actions, it is realistic that ambitious renewable energy targets for 2020 can be achieved, and that wind generation can make a valuable contribution to power sector decarbonisation required to meet carbon budgets.

Progress against power sector indicators: nuclear

There was continued progress on forward indicators for nuclear new build, with Parliamentary approval of the Nuclear National Policy Statement and submission of the planning application for the first new plant (Hinkley C).

However, significant risks remain, and the project pipeline is weak. For example, the Horizon venture to build new plants in Wylfa and Oldbury recently stalled and is now up for sale, with a buyer yet to come forward. This 5 GW investment is important in the context of delivering required power sector decarbonisation.

The key determinant of whether projects will proceed – Hinkley C, Wylfa, Oldbury and others – will be the EMR, which if designed correctly should help make investments financially viable (see below).

There is scope for life extensions of existing nuclear plants to help manage the transition (e.g. extensions of 5-7 years on existing lifetimes of seven of the eight existing nuclear plants have been proposed).

Progress against power sector indicators: carbon capture and storage (CCS)

Although there was a setback on CCS when the first demonstration project was abandoned in October 2011, there has been progress subsequently, with the announcement of a new competition supported with the £1 billion of capital funding originally earmarked for the first demonstration. This would be sufficient to support the four demonstration projects committed to in the Coalition agreement, provided it is supplemented with additional funding through the Electricity Market Reform and possible funding from the EU.

The new process has addressed some of the weaknesses in the first demonstration competition. It is open to a wider range of fuels and CCS technologies, while the sharing of CO_2 transport and storage infrastructure is encouraged. Projects will be selected by the end of 2012, to commence operation in the period 2016-2020.

Given the urgent need to prove the viability of CCS, it will now be crucial to maintain the focus on delivery and the momentum that currently exists, and to deliver these projects towards the beginning of the 2016-2020 period.

Although commencing operation around 2017 would represent some slippage relative to our original indicator – which envisaged four demonstration projects starting to operate between 2014 and 2016 – this would still be consistent with having a second phase of investment from the early 2020s, and a significant contribution to power sector decarbonisation over the next two decades and beyond.

It will be important that there are four demonstration projects in order to provide critical mass, both for testing alternative applications in the UK, and for the UK to collaborate with international initiatives. Ideally at least one project would be based on gas, given the potential importance of gas CCS for decarbonising mid-merit generation, and benefits that it would offer in a low gas price world.

In order to deliver these and future milestones for CCS, progress is needed on Electricity Market Reform (EMR) and a strategy for commercialisation and infrastructure:

- **EMR**. Early delivery will require that the reforms, or transitional funding arrangements, are in place to enable contracts for CCS projects to be signed in 2013.
- **Commercialisation**. Going beyond the initial projects, and depending on what is learned from them, it will be important that ambition is sustained and that further projects follow. In order to provide confidence for supply chain investment, greater clarity should be provided on the scale of such investments, and the circumstances under which they would proceed.
- **Infrastructure**. A strategic approach to CO_2 infrastructure, including development of scenarios for the scale and location of CCS deployment to 2030, would help to identify 'least regret' sizing of pipeline infrastructure and would also provide greater credibility to carbon capture readiness assessments.

It is crucial, with progress in these areas together with successful demonstration, that we exploit the potential for CCS to play a major role in power sector decarbonisation in the 2020s.

Progress against policy milestones: the Electricity Market Reform

There has been progress in reforming electricity market arrangements in the last year, with enabling legislation submitted for pre-legislative scrutiny as part of the Draft Energy Bill. Most notably, the Government accepted the Committee's recommendations and announced that the model for the Electricity Market Reform (EMR) will be based on long-term contracts ("Contracts for Difference") to provide revenue security for investors. This should bring forward required investments at least cost to the consumer.

In this report we present new analysis which reinforces our conclusions that early power sector decarbonisation (i.e. to the order of 50 gCO_2/kWh by 2030) is an appropriate objective across a wide range of scenarios for gas and carbon prices:

- Investing in low-carbon technologies over the next two decades offers significant cost savings under central case assumptions about gas and carbon prices compared to the alternative of investing in unabated gas-fired generation.
- Even under extreme assumptions about low gas prices, cost penalties from investment focused on low-carbon technologies are limited, if any.
- Significant departure from the early decarbonisation path would not only raise costs, but require higher build rates for low-carbon capacity in the 2030s and 2040s which may challenge the limits of feasibility.

However, there remains a perceived risk that there will be a second 'dash for gas'. This perception was heightened with the announcement in March 2012 of an Emissions Performance Standard (EPS) that would allow continued operation of unabated gas-fired plant through to 2045. A second dash for gas would be a very bad thing, given the clear advantage of a low-carbon path (i.e. it would increase costs and risks of meeting carbon budgets).

This uncertainty undermines the investment climate and should be resolved. This could be achieved through the Government making a clear statement that the objective of EMR is to decarbonise the power sector to 2030 through delivering a portfolio of low-carbon technologies provided these can be built to schedule and cost.

Specifically, an appropriate objective for the EMR would be to reduce the carbon intensity of the UK power generation sector to a level of the order of 50 gCO_2/kWh by 2030, to be achieved through investment in a portfolio of low-carbon technologies. Some flexibility should be retained over the precise path, to be determined as current uncertainties are resolved over costs, carbon prices, achievable build rates, and the level and shape of demand. Delivering on the objective will require that low-carbon investments are pursued where these are cost-competitive with unabated plant over their lifetimes, and that technology support will be provided for less mature technologies.

We therefore recommend that, in the context of new energy legislation, a carbon objective should be set and a process put in place to ensure that this objective is achieved (i.e. a set of checks and balances so that the delivery plan proposed by the System Operator and approved by the Government is consistent with the objective). There should also be a clear statement as part of the Government's planned Gas Generation Strategy that there will not be a second 'dash for gas', but rather sufficient low-carbon plant will be contracted to ensure that gas largely plays a back-up role by 2030.

In addition, it is important that technology policy objectives are set to resolve current uncertainties about the future for less mature technologies. For example, the current lack of visibility around the offshore wind market beyond 2020 is a barrier to required supply chain investment, This could be addressed through setting minimum levels of offshore wind (and other less mature technologies) to be supported through the EMR subject to cost conditionalities being met (e.g. the Government's commitment that 18 GW of offshore wind would be supported by 2020 subject to costs being reduced to £100/MWh could be extended out to 2025, by which time there is more chance that this level of cost reduction can actually be achieved).

Finally there are also a number of detailed design questions which should be resolved by the end of this year in order that the EMR can be implemented from 2013, and to ensure that contracts are bankable and projects can attract financial support (see Box 2).

Box 2: Electricity Market Reform

There are currently a number of risks related to contract design which the Government needs to address:

- **Financial security**. Investors have raised concerns about the financial security of Contracts for Differences. For example, in the absence of Government guarantees, there are questions about how investors would be protected against future changes in legislation. In addition, if contracts are to be multi-party – between a generator and all suppliers in the market – this could make resolution of disputes problematic.
- **Price risk**. There is a risk of divergence of prices paid to generators in the market and reference prices in Contracts for Difference. This risk could be mitigated by choosing the reference price for intermittent generation so as to make Contracts for Differences equivalent to feed-in tariffs.
- **Cost risk**. Investors have limited control over various cost components. For example, at least some of construction cost is exogenous to investors (e.g. the wage rate), as are fossil fuel prices (i.e. these are relevant for CCS projects). There are economic arguments that such costs should be shared between investors and consumers, through indexing of prices in Contracts for Differences, which would result in reduced cost of capital and overall benefit to consumers.
- **Demand risk**. There is uncertainty over the future load factor of low-carbon plant, given uncertainty over how much baseload demand will grow. Given this uncertainty, Contracts for Differences which remunerate generators only through operating payments could result in unnecessarily high prices. The alternative, to provide both fixed and operating payments would result in lower overall prices paid.
- **Storage risk**. This is an issue in the context of CCS investment, where generators will not operate storage facilities, and will have limited ability to manage storage risk. Offering a payment to generators which relies on successful storage would raise risks for generators, at best increasing costs and possibly stopping investment.

These risks need to be addressed to ensure that EMR can fulfil its key objective of bringing forward low-carbon investment at least cost.

Given clear objectives and detailed effective implementing arrangements, it is plausible that significant investments will be forthcoming across the range of low-carbon technologies.

This is something that should be closely monitored, with the possibility that further incentives may be needed if there were to be limited investment in low-carbon capacity (e.g. limiting the running hours of new unabated gas-fired plant deployed in the 2020s should not be ruled out at this stage).

5. Progress reducing emissions from buildings

Buildings emissions trends

Emissions from buildings account for 35% of total UK greenhouse gas emissions. In 2011, buildings emissions fell by 13% to 186 $MtCO_2$, mainly as a result of the milder winter weather in 2011 compared to the cold 2010 winter months. Weather adjusted, emissions fell by 3.5%.

- **Residential buildings**. Total residential CO_2 emissions fell by 16% in 2011 to 122 $MtCO_2$ due a combination of energy efficiency measures, higher electricity and gas prices and relatively mild winter months in 2011.
  - Direct emissions account for 55% of total residential emissions and fell by 22% in 2011. This reduction can be explained largely by the mild weather in 2011, with rising gas prices (up 7% in real terms) and the implementation of energy efficiency measures also playing a role.
  - Indirect emissions account for 45% of residential emissions and fell by 8% in 2011. The key factors were a slightly lower carbon intensity of power generation (see Chapter 2), the milder weather affecting heating-related electricity use (20% of residential electricity use) and rising electricity prices (6% increase in 2011).
- **Commercial buildings**. In 2011, commercial sector emissions fell by 5% to 47 $MtCO_2$, despite a small rise (1.6%) in output.
  - Direct emissions fell by 8% in 2011, primarily due to milder winter weather and the rising gas price.
  - Indirect emissions fell by 4% in 2011, due to a combination of the milder weather, higher electricity prices and a fall in the carbon intensity of power generation.
- **Public buildings**. Public sector emissions in 2011 fell 4% to 17 $MtCO_2$.
  - Direct emissions, accounting for around half of public sector emissions, fell 6% in 2011, primarily because of the reduced use of heating fuels due to the milder winter weather.
  - Indirect emissions decreased by 3% in 2011, largely due to the improvement in carbon intensity of power generation.

Buildings emissions in 2011 were 18 $MtCO_2$ below our indicator trajectory, mainly reflecting the impact of the recession (around 10 $MtCO_2$), together with relatively mild weather in 2011 and increases in energy prices.

This raises a question about the extent of the future emissions reduction effort required to meet carbon budgets (e.g. the first and second carbon budgets could be achieved with limited effort given the impact of the recession). The crucial point is that the implementation of all the measures that we have previously identified is still required to meet the third and fourth carbon budget, notwithstanding the impacts of the recession.

Progress against residential buildings indicators

Progress implementing energy efficiency measures in the residential sector has been mixed:

- **Loft insulation**. Professional installations increased by 62% to 0.8 million and are in line with our overall indicator. DIY installation figures decreased by 57% to 0.3 million, although there is a concern over the reliability of DIY data.
- **Cavity wall insulation**. Installations increased by 22% to 0.5 million but are still below our indicator trajectory.
- **Solid wall insulation**. While the rate of installations increased by 25%, numbers are still very low, with only 20,000 delivered in 2011.
- **Boiler replacement**. 1.3 million efficient boilers were installed in 2011. Although this is a reduction of 4% relative to 2010, this is not necessarily of concern, particularly given that uptake in 2010 is likely to have increased due to boiler scrappage schemes operating in that year.
- **More efficient appliances**. There are no data to assess the sale of energy-efficient appliances for 2011, due to a lack of monitoring by government. However, new energy efficiency minimum standards under the EU Ecodesign for Energy Related Products Directive will gradually eliminate the most inefficient appliances.

It is important to note that our indicators include a rapid increase in the pace of loft, cavity wall and solid wall insulation from 2012. The key driver for achieving this step change will be the Green Deal and the Energy Company Obligation (ECO).

Progress against residential policy milestones: the Green Deal and ECO

In October 2011, the Government passed the Energy Act which sets out the new framework for energy efficiency policy:

- **Green Deal**. Provisions in the Act enable a new financing framework to facilitate energy efficiency improvements and low-carbon heating measures in homes and non-residential properties. This is funded through a charge on energy bills that avoids the need for consumers to pay upfront costs, with the charge attached to the house rather than the owner, and paid back through the energy bill savings. The Green Deal for homes will launch in autumn 2012.
- **ECO**. This obligation on energy suppliers will replace CERT and CESP, as well as (in England) the fuel poverty programme (Warmfront). The ECO will have three separate targets to support energy efficiency measures in fuel-poor households, fund carbon-saving measures in low-income areas and subsidise solid wall insulation and hard-to-treat cavity wall insulation. The ECO will operate from October 2012 to March 2015.
- **Energy efficiency standards**. The Act includes a provision for minimum energy efficiency standards in the private rented sector from 2018.

In a December 2011 letter to the DECC Secretary of State, we expressed concern that with an ECO primarily focused on solid wall insulation (as initially proposed) and uncertainty about uptake under the Green Deal, insufficient numbers of lofts and cavity walls would be insulated. We recommended that the ECO should be made more flexible, and that this should include loft and cavity wall insulation, at least for a transitional period.

The Government announced its final design for the Green Deal and ECO in June 2012, with some significant changes that should result in more cavity walls and lofts being insulated, relative to the very low numbers in the initial proposal.

However, incentives for easy-to-treat cavity wall and loft insulation remain weak, and the estimated installation numbers are substantially below our insulation indicator trajectories, thus resulting in a potential carbon gap of at least 3 $MtCO_2$.

Options to strengthen incentives, which should be considered prior to the launch of the Green Deal in autumn 2012 include:

- Spend some of the £200 million funding made available by the Treasury for the initial phase of the Green Deal to support loft and cavity wall insulation.
- Roll any underperformance against CERT and CESP targets into the ECO.
- Link loft and cavity wall insulation to boiler replacements and extensions via the building regulations as currently being considered by the Government.
- Introduce fiscal incentives to encourage energy efficiency improvement (e.g. stamp duty or council tax differentiation according to energy performance).

The Green Deal and ECO will require close monitoring to determine whether they deliver sufficient carbon savings, with flexibility retained to further modify design and introduce additional measures as appropriate.

Progress in the non-residential sector: the CRC Energy Efficiency Scheme

The main policy covering the non-residential sector is the CRC Energy Efficiency Scheme (previously Carbon Reduction Commitment). In 2010, we published our recommendations for the capped phase of the scheme. Subsequently, the government decided to postpone the start of the scheme and dropped both the trading aspects and revenue recycling. Participants will have to purchase their first allowances covering their emissions for 2011-12 in June/July 2012.

In addition, in April 2012 the Government published a consultation on proposals to simplify the scheme and has said that if no significant reduction in administration costs can be achieved, it would abolish the CRC and replace it with a straight tax.

In considering the future of the CRC, it is important to recognise that the scheme offers a potentially powerful combination of financial and reputational incentives for energy efficiency improvement. This is in a sector where incentives have traditionally been weak, and where there is a significant opportunity to improve energy efficiency (e.g. our analysis suggests scope for a 30% reduction in energy consumption by 2020). Dropping revenue recycling has weakened but not totally eroded the financial incentives that the scheme provides.

The Government's simplification proposals would not undermine these incentives, and therefore should be welcomed to the extent that they result in a reduced administrative burden.

However, abolition of the scheme now would risk weakening incentives for energy efficiency improvement. This would be premature, particularly given evidence that the CRC has resulted in a greater focus on measuring energy consumption. The CRC should therefore be retained, at least for the time being.

In retaining the scheme, it is important that design changes are implemented to ensure that the scheme does actually provide reputational incentives, and that complementary levers are in place:

- **Reputational incentives**. These work through the league table, the first version of which was published in November 2011. Changes to the league table are required, so that it provides better reputational incentives. In particular, the table should be disaggregated such that comparable organisations are benchmarked against each other.
- **Complementary levers**. These include a provision in the Energy Act for minimum energy efficiency standards in commercial rented properties, as well as the non-residential Green Deal. Ambitious standards under the Act should be announced as soon as is practical (i.e. no later than the end of 2013), as well as an early start date for the non-residential Green Deal (i.e. no later than January 2013). This would strengthen incentives for energy efficiency improvement and help inform investment decisions with long-lived consequences to be taken by landlords.

There may also be opportunities over time to rationalise multiple policies that currently cover or impact on the non-residential sector (e.g. Climate Change Levy, Climate Change Agreements, EU ETS), and to provide financial and reputational incentives through a combination of the Climate Change Levy together with the new rules on mandatory carbon reporting that were announced in June 2012.

Progress in the public sector

As we noted in previous reports, it is imperative for its credibility that Government set an example and address its own emissions. In 2010-11, central government outperformed its target for a 10% reduction in CO_2 emissions and reduced emissions by 13.8% in 3,000 buildings on the central government estate. Some government departments achieved much larger reductions, for example the Department for Education achieved a 21.5% reduction, closely followed by 21.3% by DECC. In 2011, central government set itself a new target to reduce greenhouse gas emissions from the whole estate and business-related transport by 2015 by 25% from a 2009/10 baseline.

Progress on low-carbon heat

There is a crucial longer-term role for heat pumps in decarbonising the buildings sector to meet the 2050 target. In order to prepare for this, our indicators include renewable heat penetration of 12% in the buildings sector by 2020.

In 2011, the Renewable Heat Incentive (RHI) was introduced to promote the take-up of renewable heat technologies, although initially it has been restricted to the non-residential sector. To March 2012, around 5 MW of capacity had been accredited under the RHI, with the vast majority of this accounted for by biomass boilers.

In the residential sector, grants have been made available under the Renewable Heat Premium Payment (RHPP) but take-up has been low, with the first phase (August 2011 to March 2012) only allocating 60% of the available grants (worth £15 million).

There remains a major challenge to support investment in renewable heat in the residential sector. For example, the just over 2,500 residential heat pump installations under the RHPP can be compared to the 2.6 million installations by 2025 assumed in our analysis for the fourth carbon budget. The very limited progress to date suggests a risk that significantly increased levels of investment will not be achieved:

- In order to manage this risk, the Government should extend the RHI to the residential sector as a matter of urgency (e.g. no later than summer 2013, as currently proposed). This would provide confidence to industry about ongoing funding, and would provide a basis for investment in supply chain development, training and marketing. Inclusion should be on a basis compatible with what is required to meet the fourth carbon budget.
- Green Deal finance should also be made available in conjunction with the RHI to cover at least the additional costs of renewable heat investment compared to conventional alternatives; this would otherwise be a barrier to uptake in capital-constrained households.
- In addition, it is likely that there will also be non-financial barriers to deployment (e.g. lack of consumer information, lack of trust in renewable heat technologies and installers). The Government should set out its approach to addressing these barriers, as it has done for building fabric measures in the context of the Green Deal.

With action in these three areas we would expect to see increased uptake of these crucial technologies.

6. Progress reducing emissions from industry

Emissions from industry fell by 5% in 2011, reflecting a 6% drop in CO_2 emissions (both direct and indirect fell by 6%) and a 2% drop in non-CO_2 emissions. The extent to which these reductions reflect underlying progress is uncertain due to data constraints. However, it is unlikely that these reductions reflect fuel switching or reductions in output, suggesting that energy efficiency improvements may have been implemented in 2011:

- **Fuel switching**. Given that energy demand fell broadly in line with emissions in 2011 (7% and 6% respectively), fuel switching is unlikely to be a significant driver of lower emissions in 2011. This is borne out in data on fossil fuel consumption by industry, where the shares of various fossil fuels remained broadly constant.
- **Output**. Although overall manufacturing output in industry increased by 2%, large differences across industry sectors make it difficult to relate output and emissions for 2011. However, an initial assessment of the impact of output on emissions suggests that the net impact is broadly flat.
- **Energy-efficiency**. High fuel prices and increased investment are consistent with progress in energy efficiency in 2011; however there is a lack of direct evidence to substantiate this.

Industry emissions in 2011 were 7% below our indicator, largely because of reduced output during the recession and changed relative fuel prices that have encouraged switching to less carbon-intensive fuels.

In future reports we will use more disaggregated industry data to better understand the extent of underlying progress.

Key opportunities for reducing industry emissions over the next two decades are the use of sustainable bioenergy and carbon capture and storage (CCS) technology:

- **Bioenergy**. Modelling for our fourth carbon budget report suggested that bioenergy could meet around 25% of industry heat demand by 2030 within sustainability limits. In the near-to-medium term, our indicators envisage 13% penetration in industry by 2020.
- **CCS**. This is promising for application in a range of energy-intensive industries (e.g. iron and steel), and could result in around a 20% emissions reduction from current levels in industry over the longer term. Although widespread deployment of CCS in industry will not start until the 2020s at the earliest, it is important that approaches to deployment are developed now, given the long lead-times for investment and supporting policy development.

However, there is a need for policy development in both these areas:

- **Bioenergy**. In our 2011 Renewable Energy Review we suggested that the support levels indicated in the RHI consultation document were broadly aligned with requirements. But, in response to concerns about State Aid, the tariff level for large biomass installations was significantly reduced, resulting in low projected uptake relative to what is required in the longer term.
- **CCS**. The new competition for CCS demonstration is open to applications from industrial installations when these form part of a cluster (i.e. the application must also contain at least one power sector installation). This may be a cost-effective option for the CCS competition, but it is uncertain how this will develop and stronger incentives may be required.

Given the need to significantly reduce industry emissions to meet carbon budgets, and therefore to make progress both on the use of bioenergy and CCS, the Government should elaborate its approaches in both these areas, and show that conditions are in place to provide confidence that longer-term objectives will be achieved. This should be part of the forthcoming industry strategy, to be published by the end of the year.

7. Progress reducing transport emissions

Surface transport emissions trends

Surface transport emissions account for 24% of UK CO_2 emissions. Following two years of decline, there was no change in surface transport CO_2 emissions in 2010[3].

Data on distance travelled, biofuels and new vehicle emissions suggest that car emissions fell in 2010, while van and HGV emissions increased:

- Car travel fell by 2% in 2010, biofuel penetration increased from 2.1% to 3.2% and new car CO_2 emissions fell by 3.5%, from 149.5 gCO_2/km to 144.2 gCO_2/km.
- Van travel increased by 0.9% in 2010, while biofuel penetration was unchanged. These outweighed the improvement in new van CO_2 emissions which fell by 4.9% from 206 gCO_2/km to 196 gCO_2/km.
- HGV travel rose by 0.4% in 2010. Combined with a slight fall in biodiesel penetration and a worsening of HGV fleet emissions intensity, this suggests an increase in overall HGV CO_2 emissions.

A provisional assessment for 2011 suggests that CO_2 emissions may have fallen overall:

- Total car travel in 2011 increased 0.5% on 2010 levels. New car CO_2 emissions fell a further 4.2% to 138.1 gCO_2/km, though the emissions impact of this improvement was muted given low car sales (see below). Biofuel penetration increased marginally (up by 0.1% on 2010). The combination of these effects is that car emissions are likely to have decreased by around 1.8% in 2011.

3 Provisional 2011 results for UK greenhouse gas emissions include total transport emissions, but not the constituent components (road transport, rail transport, domestic and international aviation and shipping). Estimates of surface transport emissions in 2011 are therefore not available.

- Total van travel in 2011 increased 3% on 2010 levels, which combined with a slight decrease in biofuel penetration and limited improvement in new van efficiency suggests that van CO_2 emissions may have increased by up to 3.1% between 2010 and 2011.
- Total HGV travel in 2011 increased 0.3% on 2010 levels, and there was a fall in biofuel penetration, suggesting that CO_2 emissions may have increased by up to 0.8% between 2010 and 2011.

The increase in car and van distance travelled between 2010 and 2011 cannot be explained simply through changes in fuel prices and income. It is possible that other factors were important (e.g. car travel was low in 2010 partly due to the particularly heavy snowfall in the winter months) and/or that the increase in miles reflects the fact that data are preliminary and typically subject to significant revision before they are finalised. We will continue to monitor trends in miles data to establish whether there has been a structural change in the relationship with demand drivers. Although we envisage a small increase in miles travelled over the next decade in line with official projections, significant increases would be a matter for concern in the context of meeting carbon budgets.

Since CO_2 emissions by mode are not directly measured, these must be estimated from other sources. We have reviewed the estimation methodology used to develop the National Atmospheric Emissions Inventory (NAEI) and concluded that this produces implausible estimates of emissions by mode. We therefore recommend that a new methodology should be developed based on accurate data for fleet efficiency.

Progress against indicators: new car and van emissions

New car emissions continued to fall significantly in 2011, and continue to outperform our indicator, although the impact of this will be dampened given relatively low new car sales:

- Average new car CO_2 emissions in 2011 were 138.1 gCO_2/km, compared to 144.2 gCO_2/km in 2010 and 149.5 gCO_2/km in 2009. This compares to our indicator of 150.5 gCO_2/km for 2011.
- New car emissions fell across all car classes in 2011, by an average of 4.6% in each class. However, there was a slightly higher share of larger, higher-emitting cars in the total in 2011, which reduced the overall reduction in new car CO_2 to 4.2%
- New car sales fell in 2011 to 1.9 million units, from 2.0 million units in 2010 and a pre-recession (2002-2007) average of 2.5 million units.

Drivers of progress reducing new car emissions are likely to have been the EU new car CO_2 regulations, together with supporting fiscal policies (e.g. Vehicle Excise Duty (VED) differentiation according to CO_2 emissions). In addition, it is likely that the combination of the recession and higher fuel prices have resulted in increased weight being attached to fuel efficiency in the car purchase decision. This is therefore something we will closely monitor in future as the economy recovers, particularly as road demand remains strong. For example, it may be necessary to further differentiate VED to support achievement of EU targets.

In comparison to new car emissions, there was much less progress on new van emissions (these decreased by only 0.5% from 196 gCO_2/km in 2010 to 195 gCO_2/km in 2011). Although we expect that this would pick up following implementation of the new EU legislation agreed in May 2011, the Government should consider scope for use of complementary policy levers to strengthen incentives (e.g. fiscal levers).

Progress against indicators: electric vehicle market development

There is increasingly robust evidence showing that there is in principle a major role for ultra low emissions vehicles (e.g. battery electric, plug-in hybrid and hydrogen fuel cell) in meeting the 2050 GHG reduction target.

Given long lead-times for technology innovation and changing consumer preferences, it is important to lay the foundations now for electric vehicle market development. This is reflected in our scenarios for meeting carbon budgets, which envisage around 1.7 million electric vehicles on the road in 2020, rising to around 11 million by 2030. This path is compatible with a close to 100% share of electric vehicles in new vehicles by the mid 2030s, and a close to 100% electric vehicle fleet by 2050.

The Government has made progress developing policies to support electric vehicle market development, extending the Plug-in Car Grant to vans, with subsidies of £5,000 for cars and £8,000 for vans. Development of electric vehicle charging infrastructure has begun, with around 6,000 charge points installed across the UK in the period to end-March 2012.

Electric vehicle sales in 2011 were low, partly reflecting the fact that a limited number of models had come to market (only four electric car models were available to purchase on the UK market in 2011). However, a further five models have since been introduced in 2012, and a considerable range are currently under development and due to come to market in the near future.

Given the limited availability of electric vehicles in 2011, and that take-up in early years of new technologies is naturally expected to be slow, the low uptake in 2011 is not a matter of major concern. Rather, electric vehicle uptake should be closely monitored over the next several years, during which further approaches to addressing any barriers to uptake may be needed.

In the Budget 2012 it was announced that company car tax exemption for electric vehicles would be withdrawn from 2015/16. This decision will not raise significant revenue, given low sales of electric vehicles. However, it will undermine incentives for purchase of electric vehicles as company cars, a market niche where there is a potentially high share of early adopters. Given the importance of electric vehicles, scope for uptake as company cars, and limited tax revenues from electric vehicle sales, the budget decision should be reversed.

Progress against indicators: consumer behaviour change

Behaviour change offers around 35% of total abatement potential in surface transport to 2020. Key measures are Smarter Choices (i.e. encouraging people to switch to public transport and other means to reduce car journeys), eco-driving (i.e. encouraging people to drive in a way that maximises fuel efficiency), and enforcing the existing speed limit.

Progress towards roll-out of Smarter Choices has been good – although more is needed – with limited progress on eco-driving training, and the risk of a backward step on limiting speed:

- **Smarter Choices**. In February 2011 the Government committed £560 million funding from the November 2010 Spending Review to support sustainable travel through the Local Sustainable Transport Fund. A high-level assessment suggests that this could support roll-out of Smarter Choices across 25% of the UK. While this is positive, it leaves much to do in terms of comprehensive implementation. There is therefore a need to build on early projects and develop plans for a full roll-out of Smarter Choices over the next decade.
- **Speed limits and their enforcement**. Rather than enforcing the current speed limit on motorways, the Government is considering increasing this to 80 mph. This would both increase emissions, and provide a negative signal more generally about the Government's commitment to meeting carbon budgets. It would also increase the number and severity of accidents, and is based on a highly questionable economic rationale. We therefore strongly urge that the Government should include an appraisal of and consult on enforcing the existing speed limit as part of its proposed consultation on increasing the speed limit.
- **Eco-driving training**. The level of eco-driving training remained very low in 2011. Although eco-driving is a very cost-effective measure, the risk is that this opportunity will remain unexploited. To encourage eco-driving, the Government should consider including this as a key element in the practical driving test, and consider options to increase eco-driving training and other opportunities to provide information on fuel consumption and other benefits of eco-driving.

Going forward, the challenges are therefore to implement and then extend the current programme of Smarter Choices, to increase levels of eco-driving, and to consider enforcing rather than raising the current speed limit.

8. Progress reducing emissions from agriculture

Agriculture emissions account for around 9% (51 $MtCO_2e$ in 2010) of total UK greenhouse gas emissions.

The key gases are nitrous oxide emissions, arising largely from fertiliser use on land for crops and pasture (56% of agricultural emissions) and methane emissions from livestock (36% of agricultural emissions).

Agricultural emissions increased by 0.9% in 2010, with livestock-related emissions increasing by 1.1% and crop-related emissions by 0.6%.

The increase in livestock-related emissions reflected an increase in output of 3.2%. The fact that the emissions increase was less than in proportion to output suggests reduced carbon intensity of production and can be explained by productivity improvements in meat and dairy products and improved carbon intensity of grassland.

The increase in emissions related to crop production reflects increased carbon intensity (up 1.3%), driven by a significant increase in the use of inorganic fertiliser per unit of output (up 3.9%), whilst overall output fell (down 0.7%). This is of particular concern and runs counter to the reduction required if agriculture emissions are to be reduced and carbon budgets achieved. The context is one where there was a small (5%) increase in the price of fertiliser in 2010, following a significant reduction in 2009 (33%).

Although emissions in 2010 were in line with our indicator trajectory, the evidence base for assessing progress reducing emissions remains incomplete (i.e. we do not have a systematic understanding of current farming practice, and therefore potential for reducing emissions through changing practice). In order to address this, a framework of indicators and supporting data on farming practices should be established by the end of 2012, and clear milestones set for the Government's project to develop a smart emissions inventory.

The Government's policy review includes a number of useful elements but should be broadened in scope to consider the full range of policy options (e.g. carbon price, cap and trade, regulation) and circumstances under which it would be appropriate to move from the current voluntary approach to one with stronger incentives for action. Triggers for moving from the current voluntary approach should be set out by the end of the year.

9. Progress reducing waste emissions

Waste emissions, mostly methane, account for around 3% of UK greenhouse gas emissions. In 2010 (the latest year of data available), waste emissions fell by 3%, continuing a longer-term trend whereby emissions have fallen 64% over the period since 1990. This is largely due to a reduction in biodegradable waste sent to landfill in response to the landfill tax, which was introduced to meet targets under the EU Landfill Directive. It also reflects an increase in the share of emissions assumed to be captured at landfill sites

The Government projects emissions will be reduced by a further 22% by 2020 relative to 2010 (i.e. a 72% reduction from 1990) in line with targets under the Directive for diverting waste away from landfill.

The Government's strategy to deliver reductions in waste emissions is centred around further increases in the landfill tax, but may not effectively incentivise actions throughout the waste chain (e.g. households threw away 4.4 million tonnes of food waste that could have been avoided in 2010 and less than half of English local authorities have introduced separate collections for food waste in response to the landfill tax). The Waste Review (2011) set out further measures, with a focus on waste prevention programmes and voluntary responsibility deals rather than regulatory measures.

Greater reductions are possible (particularly for food and paper/card waste), given opportunities for waste prevention and for using non-landfill disposal options such as recycling, composting, and energy from waste. While the costs associated with these opportunities are uncertain, increased ambition may be desirable, given that legacy emissions from waste may make future carbon targets harder to meet (i.e. once biodegradable waste is landfilled it will continue to emit methane for many years) and given potential co-benefits from waste reduction and alternative waste treatments (e.g. anaerobic digestion can contribute towards the UK's renewable targets).

We therefore recommend that the Government considers increasing its ambition for emissions reductions from waste. In particular, specific strategies for reducing both food and paper/card waste sent to landfill should be developed, given the potential to do more in these areas.

Since the Government's approach also carries the risk that there may not be sufficient action to drive further reductions, the effectiveness of waste policy should be carefully monitored throughout the waste chain, with stronger levers introduced as needed (e.g. recycling targets, mandatory sorting and collection requirements, and landfill bans/restrictions).

10. Progress reducing emissions in the devolved administrations

Final emissions data for 2009 (the most recent available) show a large fall in emissions in all devolved administrations, which, as for the 9% fall in UK emissions in 2009, was primarily due to the drop in economic activity during the recession.

- Emissions fell 7% in Scotland to 48.1 $MtCO_2e$, with the largest falls in non-residential buildings (12%), industry (11%), and the power sector (7%).
- Emissions fell 14% in Wales in 2009 to 42.6 $MtCO_2e$, with significant falls in the power sector (23%), industry (16%) and non-residential buildings (12%).
- Emissions fell 8% in Northern Ireland in 2009, with the largest falls in power (24%) and industry (21%).

Energy data for 2010, together with EU ETS, temperature and macroeconomic data, suggest emissions are likely to have increased in 2010 across the devolved administrations. At the UK level, emissions fell 7% in 2011; it is likely that emissions will also have fallen in the devolved administrations in 2011, given milder winter weather and large reductions in emissions observed in the energy-intensive sectors in the EU ETS.

Progress has been made in the last year by each of the devolved administrations in continuing to develop emission reduction strategies and targets:

- The Scottish Government legislated emission reduction targets to 2027. These follow advice provided by the Committee and reflect a halving of 1990 emissions by 2025.
- The Welsh Government has produced its first update on progress meeting emission reduction targets and refreshed its climate change strategy.
- The Northern Ireland Executive has increased the emission reduction target for Northern Ireland from a 25% reduction to a 35% reduction by 2025 relative to 1990 and published its first annual report on progress. Following advice from the Committee on the appropriateness of climate change legislation in Northern Ireland, the Environment Minister is now taking forward plans for a legally-binding climate change framework.

Our assessment of progress so far in implementing these programmes is that there are a number of positive areas. These include progress increasing renewable capacity, implementing energy efficiency and fuel poverty programmes, developing firm and ambitious policies on waste and, in the case of Scotland, improving afforestation rates. However major challenges remain in meeting the increase in effort across all sectors that will be needed to meet future emission reductions and continued action to develop and implement policies across all sectors will be vital. Key areas of devolved powers include transport demand-side measures, energy efficiency, waste, agriculture and land use, though there is also an important role in the development and implementation of UK policy, such as the EMR.

11. Current and future funding for implementation of measures

It will be important that policies are adequately funded through a combination of Exchequer and levy funding:

- Some of the required funding will be provided from budget revenues (e.g. for investment in renewable heat, support for electric vehicle market development, roll-out of Smarter Choices programmes).
- Funding for energy efficiency under the ECO will come from consumer levies.
- Funding for low-carbon generation (e.g. under the Renewables Obligation and Electricity Market Reform) will come from consumer levies covered by the Levy Control Framework. This provides a funding cap, and is set by HM Treasury.

For policies covered by budget revenues, our high-level assessment – set out in previous reports – is that funding for the current Spending Review period (2011/12 – 2014/15) is broadly adequate, but that further and increased funding will be required for the next period. It is important to note that revenues from carbon policies will also increase (e.g. from the carbon price underpin).

For the ECO (which will be funded through consumer levies but which is outside of the Levy Control Framework), the Government has recently confirmed that around £1.3 billion will be available; there is uncertainty over whether this will support required emissions reductions (see discussion of the Green Deal above).

Our assessment of the current Levy Control Framework suggests that it is broadly consistent with what is required to deliver the renewable power investments in our indicator framework to 2015.

In the period to 2020 increased Levy Control funding will be required to support achievement of renewable energy targets and carbon budgets (e.g. our analysis suggests a funding requirement of the order £8 billion in 2020 in real terms).

As we have shown in our analysis of energy bill impacts,[4] the implication of costs of this order for the typical dual-fuel household is an increase in annual energy bills in 2020 of around £100; there is scope for energy efficiency improvement to broadly offset this.

Clarity on Levy Control future funding would be helpful given long project lead times. This could best be provided by agreeing a funding envelope (i.e. around £8 billion in 2020), together with flexibility mechanisms in recognition that future funding costs are highly uncertain (e.g. the funding requirement could be +/- 20-25% depending on gas prices and low-carbon technology costs).

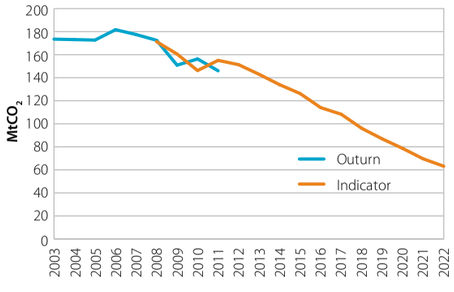
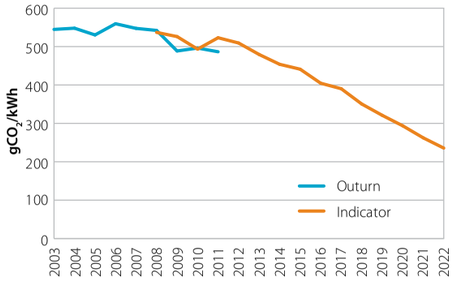
Funding will be a crucial determinant of whether future carbon budgets will be achieved, with the need to ensure that commitments made for the current Spending Review period are maintained, and that adequate funding is provided for the next Spending Review period. This is required under the Climate Change Act (Section 13) which states that policies must be in place – and by implication funded – to meet carbon budgets. We will continue to monitor and provide more detailed analysis of funding in future progress reports.

4 CCC (December 2011) *Household energy bills – impact of meeting carbon budgets.*

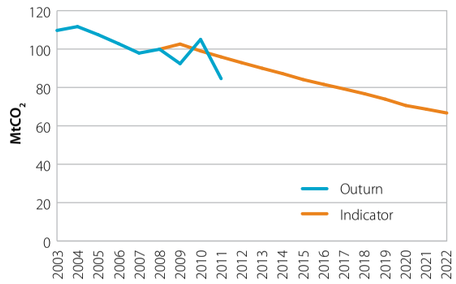
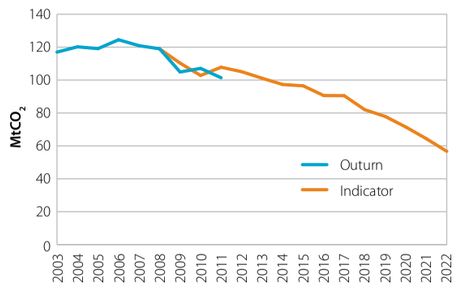
Summary of progress against indicators and future challenges

Economy-wide

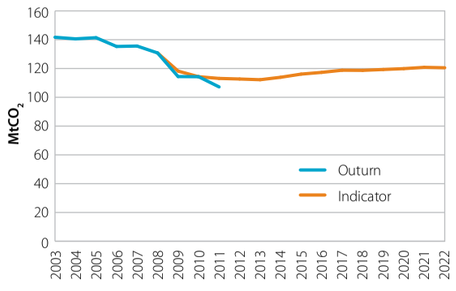
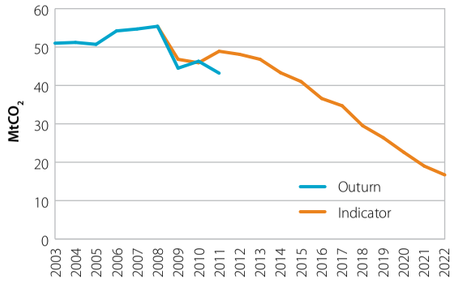
Fall in emissions in 2011 largely reflects warm weather and other transitory factors. Implementation of measures reduced emissions by around 1%.
Implementation of measures was broadly on track, though some areas continue to lag behind even the low ambition built into our indicators for the first budget period. A step change in the rate of implementation is now needed urgently as we move into budget two.
There has been progress developing policies but a number of key policy challenges remain (e.g. a clear objective for the EMR, strengthening incentives for investment in renewable heat).

		Progress against indicators and milestones	Challenges
Power			
Emissions  **Emissions intensity**  	**Market**	White Paper (July 2011) confirmed long-term contracts for low-carbon capacity.	Needs a clear carbon objective and process to ensure this is delivered. Detailed design issues need to be resolved.
	Transmission	Some transmission owner business plans approved by Ofgem, progress on gaining planning approval for some key investments, review of charging system for transmission network completed.	Still a need for approval of the National Grid business plan and planning approvals for some infrastructure, especially in Wales.
	Planning	An increasing stock of onshore wind projects awaiting approval. Declining approval rates. The average time taken for wind projects to be determined remains high (e.g. up to 55 months for large scale onshore), and well above our indicator and guidance (12 months).	Deployment is at risk if there is a continuation of the decline in approval rates.
	Wind	Total installed capacity broadly in line with our indicators, but with slow progress from approval to commissioning for onshore projects.	Significant acceleration in the pace of investment required in longer-term. Resolution of financial and non-financial uncertainties required in order to translate the strong project pipeline into generation.
	Nuclear	Generic Design Assessment received interim approval, final approval expected by end 2012. National Policy Statement for nuclear approved in July 2011. First planning application submitted for approval.	Successful implementation of the Electricity Market Reform is required for nuclear investment to proceed.
	CCS	First competition failed to award funding to projects. Second competition launched in 2012.	Urgent need to award funding this year to facilitate the first demonstration plant becoming operational as soon as possible (e.g. from 2017).

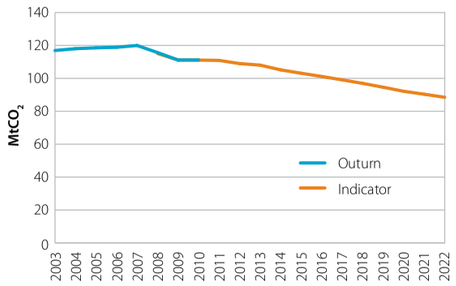
Summary of progress against indicators and future challenges

		Progress against indicators and milestones	Challenges
Buildings			
Direct emissions  **Indirect emissions**  	**Residential**	Delivery increased in 2011 for cavity wall, solid wall and professional loft insulation but fell for DIY loft insulation. Good progress on boilers.	Uptake of insulation measures is likely to fall substantially after the end of CERT.
		Energy Act 2011 set up the framework for the Green Deal and the Energy Company Obligation as successor to CERT.	Uncertainty over uptake of measures due to market-based nature of Green Deal. Additional measures may be needed.
		ECO to focus on solid wall insulation and hard to treat cavity wall insulation, as well as fuel poverty measures.	ECO and Green Deal uptake figures are potentially well below numbers needed for carbon targets. Amount of money available for fuel poverty measures is reduced which may be an issue for energy affordability in low income households.
		Minimum energy efficiency standards for private rented properties to be introduced in 2018.	Standards should be introduced earlier.
	Non-residential	Green Deal for non-residential sector to start in 2013.	Voluntary uptake of Green Deal expected to be low.
		First CRC league table published. CRC simplification proposals and suggestion of possible abolition.	Abolition would be premature in the absence of other effective policy levers.
		Minimum standards for rented premises proposed from 2018.	Standards need to be firmed up soon to ensure that landlords make relevant appropriate investment decisions.
		Public sector – central government 10% reduction target for 2010-11 achieved and new target set for 2015.	Abolition of national indicators for local authorities – unclear whether there are now enough incentives for emission reductions across all local authorities.
	Renewable heat	RHI started for the non-residential sector in November 2011. Residential sector RHI delayed until 2013, small grant scheme available.	Lack of interest in residential grant system. RHI needs to be available to residential sector as soon as possible. Need to resolve uncertainty about RHI beyond 2015.

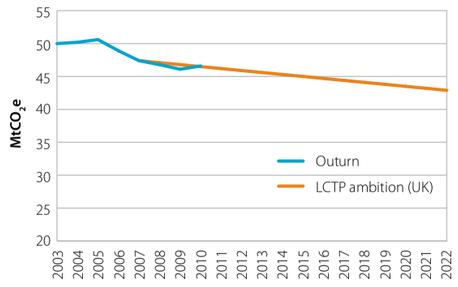
Summary of progress against indicators and future challenges

		Progress against indicators and milestones	Challenges
Industry			
Direct emissions  Indirect emissions 	**Energy intensity**	To be reported next year	
	Renewable heat	Good progress, ahead of indicator trajectory.	Given that large biomass installations are likely to be a priority in future, Government should closely monitor uptake and set out an approach to large scale applications of biomass.
	CCS	CCS competition announced that is open to industry if part of a cluster.	Limited progress internationally. Need to outline approach to CCS development and deployment.
	Other milestones	New design of CCAs announced which reduce the scope of coverage to non-EUETS emissions only, and does not address barriers to uptake.	Significant barriers remain in industry, new policies are required to provide stronger incentives, particularly for investment in more expensive measures. The Governments forthcoming industry strategy provides an opportunity to set out how gaps in the current policy framework can be filled, and more confidence provided over implementation of the measures that we have highlighted, and that are also included in the Governments carbon plan.

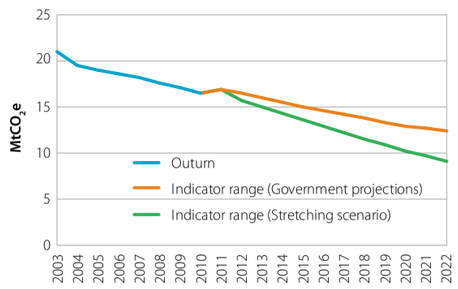
Summary of progress against indicators and future challenges

		Progress against indicators and milestones	Challenges
Road transport			
Direct emissions 	**New car fuel efficiency**	Significant improvement in new car gCO_2/km, reduced by small shift towards larger, higher-emitting cars.	To ensure continued progress, potentially through use of fiscal levers if required.
	Reducing van emissions	In May 2011, EU adopted a limit of 147 gCO_2/km for new vans by 2020.	To ensure new vans in the UK achieve the EU target.
	Development of electric car market	Price support of up to £5,000 for purchase of electric cars came into effect in January 2011. Grants of £8,000 were introduced in January 2012 for electric vans. Funding had been provided for eight Plugged-in Places (PiP) pilots in different parts of the country. Commitment to mandate and to deliver a nationwide strategy for national recharging network for electric vehicles.	Need deployment targets for 2020. Greater price support may be required to support early market. Budget 2012 announcements on removal of tax exemptions for company cars from 2016 threaten progress and should be reversed. Substantive investment in public charging infrastructure is necessary. Continued implementation of the PiP programme is crucial to providing investor confidence.
	Increased use of biofuels	Biofuels penetration remained broadly unchanged in 2011. Still on track to meet our indicator for 2020.	Sustainability criteria for biofuels need to be strengthened to ensure that indirect land use impacts are minimised.
	Smarter Choices	Local Sustainable Transport Fund is sufficient to roll out Smarter Choices to around 25% of the UK by 2015.	Further funding will be required to support full roll out by 2020.
	Eco-driving	Very low levels of eco-driving training in 2011.	Consider steps to facilitate large-scale roll out though inclusion of eco-driving in the practical driving test, and consider other options to increase eco-driving.
	Speed limiting	Almost 50% of drivers violated speed limits on motorways in 2010, resulting in increased emissions.	Proposals to raise the speed limit will increase emissions. Government should consult on stricter enforcement of existing speed limits.
	Land use/transport planning	New National Planning Policy Framework published in March 2012.	To ensure that the new framework results in appropriate land use planning decisions by monitoring decisions on new developments and their implications for emissions.

Summary of progress against indicators and future challenges

		Progress against indicators and milestones	Challenges
Agriculture			
GHG emissions  	**Agriculture**	Phase 1 of the GHG Industry Action Plan completed in 2012.	More detail required on Phase 2 delivery: resolving the funding arrangements for the roll-out of the Farm Efficiency Hub, and the establishment of a framework to monitor progress.
		Government policy review due end of 2012.	Policy assessment should include the full range of options and a set of triggers for the introduction of new policies if voluntary measures fall short of agreed savings set out in the LCTP.
		Government is developing a longer-term evaluation framework of performance indicators to track progress reducing emissions, with supporting data on farm practices.	Should be established as a matter of urgency.

Summary of progress against indicators and future challenges

		Progress against indicators and milestones	Challenges
Waste			
GHG emissions  	**Waste**	Recent revisions to emissions inventory and projections show emissions were lower in 1990 relative to previously modelled, have fallen more quickly and will continue to decrease faster than previously expected. The Government's Waste Review (2011) aims to put the UK on a path towards a 'zero waste' economy with the landfill tax remaining a key driver and with a commitment to implementing measures targeting actions across the waste chain. AD Strategy and Action Plan also published.	Data limitations mean that that the precise level of emissions remains uncertain, and makes monitoring of progress difficult. The costs and carbon benefits from some landfill diversion treatments are poorly characterised/ understood. Higher ambition for waste emissions reductions should be considered. Barriers to recycling/sorting/separate food waste collection and energy from waste (e.g. AD) may require stronger levers than planned in the Government's Waste Review. Specific strategies should be developed to reduce food and paper/card waste sent to landfill (the largest contributor to future waste emissions).

Introduction and key messages

1. Economy-wide emissions trends and drivers
2. Non-traded emissions
3. Traded emissions
4. Emissions projections
5. Government policy and strategy

Chapter 1: Overview

Introduction and key messages

In our previous progress reports we showed that UK greenhouse gas emissions fell by 9% in 2009, largely due to the recession, and then rose by 3% in 2010 as cold winter temperatures drove up energy demand.

In this chapter we provide a high-level overview of emissions trends in 2011; we adjust emissions figures to allow for winter temperatures; we consider whether underlying progress is sufficient to meet carbon budgets; and we summarise key challenges in developing and implementing new policies.

We first present analysis for the economy as a whole, then disaggregate to non-traded and traded emissions, and within this to specific sectors.

Our key messages are:

- Economy-wide emissions fell by 7% to 547 $MtCO_2e$ in 2011, in the context of warmer winter weather, low economic growth and rising fuel prices. Without the mild winter weather emissions would have fallen by around 4%, with delivery of measures to reduce emissions contributing around 0.8%. Despite current emissions remaining below budgeted levels (which were set before the full impact of the recession in 2009), this rate of underlying progress would be insufficient to meet future budgets, which will require annual emissions reductions of around 3%.
- Although non-traded emissions fell by 7%, without the mild winter weather they would have fallen by only 2%. Against a relatively low level of ambition, progress in delivering measures to reduce emissions was mixed, with significant improvements in the emissions intensity of new cars, rates of insulation of lofts and cavity walls in line with our indicators, but continued low uptake of solid wall insulation.
- Traded emissions fell by 7% in 2011 and remained below the UK's share of the EU ETS cap. Progress adding low-carbon capacity in the power sector was broadly on track against our indicator framework but will need to accelerate in future, as will implementation of measures to reduce emissions from energy-intensive industry.
- We have previously highlighted the need for a step change in the pace of implementation of measures as policies developed over the first budget period start to deliver. This step change is now needed urgently if we are to remain on track to meeting future carbon budgets. There is a need to do more across almost the full range of measures, with major challenges sustaining and increasing the pace of investment in low-carbon power generation, buildings fabric measures, renewable heat, electric vehicles, and travel behaviour change.

- In order to ramp up delivery, a number of key policy challenges remain. These include resolving uncertainty in Electricity Market Reform, implementing the Green Deal and ECO so as to deliver the full range of building fabric measures, introducing strong incentives for residential renewable heat, and ensuring these and other policies – including the Renewable Heat Incentive and support for electric vehicles – are adequately funded over this and future spending review periods.
- Given the importance of delivering measures to meet future carbon budgets, outperformance of the current budget due to the recession should not be banked.

We set out our analysis in five sections:

1. Economy-wide emissions trends and drivers
2. Non-traded emissions
3. Traded emissions
4. Emissions projections
5. Government policy and strategy

1. Economy-wide emissions trends and drivers

2011 emissions

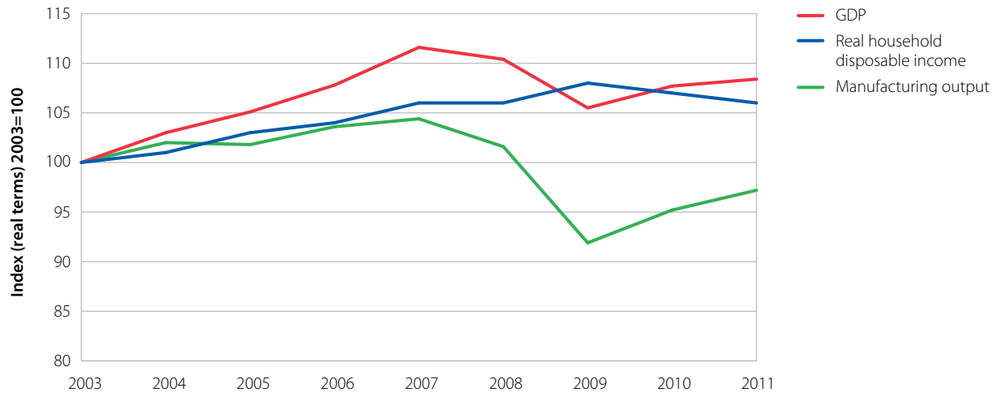
Our focus in this chapter is on emissions currently covered by carbon budgets. These are UK emissions of all greenhouse gases (i.e. the six gases in the Kyoto basket) from all sectors of the economy except international aviation and shipping. Parliament is due to take a decision on inclusion of international aviation and shipping emissions in carbon budgets by the end of 2012, following advice from the Committee published in April 2012 (see section 5).

The context for 2011 emissions is one of limited GDP growth, increasing energy prices, higher transport fuel prices and relatively mild winter months.

- GDP grew in 2011 by only 0.7% (in real terms) following growth in 2010 of 2.1% (Figure 1.1). Within this, manufacturing output grew by 2.0%, while real household disposable income fell by 1.2%.
- Wholesale gas price increases in 2011 resulted in a 9% (7% in real terms[1]) increase in residential gas prices, and an 8% (6% in real terms) increase in residential electricity prices (Figure 1.2).
- In the transport sector, petrol prices rose by 14% (11% in real terms) and diesel prices rose by 16% (14% in real terms) – see Figure 1.3.

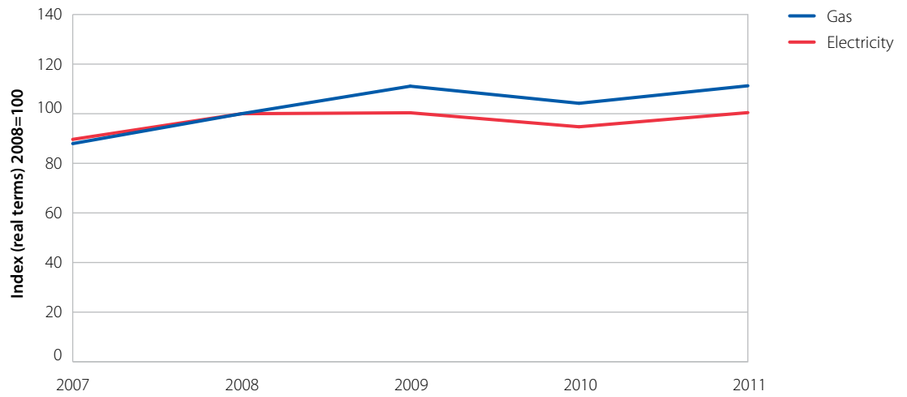
1 Energy price data have been converted to real terms using the Treasury's GDP deflator series, as this is how these data are published by DECC. For 2011, this implies an inflation rate of 2.33%, considerably below the rate (over 4%) implied by the consumer price index (CPI) and retail price index (RPI).

Figure 1.1: UK Economic Indicators (2003-2011)



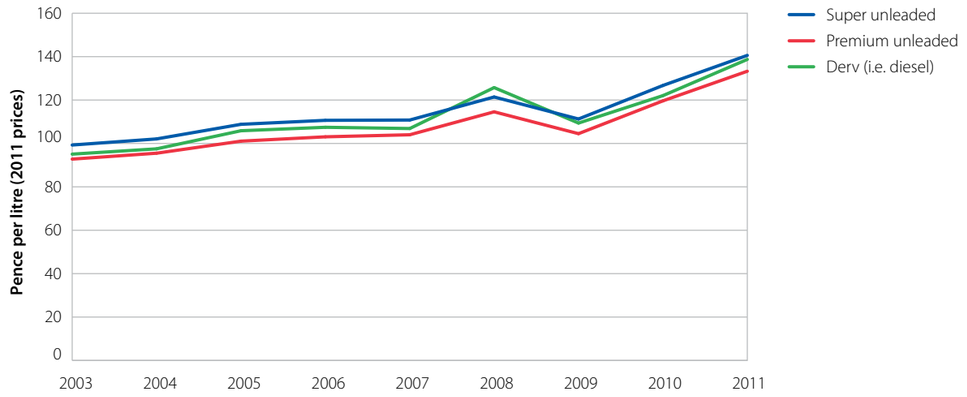
Source: ONS (2012) *Quarterly National Accounts.*

Figure 1.2: Fuel prices in the residential sector (2007-2011)



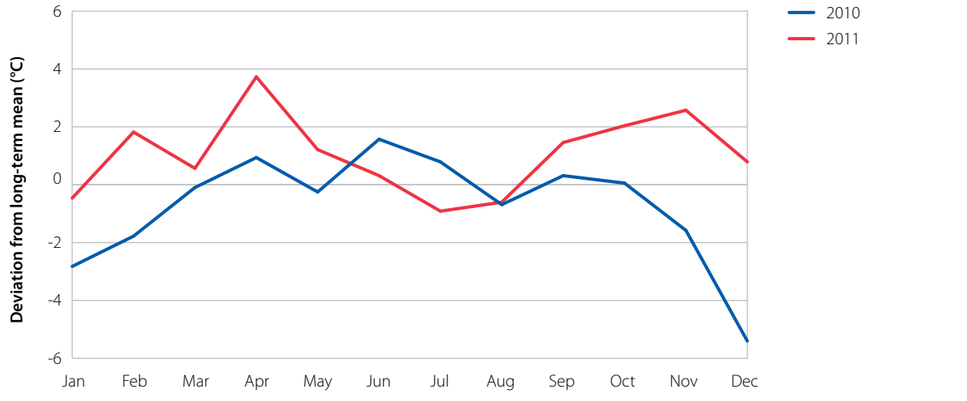
Source: DECC (March 2012) *Quarterly Energy Prices* Tables 2.2.1 and 2.3.1, CCC calculations..

Figure 1.3: Petrol and diesel prices (2003-2011)



Source: DECC (March 2012) *Quarterly Energy Prices* Table 4.1.2.

Figure 1.4: Average daily temperature – deviation from long-term mean (2010 and 2011)

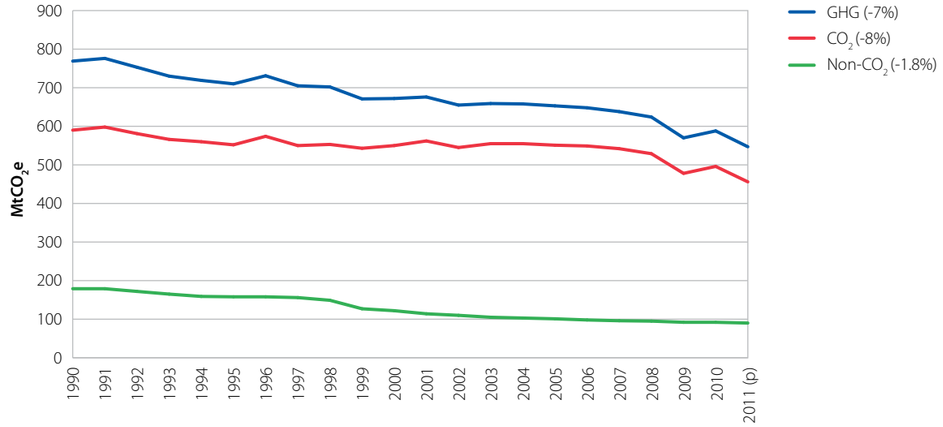


Source: DECC (February 2012) *Energy Trends* Table 7.1.
Notes: The long-term mean for each month is the mean temperature between 1971 and 2000.

- The winter months in 2011 (i.e. January, February and December) were around 4°C warmer than those in the previous year and there were 27% fewer heating degree days (HDD)[2] over the year (Figure 1.4).

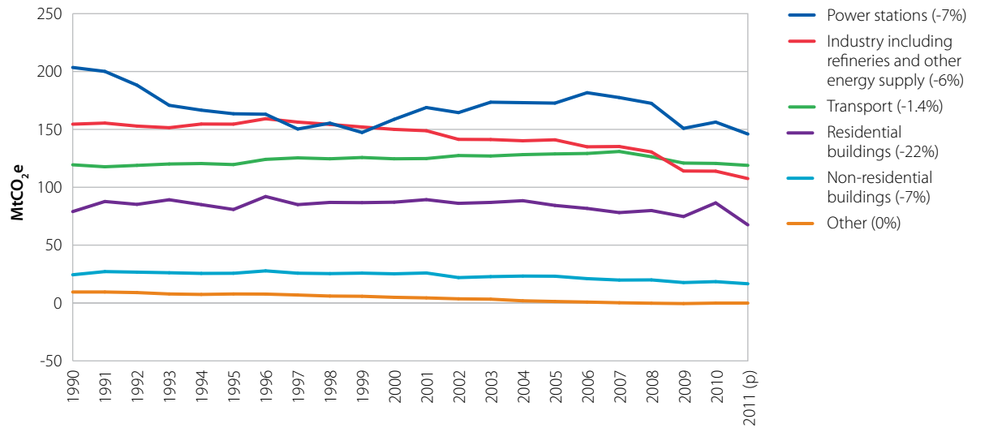
2 HDD are calculated relative to a baseline temperature, typically 15.5°C, which is the outside temperature above which a building typically needs no heating. The number of HDD on a given day is the number of degrees centigrade that the actual temperature is below the baseline temperature (e.g. if the temperature was 5.5°C for one day the number of HDD would be 10).

Figure 1.5: UK greenhouse gas emissions (1990-2011)



Source: DECC (2012) *2011 UK greenhouse gas emissions, provisional figures.*

Figure 1.6: UK CO_2 emissions by sector on a source basis (1990-2011)



Source: DECC (2012) *2011 UK greenhouse gas emissions, provisional figures.*

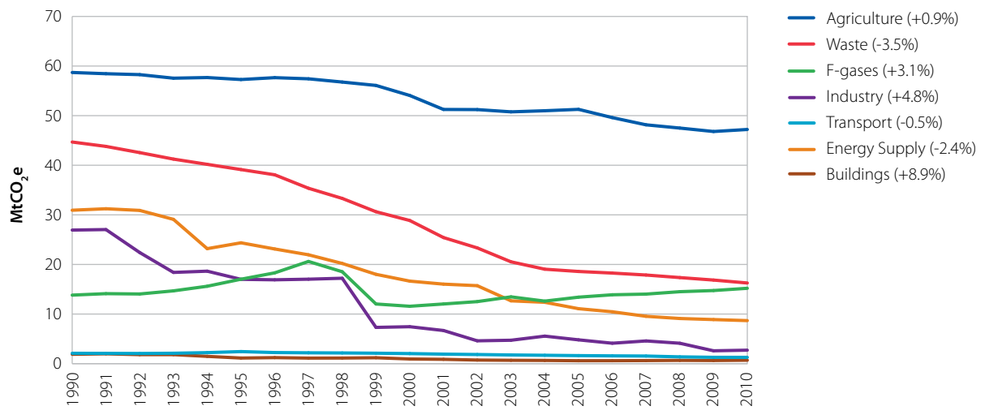
Within this context, UK greenhouse gas emissions decreased by 7% in 2011 to 547 $MtCO_2e$ (Figure 1.5). This reflected decreased CO_2 emissions in all sectors, particularly the residential and power sectors.

- CO_2 emissions account for 83% of total UK greenhouse gas emissions. They decreased by 8% in 2011 to 456 $MtCO_2$, reflecting reduced emissions from buildings, industry and power generation (Figure 1.6):

- Direct emissions in buildings (e.g. from burning of fossil fuels for heat), which account for 19% of total CO_2 emissions, fell by 19% in 2011 to 85 $MtCO_2$. In particular, direct emissions from residential buildings fell by 22% to 68 $MtCO_2$. This reflected a 24% fall in average gas demand per household, such that residential gas bills fell by 16% despite higher gas prices, while residential electricity bills were broadly flat (Box 1.1).
- Direct emissions from industry, which account for 23% of total CO_2 emissions, fell by around 6% in 2011 to 107 $MtCO_2$.
- Emissions from power generation, which account for 32% of CO_2 emissions, decreased by 7% to 146 $MtCO_2$ due to reduced electricity demand as well as lower carbon intensity of generation.
- Transport emissions, which account for 26% of total CO_2 emissions, fell by 1.4% in 2011 to 119 $MtCO_2$.

- Non-CO_2 emissions account for 17% of total UK greenhouse gas emissions and largely comprise emissions from agriculture and waste. Provisional emissions statistics for 2011 include non-CO_2 emissions at 90 $MtCO_2e$ (1.8% lower than in 2010, continuing long-term trends) (Figure 1.7).

Figure 1.7: UK non-CO_2 emissions by sector (1990-2010)



Source: NAEI (2012).

Box 1.1: Fuel bills in 2011

2011 saw rising prices but falling demand for gas and electricity in the residential sector:

- In 2011 average gas and electricity prices increased by 9% and 8% respectively (not adjusting for general inflation). Both these price rises were driven by increases in the wholesale price of gas (which increased from 1.5 p/therm in 2010 to 1.9 p/therm in 2011)
- At the same time, consumption fell, offsetting the price increase: average gas demand fell by 24% and average electricity demand fell by 6%.

As a result, the average annual gas bill fell by 16% and the average electricity bill increased by 2% (to £527 for gas and £443 for electricity for the median dual-fuel household). This compares to general inflation (i.e. as measured by the retail and consumer price indices, RPI and CPI) of over 4%.

Some of the 7% reduction in greenhouse gas emissions is attributable to the mild winter weather in 2011 relative to very cold winter weather in 2010. The reduction would have been around 4% after adjusting for the impact of the mild temperatures in the winter months (Box 1.2). In order to understand whether this represents sufficient progress towards meeting carbon budgets, a more detailed assessment of sectoral emissions trends and drivers is required, as set out in the rest of this chapter and report.

Box 1.2: The impact of temperature on energy demand and the Committee's approach to temperature adjusting

As noted in our 2011 progress report, weather can have a significant impact on energy consumption and therefore emissions. Winter temperatures in particular can affect demand for heating fuels (summer temperatures currently have a much smaller effect given that energy demand for cooling remains significantly lower than demand for heating in the UK).

The winter months of 2011 (January, February and December) were significantly warmer than those of 2010 resulting in lower emissions, particularly in the residential sector. We have used DECC estimates of the "temperature-adjusted" change in energy consumption from 2010 to 2011, which can be interpreted as how energy consumption would have changed without the increase in winter temperatures. We have then applied our own estimates of emissions intensity in 2011 to calculate the effect on emissions. This allows us better to assess underlying progress, abstracting from year-to-year variations in weather, which is useful in assessing future prospects for emissions.

Total CO_2 emissions in 2011 fell by 8%, but adjusting for temperature they would have fallen 4%. The adjustment is primarily in energy use for heating buildings, with the largest impact in the residential sector.

DECC have recently released their own estimates of temperature-adjusted emissions (currently classed as experimental statistics) which suggest a larger impact, such that after adjusting for temperature total emissions in 2011 would have fallen by only 1%. DECC's methodology adjusts emissions directly (as opposed to energy consumption) and as such, may capture second-order impacts such as fuel switching. Our approach is to identify the impact of fuel switching separately and we therefore continue to use our previous methodology for temperature-adjusting emissions, based on energy consumption.

2. Non-traded emissions

Trends in emissions in the non-traded sectors

Non-traded emissions are those outside of the EU ETS and include direct emissions from use of fossil fuels in buildings, non-energy intensive industry (primarily for heat) and transport, as well as most non-CO_2 emissions (e.g. from agriculture and waste). Non-traded emissions accounted for 60% of total UK greenhouse gas emissions in 2011.

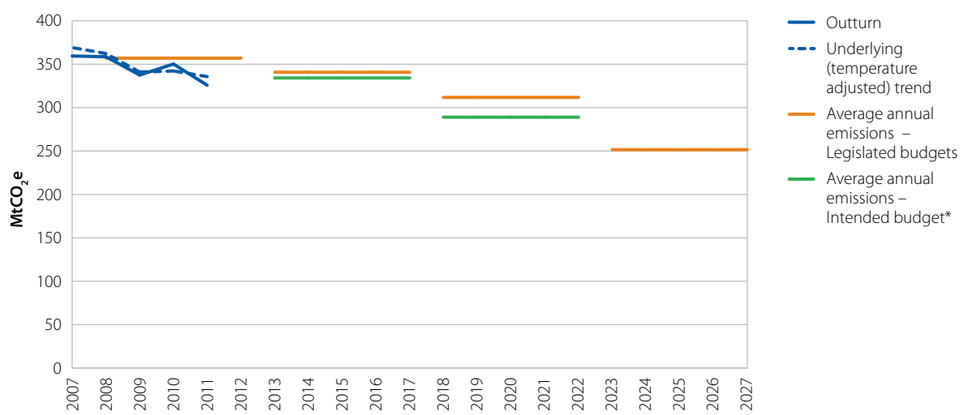
Non-traded emissions fell by 7% in 2011 to 326 $MtCO_2e$, more than offsetting the 4% rise in 2010. However, after adjusting for temperature, emissions fell by only 2% in 2011.

In 2009, 2010 and 2011, non-traded emissions were below the level required to meet the first carbon budget, even after adjusting for temperature impacts (Figure 1.8). This is because carbon budgets were initially designed and legislated before the significant emissions reductions that occurred during the recession, particularly in 2009.

There is a similar pattern at the sectoral level, where emissions remain below levels in our indicator trajectories, again because these trajectories were developed before the full impacts of the recession occurred.

- Direct emissions from residential buildings fell by 22% in 2011 and were below our indicator trajectory. Without the temporary impacts of the weather, emissions would have fallen only 4% but would still have been below the indicator trajectory.
- Direct emissions from non-residential buildings fell by 7% in 2011. Correcting for temperature impacts, emissions would have fallen only 2%, again below our indicator trajectory.

Figure 1.8: Non-traded sector emissions compared to budgets (2007-2027)



Source: NAEI (2012); DECC (2012) *2011 UK Greenhouse gas emissions, provisional figures*; European Commission (2 April 2012) *Verified Emissions for 2008-2009-2010-2011 and allocations 2008-2009-2010-2011*; CCC calculations.
Notes: *As proposed in our 2008 report, the Intended budget (2008-2022) corresponds to the UK share of an EU 30% 2020 target. We recommended it should be enacted in the context of a global deal to reduce emissions.

- In 2010, road transport emissions were flat and were in line with our indicator trajectory. Data for road transport emissions in 2011 are not yet available. However, a preliminary assessment of distance travelled and other factors suggests that emissions may have fallen slightly in 2011, with reduced emissions from cars but increased emissions from vans and HGVs.
- Non-CO_2 emissions fell by 1.8% in 2011 to 90 $MtCO_2e$, having been broadly flat in 2010. In 2010, emissions from agriculture (of which 92% are non-CO_2 emissions) rose by around 1%, though remained below our indicator trajectory. Offsetting this increase, emissions from waste (of which 98% are non-CO_2) fell by 3% in 2010. A breakdown of non-CO_2 emissions in 2011 by sector is not yet available.

The relatively small reduction in temperature-adjusted emissions in 2011 – particularly in the context of falling disposable income, limited GDP growth and high energy and fuel prices – raises the question of how much underlying progress there has been in terms of implementation of measures to reduce emissions.

We now consider the extent to which the reduction in temperature-adjusted emissions in 2011 was driven by underlying progress in delivering measures.

Underlying progress in the non-traded sectors

Our indicator framework for monitoring progress against carbon budgets includes not only emissions, but also implementation of measures to reduce emissions. In doing so, it provides an early signal of future emissions, to enable appropriate policy responses. The framework sets out trajectories for delivery based on our Extended Ambition scenario, which is set out in our first (October 2009) progress report to Parliament and which we have shown previously to be broadly consistent with Government ambition.

Against this framework, there has been progress in some areas but with other areas falling behind (Table 1.1):

- In buildings, there was continued progress on boiler replacement with mixed progress on insulation measures.
  - Boiler replacement remained ahead of schedule, with the annual rate of installation maintained from the previous year when a boiler scrappage scheme drove accelerated uptake.
  - Uptake of loft insulation was ahead of our indicator trajectory, and there was an increase in the rate of professional installations, although the rate of DIY installations fell. There was an increase in the rate of cavity wall insulation although uptake was behind our indicator trajectory.
  - Levels of solid wall insulation remained very low relative to our indicator trajectory, notwithstanding an increase in the annual rate of installation.

- In 2010, total renewable heat penetration reached around 1.8%, against our trajectory level of 1.2%, but was largely based on deployment in non-residential sectors[3]. The Renewable Heat Incentive was launched in November 2011, initially for non-residential schemes, with only a small-scale pilot scheme (the RHPP) to fund investments in the residential sector. Although data for renewable heat penetration in 2011 are not yet available, other data (i.e. from the RHI and RHPP) suggests continued progress in non-residential sectors, but with uptake in the residential sector remaining very low.
- In road transport, the emissions intensity of new cars was ahead of trajectory for a third year running, with some progress achieved in laying the foundations for electric vehicle market development, but limited progress on measures to encourage travel behaviour change.
  - New car emissions intensity fell by 4.2% in 2011, to 138 gCO_2/km – well ahead of our trajectory level of 151 gCO_2/km.
  - Following the launch of new electric car models and the plug-in car grant in 2011, around 1,100 electric cars were registered in 2011, compared with around 170 in 2010. While this is low relative to our indicator we would expect increased uptake as new models come to market in 2012.
  - Biofuels penetration, which was broadly flat at 3.5%, was slightly behind our indicator trajectory for 2011.
  - Following announcement of the £560 million Local Sustainable Transport Fund in early 2011 (sufficient to roll out Smarter Choices to around 25% of the UK by 2015), two of the three phases have now been allocated. A preliminary assessment suggests that this fund is supporting Smarter Choices projects. However, further funding will be required for full roll-out to the UK by 2020.
  - Number of drivers trained in eco-driving remained at less than 5% of the level in our indicator framework.
  - A proposed consultation was announced on increasing the speed limit on motorways and potentially dual carriageways. This would significantly increase emissions relative to the alternative of enforcing the current speed limit (e.g. we estimated up to 3.5 $MtCO_2$ in 2020).

Based on the assumptions for the carbon savings per measure underpinning our indicator framework, we estimate that the identifiable measures delivered in 2011 reduced emissions by around 2.5-3 $MtCO_2e$ relative to 2010, accounting for around 0.8 percentage points of the 2% temperature-adjusted fall in non-traded emissions (Figure 1.9).

The relatively low level of savings from delivery of measures in 2011 is built into our indicator framework, which envisages limited effort through the first budget period while new policies are developed and implemented. However, our indicators reflect an assumption of significantly increased effort moving in to the second budget period (Table 1.2).

3 To the extent that some emissions from these sectors are covered by the EU ETS, some of this penetration may be in the traded sectors.

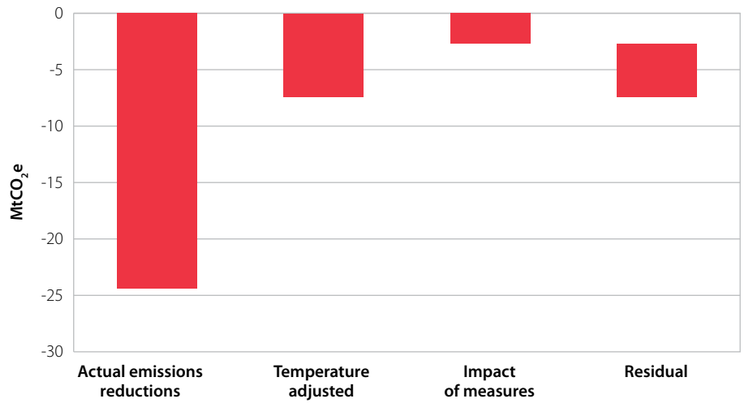
Table 1.1: Progress against measures in the non-traded sector

	Annual progress†		Cumulative progress‡		Emissions reduction from measures installed in 2011 ($MtCO_2$)
	2011* indicator	2011* outturn	2011* indicator	2011* outturn	
Residential buildings					
Loft insulation (millions)	0.6	0.8 (CERT professional) + 0.3 (DIY & other)	2.2	2.4 (CERT professional) + 1.5 (DIY & other)	0.1 (CERT professional) + 0.1 (DIY & other)
Cavity wall insulation (millions)	0.6	0.5	2.4	2.1	0.3
Solid wall insulation	120,000	19,000	330,000	60,000	<0.1
Efficient boilers (millions)	1.0	1.3	4.0	4.9	0.6
Renewable heat					
Renewable heat penetration (% of total heat demand)	0.0%	+0.2%	1.2%	1.8%	0.4
Road transport					
New car gCO_2/km	-4.7	-6.1	151.0	138.1	1.5
Biofuels penetration (% by volume)	+0.6%	-0.1%	4.0%	3.5%	-0.1
Car drivers trained in eco-training	300,000	8,000	885,000	23,000	0
Electric car sales (PHEV/BEV)	8,100	1,100	13,000	1,300	0

Source: OFGEM (2012) CERT update quarter 15, DCLG (2012) Housing statistics – Table 241, Heating and Hotwater Council (2012) DECC (2012) Estimates of home insulation levels in Great Britain, DECC (2011) DUKES Table 7.7, SMMT (2012) New Car CO_2 Report, SMMT (2012), HMRC (February 2012) Hydrocarbon Oils Duties Bulletin, Energy Saving Trust (2012), CCC calculations.
Notes: *2010 for renewable heat. †Annual progress represents additional uptake/improvement in 2011 (2010 for renewable heat) relative to the previous year. Cumulative progress represents: for residential building measures, total additional installations between 2007 and 2011; for road transport measures, level achieved in 2011; for renewable heat penetration, level achieved in 2010.

Therefore continued implementation of measures at the rate achieved in 2011 would be insufficient to meet carbon budgets (Figure 1.10). As we have concluded in previous reports, even after the impact of the recession, a significant ramp-up in the pace of delivery will be required in order to meet the currently legislated third budget. This ramp up is now needed urgently, particularly for more challenging measures such as renewable heat and electric vehicles. An even greater acceleration will be needed to meet the fourth carbon budget (which is likely to require outperformance of budgets two and three). Development and implementation of new policies will be required to drive this acceleration; this is discussed at a high level in section 5 below and in more detail in Chapters 2-8.

Figure 1.9: Drivers of emissions reductions in the non-traded sector in 2011



Source: DECC (2012) *2011 UK Greenhouse gsa emissions, provisional figures*; DECC (March 2012) *Energy Trends;* CCC calculations.
Notes: The residual change in emissions in 2011 is that which is unexplained by weather impacts or implementation of identifiable measures. This is likely to be largely attributable to a combination of falling household incomes and rising fuel prices, partly offset by rising GDP. Some emissions reductions may also have ensued from measures for which we do not have data (e.g. in the commercial sector), though there is little evidence to suggest widespread implementation of these measures (e.g. there was virtually no change in Energy Performance Certificate ratings, see Chapter 3).

Table 1.2: Required ramp-up in delivery in the non-traded sector

	Annual uptake/improvement				
	2010 outturn	**2011 outturn**	**Required Budget 1 average**	**Required Budget 2 average**	**Required Budget 3 average**
Residential buildings					
Loft insulation (million homes)	0.5 (CERT professional) + 0.8 (DIY & other)	0.8 (CERT professional) + 0.3 (DIY & other)	0.9	2.1	n/a
Cavity wall insulation (million homes)	0.4	0.5	0.8	1.4	n/a
Solid wall insulation (homes)	13,000	19,000	90,000	150,000	220,000
Efficient boilers (millions)	1.3	1.3	1.0	0.9	0.7
Renewable heat					
Renewable heat penetration (% of total heat demand)	0.2%	n/a	0.1%	0.8%	2.4%
Road transport					
New car emissions intensity (gCO_2/km)	-5.3	-6.1	-3.8	-6.0	-5.8
Biofuels penetration (% by vol)	0.7%	-0.1%	0.7%	0.7%	0.4%
Car drivers undertaking eco-driving training	9,700	8,000	300,000	320,000	340,000
Electric car sales (PHEV/BEV)	170	1,100	5,000	130,000	450,000

Source: OFGEM (2012) CERT update quarter 15, DCLG (2012) Housing statistics – Table 241, Heating and Hotwater Council (2012) DECC (2012) Estimates of home insulation levels in Great Britain, DECC (2011) DUKES Table 7.7, SMMT (2012) New Car CO_2 Report, SMMT (2012), HMRC (February 2012) Hydrocarbon Oils Duties Bulletin, Energy Saving Trust (2012), CCC calculations.

Figure 1.10: Non-traded sector emissions based on continued implementation of measures in 2011 (2007-2027)

Source: NAEI (2012); DECC (2012) *2010 UK Greenhouse gas emissions, provisional figures*; CCC calculations.
Notes: *As proposed in our 2008 report, the Intended budget (2008-2022) corresponds to the UK share of an EU 30% 2020 target. We recommended it should be enacted in the context of a global deal to reduce emissions. **Based on the Baseline scenario from DECC (2011) UEP, net of estimated savings ensuing from continued uptake of measures at the rates seen in 2011, until 2027 or until full potential is realised (e.g. all lofts have been insulated), whichever is sooner. Trajectory has been smoothed.

3. Traded emissions

Traded emissions in the UK

Our focus in this section is on traded emissions covered by carbon budgets. These include emissions from power generation and energy-intensive industries (e.g. refineries, production of cement, iron and steel), and from 2012, emissions from domestic aviation (but currently not international aviation) and some non-CO_2 emissions. Traded emissions accounted for 40% of total UK greenhouse gas emissions in 2011.

Under the Climate Change Act, traded sector emissions are accounted for on a net basis (i.e. net of purchase of EUAs or offset credits). Given these emissions are capped under the EU ETS, the traded portion of carbon budgets should, by definition, automatically be achieved, through a combination of domestic emissions reductions and, where gross emissions exceed the cap, purchase of allowances from other countries.

However, the importance of power sector decarbonisation for the economy-wide decarbonisation strategy, means it is important to reduce gross (rather than only net) traded emissions. For example, in our previous work (e.g. our advice on the fourth carbon budget) and again in this report (Chapter 2), we have suggested that an appropriate aim is to largely decarbonise the UK power sector over the next two decades (e.g. to around 50 gCO_2/kWh in 2030).

Gross traded sector emissions fell by 7% in 2011 to 221 $MtCO_2e$, driven by reductions in both power and industry, and were below our indicator trajectory (Figure 1.11).

- Power sector emissions fell by 7% driven by a combination of lower emissions intensity of generation and reduced demand for electricity.
  - Emissions intensity of generation fell by 2% to 486 gCO_2/kWh due to increased renewable generation (wind and hydro, in the context of a particularly wet and windy year) and fewer nuclear outages.
  - Demand for electricity fell by 4% in 2011 with reductions across buildings and industry. This was driven partly by weather effects: after adjusting for temperature, demand would have fallen only 2%.
  - Without the mild winter weather in 2011, emissions would still have fallen 5% and been below our indicator trajectory.
- Direct emissions from energy-intensive industries fell by 8% in 2011.
  - Emissions fell in some industries (e.g. steel and paper) and increased in others (e.g. cement).
  - There is limited evidence for the fall in emissions being due to fuel switching or output, suggesting that energy efficiency improvements may have been implemented in 2011 (see Chapter 4).

As for the non-traded sector, it is important to track not just current emissions but indicators of future emissions in the traded sector, particularly given long asset lifetimes.

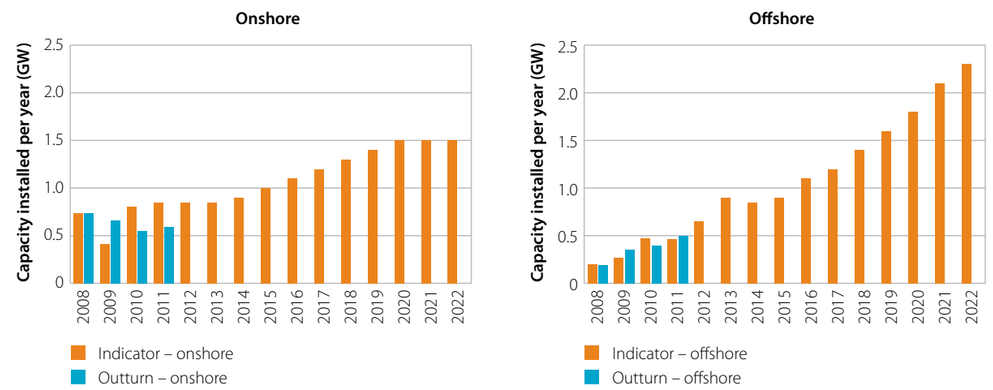
Figure 1.11: Traded sector emissions compared to budgets (2007-2027)

Source: DECC (2012) *2011 UK Greenhouse gas emissions, provisional figures*; European Commission (2 April 2012) *Verified Emissions for 2008-2009-2010-2011 and allocations 2008-2009-2010-2011*; CCC calculations.
Notes: *As proposed in our 2008 report, the Intended budget (2008-2022) corresponds to the UK share of an EU 30% 2020 target. We recommended it should be enacted in the context of a global deal to reduce emissions.

We focus on investments in low-carbon power, where progress in 2011 was broadly on track, with 0.6 GW of onshore and 0.5 GW of offshore wind capacity added to the system (Figure 1.12). However, the level of ambition in our indicator framework is relatively low over the first budget period – reflecting projects that were already in the pipeline in 2009 – with a significant ramp-up in delivery required over the next decade. In Chapter 2 we consider whether sufficient new projects are coming forward to achieve this required acceleration in the near term, and whether the right policies are being developed and deployed to support investment in the longer term.

In industry, the clear historical link between emissions and output highlights the need for implementation of measures if emissions are to be reduced in the context of a return to growth in manufacturing output. A key area for delivery will be renewable heat. Data on renewable heat penetration in 2011 are not yet available, but in 2010 renewable heat accounted for around 2.8% of industrial heat demand – against an expected level of 2.1%[4]. In Chapter 4 we consider other opportunities for reducing emissions in industry, and progress in putting in place policies to support the necessary investments.

Figure 1.12: Additional operational wind capacity per year (2008-2022)



Source: DECC (March 2012) *Energy Trends*.
Notes: 2011 data are provisional.

EU ETS emissions and carbon prices

EU ETS emissions trends

UK traded emissions will in part be driven by the carbon price within the EU ETS. As the carbon price is determined by the level of gross EU traded emissions relative to the EU ETS cap, these emissions are highly relevant for the UK.

Gross EU traded emissions fell by 2% in 2011, partly offsetting a 3% rise in 2010.

4 To the extent that some industrial emissions are outside of the EU ETS, some of this penetration may be in the non-traded sector.

- Key drivers of the overall reduction were falls in emissions from France, Germany, Finland, Denmark, Sweden, Belgium and the Netherlands, as well as the UK. These occurred despite increases in GDP and total industrial production, due to increased low-carbon power generation (nuclear and renewable). Winter temperatures in Europe were also higher in 2011 than 2010 which may have played a part in reducing demand for electricity for heating.
- Offsetting these reductions were increased emissions from Spain, Poland, Bulgaria and Romania. In Poland, emissions increased as GDP and industrial output grew. In Spain, emissions increased despite limited GDP growth and a fall in industrial production, due to reductions in low-carbon power generation, particularly hydro.

Emissions remained well below the EU ETS cap in 2011, reflecting the significant fall in 2009 as a result of the global economic downturn.

Current emissions are below the level of the cap out to around 2017, with the prospect that outperformance of the cap in early years could mean that the entire Phase III cap (2013-2020) could be met without any further reduction in emissions (given scope to bank outperformance towards meeting the cap in future years) – see Figure 1.13.

Carbon price trends

The low level of emissions has seen the carbon price fall to very low levels (Figure 1.14), following a period of volatility during 2011:

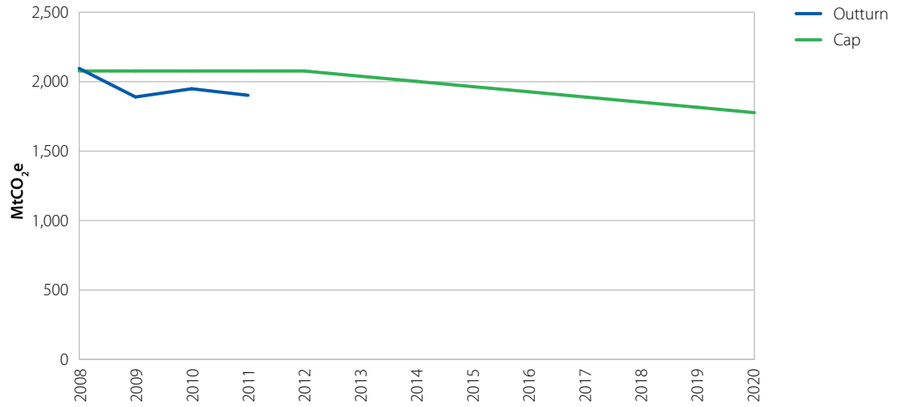
- The carbon price during 2011 was, on average, around €13/tCO_2 compared to €14/tCO_2 in 2010, with a peak of €17/tCO_2 in June and a minimum price of €7/tCO_2 in December.
- In the early months of 2012 the carbon price has fluctuated below €10/tCO_2, with lows around €6/tCO_2.
- The low level of 2011 emissions announced by the EU in April this year has acted to further suppress the carbon price as the oversupply of EUAs (i.e. the cumulative difference between outturn emissions and the Phase II cap) has now reached around 470 $MtCO_2$.

Given the headroom in the cap, the carbon price is likely to remain low under the current scheme design. In fact, with projected emissions below the cap, it is likely that the price would be even lower (possibly zero) if there were not some policy uncertainty as to whether the cap might be tightened (either for the current Phase, or beyond 2020). Tightening the cap would be one way of strengthening the EU ETS price signal, to which we now turn.

Strengthening the carbon price signal at the EU level

The low carbon price reflects the low level of ambition in the EU's current target to reduce greenhouse gas emissions to 20% below 1990 levels by 2020. The EU has acknowledged that this ambition can be increased by committing to a 30% target in the context of a new global deal to reduce emissions. In addition, the EC's low-carbon roadmap suggests that it is appropriate to aim for a 25% gross emissions reduction by 2020 on the path to achieving an 80-95% reduction by 2050.

Figure 1.13: Emissions within the EU ETS versus cap (2008-2020)



Source: European Commission (April 2012) *Verified emissions data for 2011;* European Commission (22 October 2010) *Commission Decision 2010/364/EU.*
Notes: Excludes International Aviation.

Figure 1.14: EU ETS carbon price (February 2008-May 2012)

Source: Bluenext Statistics http://www.bluenext.eu

The international situation regarding an ambitious global deal is uncertain following negotiations in Durban. There is a clear climate objective and an agreed process to work towards a global deal, with good progress in some major emitting countries, but significant risks remain that there will be insufficient global action to achieve the climate objective:

- The latest United Nations Conference of the Parties was held in Durban in December 2011. Parties are committed to limiting global warming to 2°C, but noted the significant gap between this objective and the current emissions pledges for 2020. The Durban Platform paves the way for agreement on a new, globally comprehensive deal to be implemented by 2020, although the level of ambition it will set for emissions reduction has yet to be agreed.
- Several jurisdictions instituted new domestic climate actions in the last year, including China, Australia and Mexico, as well as the state of California and the province of Quebec (Box 1.3).
- However, the International Energy Agency (IEA) has highlighted the risks in further delaying rapid global action[5]. It concludes that 80% of total CO_2 emissions allowed to 2035 is already "locked in" by existing infrastructure. Without further action before 2017 this will reach 100%, meaning that all subsequent stock would have to be zero-carbon (or high-carbon infrastructure would need to be scrapped prematurely) to be consistent with a 2°C trajectory.

Increased EU ambition would be constructive in the global context, as well as putting the EU on the cost-effective path to its longer-term emissions objectives. While there is broad support among EU member states, a direct increase in the 20% target may prove difficult to agree. Various other options to increase the level of ambition to 2020 and to strengthen the carbon price signal are also available:

- Directly tightening the EU ETS cap by retiring EUAs.
- Indirectly tightening the cap through setting a sufficiently strong reserve price in the auction of EUAs, or an EU-wide carbon price underpin.
- Setting ambitious emissions reduction targets covering the period 2020-2030.

A combination of tightening the cap to 2020 and setting an ambitious path through the 2020s would be preferable from the perspective of strengthening the carbon price signal specifically while also improving the low-carbon investment climate more generally.

The EU should therefore continue to pursue options to tighten the EU ETS cap and to start discussion of a 2030 package including overall ambition, a split of reduction effort between traded and non-traded emissions, and supporting sectoral targets where they may be necessary (e.g. for new car emissions in 2030). Providing this long-term visibility for investors would address uncertainties relating to the period beyond 2020 that currently undermine the low-carbon investment climate across the EU, and could help strengthen the carbon price alongside other measures.

The UK should pro-actively engage in this discussion in order to strengthen incentives in the UK and put the EU on a cost-effective pathway to meeting its 2050 target.

5 IEA (2011) World Energy Outlook.

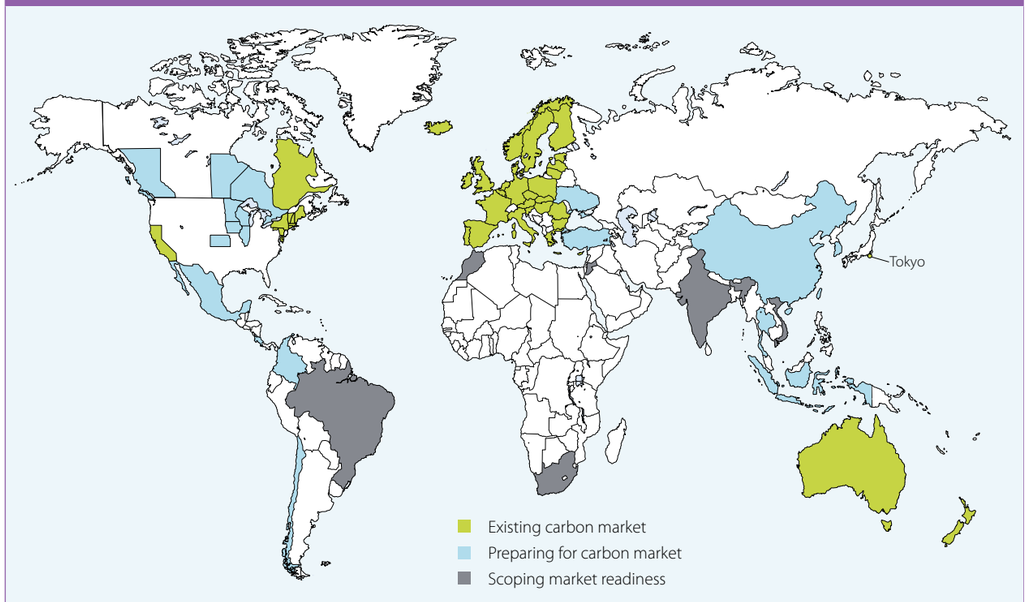
Box 1.3: Developments in climate policy around the world

While UN international negotiations continue, steps have been taken by both industrialised and industrialising countries to enact domestic climate policies in the last year:

- Australia has passed the Clean Energy Act with the aim of a 5-25% reduction in emissions below 2000 levels by 2020, contingent on international action, and 80% by 2050. Emitting facilities covering around two thirds of Australia's emissions will be faced with a carbon price starting at 23 AUD (£15) per tonne, transitioning to an Emissions Trading Scheme (ETS) in 2015.
- China has published its 12th Five Year Plan, including a target to lower the carbon intensity of GDP 17% below 2005 levels by 2015 on the path to a 40-45% reduction in 2020 (comparable to the UK reduction implied by currently legislated carbon budgets). It has also created seven different local carbon trading schemes with a view to rolling out the best model nationally in future.
- Both the US state of California and the Canadian province of Quebec have proceeded with capped ETSs. California, which would be one of the top 20 world emitters in its own right, aims to return its emissions to 1990 levels by 2020 (a cut of around 15% from today's levels), and its ETS covers 85% of total emissions.
- Mexico has passed the Climate Change General Law, targeting a 30% reduction in emissions below business as usual by 2020, followed by 50% by 2050. It too provides support for creating an ETS.
- South Korea, having passed a Green Growth Law in 2010 setting out an emissions reduction target of 30% below business as usual by 2020, also passed the Emissions Trading Law which legislates for a national ETS to be in place by 2015.

The pricing of carbon emissions has expanded rapidly beyond the EU ETS as a result, and is actively being explored by several other countries (Figure B1.3). Taken together, the countries, regions and cities operating or exploring ETSs are responsible for over 50% of total global emissions.

Figure B1.3: Emerging and operational carbon markets



Source: www.globeinternational.org, www.wbcarbonfinance.org/pmr
Notes: Nations defined as 'scoping market readiness' are those participating in the World Bank Partnership for Market Readiness (PMR). 'Preparing for carbon market' denotes a) PMR participants now given funding to design and pilot carbon markets; b) South Korea, which plans for an ETS to be in place by 2015; c) US states Iowa, Illinois, Kansas, Minnesota and Wisconsin, which published a model cap-and-trade rule in 2010 but have not progressed further; and d) Canadian Provinces British Columbia, Manitoba and Ontario, which collaborate with Quebec and California in the Western Climate Initiative.

UK carbon price floor

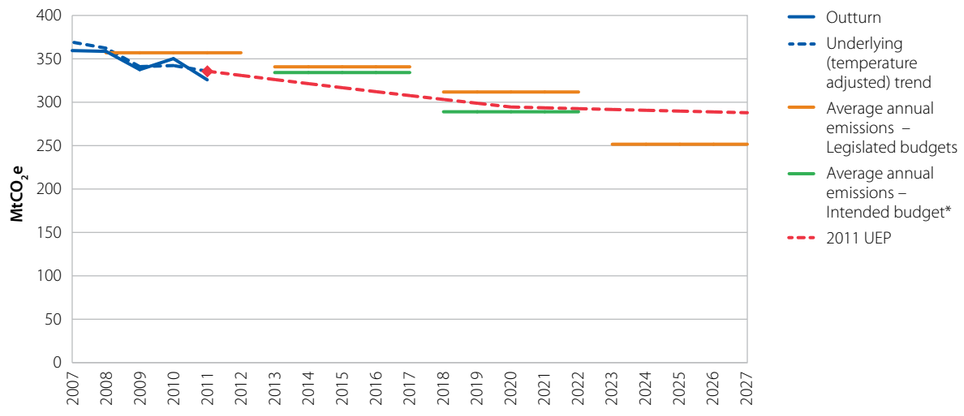
In 2011 the Government announced plans to introduce a floor price to the UK power sector (Figure 1.15):

- The Government has defined a minimum target carbon price starting at £16/tCO_2 in 2013. This will rise linearly to £30/tCO_2 in 2020, then to £70/tCO_2 in 2030 (real 2009 prices).
- An annual support rate will be set two years in advance, based on the difference between the expected EU ETS price and the minimum target price. The support rate has been set at £4.94 per tonne for 2013-14, and £9.55 per tonne for 2014-15. However, these rates were set prior to the recent falls in the EU ETS price; coupled with the current EU ETS price, they will not be sufficient to meet the target UK carbon price trajectory.
- Electricity generators will be taxed at the support rate, based on the average carbon content of the fuels they use, in addition to the requirement to purchase allowances to cover their emissions.

An EU-wide carbon price floor would be preferable since it would deliver a net reduction in emissions across the EU and avoid risks of UK competitiveness impacts on a small number of electricity-intensive sectors (e.g. iron and steel). However, we concluded in our 2011 progress report that in the absence of an EU-wide instrument, the UK carbon price floor would strengthen incentives for UK investment in low-carbon technologies.

To mitigate competitiveness impacts associated with UK carbon price support, and those of the EU ETS more generally, the Government has introduced a £250 million package of tax relief and compensation (see Chapter 4). With successful implementation of these measures, the UK's commitment to a carbon price rising to £70/tCO_2 in 2030 could therefore help reduce UK emissions as part of the wider policy package set out in the Government's December 2011 Carbon Plan (see section 5).

Figure 1.15: Non-traded sector emissions under central government projection (2007-2027)



Source: NAEI (2012); DECC (2012) *2011 UK Greenhouse gas emissions, provisional figures*; European Commission (2 April 2012) *Verified Emissions for 2008-2009-2010-2011 and allocations 2008-2009-2010-2011*; DECC (2011) *Updated Emissions Projections*; CCC calculations.
Note: Trajectories have been smoothed. *As proposed in our 2008 report, the Intended budget (2008-2022) corresponds to the UK share of an EU 30% 2020 target. We recommended it should be enacted in the context of a global deal to reduce emissions.

4. Emissions projections

We set out in section 2 that continued implementation of measures at current rates would be insufficient to meet future carbon budgets. We have previously concluded that where measures are implemented in line with our Extended Ambition scenario (i.e. as in our indicators), this would result in outperformance of the second and third legislated budgets.

Our approach to projecting emissions is to start with a reference case (i.e. reflecting limited abatement under current policies), and to net from this our assessment of abatement potential that should be addressed, either because this is cost-effective, or because it is associated with developing options for emissions cuts required further out in time. Our reference case is taken from a run of the DECC Energy and Emissions Model for CO_2 emissions and Government projections for non-CO_2 emissions.

Under latest projections, reference emissions are lower than previously projected:

- Compared to projections in 2010, future GDP is now expected to be lower and fossil fuel prices are expected to be higher. Given these are key drivers of emissions, this suggests future emissions will be lower.
- In 2011 we commissioned Cambridge Econometrics to review the DECC model's response to recession and recovery, and set out their recommendations in our third progress report. DECC's 2011 Updated Emissions Projections reflected a number of methodological changes following an internal review which took account of these recommendations (Box 1.4). As a result, projected 2020 emissions are now lower than in the 2010 projection.
- There have also been updates to Government's non-CO_2 emissions projections, based on a review of data and key assumptions, such that projected non-CO_2 emissions are also lower in 2020 compared to the projection from 2010. This particularly reflects changes in the projection of emissions from the waste sector, which we consider in Chapter 7.

Taking account of these revisions, this suggests that where measures are implemented in line with our Extended Ambition scenario, this would result in outperformance of the second and third legislated budgets beyond that previously projected. Government analysis leads to a broadly similar conclusion (Figure 1.15)[6].

As previously recommended, given the need to implement measures in our Extended Ambition scenario in order to meet the fourth carbon budget, the aim should continue to be to outperform the second and third budgets. Outperformance of the current budget should not be banked through to the second budget, so as to preserve ongoing incentives for required implementation of measures.

6 We have shown previously that implementation of measures in our Extended Ambition scenario is broadly consistent with Government ambition for policy delivery – see CCC (2010) *The fourth carbon budget*.

The need to implement measures is reinforced when uncertainties around future emissions are considered. A particular uncertainty at present is over the precise nature of the response to recession and the extent to which impacts on emissions will indeed persist as the economy returns to growth (Box 1.5). There is a risk that emissions could bounce back to a higher level than expected.

Box 1.4: Updates to the DECC model

The review we commissioned from Cambridge Econometrics identified the following recommendations for the DECC model:

- Making greater use of the most recent outturn data in forming projections, including responding to recent forecast errors.
- More regular updating of key input projections – specifically for industry GVA at the sub-sectoral level.
- Increased transparency over the functioning of the model, the input assumptions and the drivers behind changes in the published projections.
- In the longer term there may be scope to re-estimate the key relationships in the model and build in more bottom-up components (e.g. to better explain improvements in energy efficiency).

DECC have since developed their modelling and reporting in line with the first three of these recommendations:

- The model now uses the most recent available outturn data in demand equations.
- The model uses new industrial sub-sector equations, which can be and are regularly updated to make use of most recent data.
- DECC will maintain a technical report to help increase transparency over the equations used to project demand and industrial sub-sector growth.

As a result of the changes made, DECC's emissions projections are now lower and assume that most of the impact of the recession on emissions persists to future years.

Box 1.5: Impact of recession and recovery on emissions

We have previously highlighted uncertainties around how emissions would respond after the initial impacts of a major recession, and the extent to which this is captured in emissions projections:

- There is a risk that emissions could 'bounce back' beyond the level implied by a simple relationship to output, with only some of the reduction during the recession locked in to future periods (e.g. if households abandon temporary behaviour changes implemented during the recession).
- Conversely, in some areas the full impact of the recession in reducing emissions may not yet have been seen (e.g. if firms delayed investments in energy efficiency, but do implement them later).

As more data have become available, we are now able to assess in more detail the nature of the emissions response to the recession, and the implications for future emissions.

Some of these data suggest that future emissions could bounce back and increase more rapidly than the pre-recession trend:

- In industry, energy intensity (i.e. energy demand per £ of output) fell rapidly in 2009 (by 5%), before bouncing back somewhat in 2010 (by 2%), suggesting temporary changes in production which were reversed to some extent as industry adjusted to new conditions. There was another significant fall in energy intensity in 2011 (6%), which raises the possibility of another bounce back to come.
- In transport, 2009 saw a shift in purchase behaviour towards smaller-engined vehicles (with lower gCO_2/km). This coincided with a shift in the balance of new car sales from company cars to private cars (company cars fell from 60% of new car sales in 2007 to 50% in 2009). There is a risk that a shift back to a higher share of company cars in new car sales will lead to a reversal of this downsizing, with some signs that this is already occurring (i.e. the share of company car sales and the average engine size of new vehicles in 2010 and 2011 have recovered towards pre-recession levels).
- In residential buildings, internal temperatures rose steadily from 1970 to 2005 (from 12°C to 18°C), but have since fallen each year to 2009 (the latest year available), suggesting that thermostats have been turned down in response to rising gas prices and the recession. As the economy returns to growth and gas prices stabilise this recent trend could be reversed, which would lead to an increase in emissions.

However, the data also suggest that there was slower stock turnover and refurbishment during the recession (e.g. gross capital formation fell by 16%, repair and maintenance of non-residential buildings fell by 10% and new sales of cars, LGVs and HGVs fell by 7%, 35% and 40% respectively). This implies that the current stock is older than it would have been and has more potential for energy efficiency improvement (e.g. the incremental improvement in gCO_2/km for a new car will be greater where it replaces an old inefficient vehicle and there may be scope for increased stock turnover as delayed investments are now made). This could lead to above-trend improvements in future, and slower emissions growth.

In conclusion, there remains some risk of a bounce back in emissions following the recession, but the likely magnitude is uncertain. This is an area we will continue to monitor.

5. Government policy and strategy

Recent policy developments

In order to achieve the significant ramp-up in ambition in our indicator framework over the second and third budget periods, and to prepare for meeting the fourth budget, new policies are required to overcome barriers and drive uptake.

The Government's Carbon Plan published in December 2011 sets out its strategy for meeting the first four carbon budgets, on a pathway consistent with meeting the 2050 target (Box 1.6). It includes scenarios to 2030 and for 2050, which are broadly consistent with scenarios the Committee has set out (e.g. in our December 2010 report on the fourth carbon budget) and with the indicator framework used in this report. The Plan identifies existing policies that support delivery of abatement measures in each sector and sets out additional actions and high-level policy options that are likely to be required to accelerate delivery. The task for Government now is to develop more detailed policy options, and to address concerns raised by the Committee over some existing policy proposals.

Box 1.6: The Carbon Plan

The Government's Carbon Plan includes ranges for sectoral emissions from now to 2030, reflecting different scenarios for emissions reduction. It identifies existing policies and additional actions and high-level policy options to achieve these scenarios in practice.

- In power, scenarios include emissions intensity of 50-100 gCO_2/kWh in 2030 based on an additional 40-70 GW of low-carbon capacity on the system and at least 40% renewable generation, rising from 30% in 2020. Policies to deliver this include Electricity Market Reform, CCS demonstration, planning reform and new transmission and distribution frameworks.
- In buildings, scenarios include all lofts and cavity walls, and 1.5 million solid walls, insulated by 2020 with a further 1.0-3.7 million solid walls by 2030, and 21-45% renewable heat penetration by 2030. Policies to deliver energy efficiency and renewable heat uptake include the Green Deal and Energy Company Obligation, building regulations, Smart Meters, the Carbon Reduction Commitment, Energy Performance and Display Energy Certificates, and the Renewable Heat Incentive (RHI).
- In industry, scenarios include energy, process and materials efficiency improvements largely over the next decade, 42-95 TWh of low-carbon heat by 2030 and initial uptake of CCS. The EU ETS is cited as a key policy lever complemented by the Climate Change Levy and Climate Change Agreements, the RHI and support for CCS research projects.
- In transport, scenarios include new car emissions of 95 gCO_2/km in 2020 falling to 50-70 gCO_2/km in 2030 (and near-zero in 2040). The key role for ultra-low emissions vehicles (ULEVs) in the long term, and the need to support early market development, is recognised, although scenarios to 2030 are open regarding technology mix. EU targets are cited as the key driver of new vehicle emissions reductions, with ULEVs supported by the Plug-In Car Grant, Plugged-In Places and R&D support.
- In agriculture and LULUCF, scenarios include on-farm measures and woodland creation. Actions to deliver in agriculture (which complement industry action plans) include research to improve the evidence base, improvements to provision of advice to farmers, and streamlining of advice and incentives. Support for woodland creation includes woodland grant schemes and a variety of other measures.
- In waste, scenarios include measures to reduce waste arisings, reduce emissions from landfill and increase energy recovery from residual waste. Policies and actions to deliver this include the Waste Prevention Programme, WRAP, landfill tax, possible restrictions on landfill and support for anaerobic digestion (through Feed-In Tariffs and the RHI).

Looking further ahead, the Carbon Plan includes scenarios for 2050 that are consistent with these trajectories and with the economy-wide target for an 80% emissions reductions versus 1990.

Government has also recently made a number of key policy announcements (on Electricity Market Reform, the Green Investment Bank, the Green Deal and the Energy Company Obligation), as well as publishing strategies for Bioenergy and Heat, together with a CCS Roadmap.

- **Electricity Market Reform (EMR)**. The EMR White Paper was published in July 2011 setting out "measures to attract investment, reduce the impact on consumer bills, and create a secure mix of electricity sources". The EMR was introduced to Parliament in May 2012 as part of the Energy Bill. This established the framework, with secondary legislation now needed to flesh out the reforms. Consistent with the Committee's recommendations, the model for the EMR will be based on long-term contracts to provide revenue security for investors. It will be important that the EMR is based around a clear objective for decarbonisation by 2030 to provide certainty to low-carbon investors and confidence that future carbon budgets will be met (see Chapter 2).
- **Green Investment Bank (GIB)**. An update on the Design for the GIB was published in May 2011, with a further announcement on the bank's initial priorities in December 2011. The GIB will be established under the Enterprise and Regulatory Reform Bill, due later in 2012. It has the potential to play a particularly valuable role supporting mobilisation of project finance for renewable power generation projects and energy efficiency improvement.
- **The Green Deal**. The Energy Act 2011 included provision for the Green Deal and the Energy Company Obligation (ECO) to support uptake of energy efficiency measures. In December 2011, the Committee wrote to the DECC Secretary of State expressing concerns that the proposals carried risks for delivery of loft and cavity wall insulation. The Government announced its final design for the Green Deal and ECO in June 2012, with some significant changes that should result in more cavity walls and lofts being insulated relative to the initial proposals, though risks remain. Options to strengthen incentives for loft and cavity wall insulation should be considered. More generally, the Green Deal and ECO will require close monitoring with the flexibility retained to modify design (see Chapter 3).
- **Low-carbon heat**. The Government's Heat Strategy, launched in early 2012, sets a high-level direction for decarbonising the UK heat sector by 2050. Consistent with the Committee's analysis, this recognises the importance of energy efficiency and identifies heat pumps as the primary building-scale option, with district heating offering an alternative approach (e.g. in urban areas). There remain challenges however (e.g. around longer-term funding for heat pumps and barriers to district heating), which it will be important to address in DECC's forthcoming policy proposals. Steps to address barriers to renewable heat in the residential sector should also be taken within the current policy framework as a matter of urgency (e.g. extension of the RHI to cover this sector, see Chapter 3).

- **Bioenergy Strategy**. The Government's Bioenergy Strategy was published in April 2012, taking account of recommendations from the Committee's December 2011 Bioenergy Review. The aim of the strategy is to "set a framework of principles to guide UK bioenergy policy in a way that secures its benefits, while managing risks, with the overarching principle that bioenergy must be produced sustainably". Its conclusions on sustainability risks and long-term sustainable supply of bioenergy together with priority sectors for use are broadly consistent with those in our Bioenergy Review. Going forward it will be important that this framework is applied to policy decisions on electricity, heat and transport.
- **CCS demonstration**. April 2012 saw the launch of the Government's CCS Roadmap and a new competition supported with £1 billion of direct funding, and additional funding through the EU and the mechanisms being introduced as part of the Electricity Market Reform. These are intended to support the four demonstration projects committed to in the Coalition agreement. Given the key role for CCS in power generation and more widely, it is vital that these projects are delivered, and that they cover multiple technology options (see Chapters 2 and 4).

The key challenges for the Government in driving an increased pace of emissions reduction are therefore to set out implementing arrangements and a clear objective for the EMR, to provide strong incentives for uptake of the full range of building fabric measures, to strengthen incentives for investment in renewable heat, to introduce further safeguards ensuring that bioenergy is sustainable, and to move forward with the CCS demonstration programme.

Inclusion of international aviation and shipping emissions in carbon budgets

There is an important decision for Parliament on inclusion of international aviation and shipping emissions in carbon budgets, based on our advice provided in April 2012, and to be taken by the end of the year. Our advice was that international aviation and shipping emissions should be included in carbon budgets and the 2050 target (Box 1.7). A failure to do so would represent a departure from the approach taken by the Government in its Carbon Plan, and could result either in increased costs and risks of meeting carbon budgets, or in accepting higher risks of dangerous climate change.

Box 1.7: Advice on inclusion of international aviation and shipping in carbon budgets

In April 2012 we published our statutory advice on inclusion of international aviation and shipping emissions in carbon budgets. These are currently excluded from carbon budgets and the 2050 target, but under the Climate Change Act the Government must decide on inclusion by the end of 2012.

We concluded that there is no longer any reason to account for these emissions differently to those from other sectors in UK carbon budgets (e.g. power, buildings, surface transport), and therefore recommended that emissions from international aviation and shipping should be included in carbon budgets and the 2050 target:

- Greenhouse gas emissions from international aviation and shipping cause warming and therefore must be managed.
- Including international aviation and shipping in carbon budgets and the 2050 target would be the most transparent, comprehensive and flexible approach to achieving the climate objective.
- Potential complexities that we previously identified (relating to design of the EU ETS cap for aviation and the accounting methodology for shipping) no longer exist.

We recommended that this be implemented by increasing carbon budgets two to four to allow for international aviation and shipping:

- Currently legislated carbon budgets that *exclude* international aviation and shipping were designed to put the UK on track to an 80% reduction target that includes emissions from these sectors. Therefore, no increase in effort is required from other sectors to accommodate international aviation and shipping.
- International aviation emissions should be added based on the UK share of the EU ETS cap, and international shipping emissions should be added on a bunker fuels basis reflecting current international policy (i.e. the Energy Efficiency Design Index adopted by the International Maritime Organisation).

There are no additional costs associated with our proposed budget adjustments, given that these reflect commitments that have already been made (i.e. to currently legislated budgets, to inclusion of aviation in the EU ETS, and to the IMO's policy for reducing shipping emissions).

The overall costs associated with meeting a 2050 target that includes international aviation and shipping emissions, of the order of 1-2% of 2050 GDP, were accepted at the time the Climate Change Act was legislated.

Our proposals for inclusion do not imply UK unilateral approaches to reducing international aviation or shipping emissions, which could have perverse consequences including competitiveness impacts and would therefore not be desirable.

Funding of policies to meet carbon budgets

Finally, it will be important that polices are adequately funded. Key policy areas which require or will require funding are residential energy efficiency improvement, investment in renewable heat, the Electricity Market Reform, demonstration of CCS technology, development of electric vehicle markets, and roll-out of Smarter Choice programmes. Some of the required funding will be provided from budget revenues while part of it will come from various consumer levies:

- **Budget**. Policies funded through budget revenues include investment in renewable heat, support for electric vehicle market development, roll-out of Smarter Choices programmes and demonstration of CCS. Funding allocated for this Spending Review period includes £300 million available in grants for electric vehicles (up to £5,000 for cars and £8,000 for vans), £30 million for the Plugged-In Places initiative to develop battery charging infrastructure, a £560 million Local Sustainable Travel Fund, £864 million for the Renewable Heat Initiative, and £1 billion in capital grant funding for four CCS projects.

- **Consumer levies**. Policy areas funded or likely to be funded through consumer levies include residential energy efficiency improvement and investment in renewable and other low-carbon power generation. Some of these are covered by the Levy Control Framework (Box 1.8) which sets caps on spending for these policies.
  - **ECO**. The Energy Company Obligation (ECO) will replace CERT and CESP to support energy efficiency measures in fuel poor households and hard-to-treat homes and will be funded through a price premium across all consumer bills.
  - **Levy Control Framework**. Currently the Framework covers ongoing support for renewable energy investments through the Renewable Obligation and Feed-In Tariffs, as well as the Warm Home Discount which helps low-income and vulnerable households with energy costs. It is anticipated that in future Contracts for Difference under the EMR will be covered.

For policies covered by budget revenues, our high-level assessment – set out in previous reports – is that funding for the current Spending Review period (2011/12-2014/15) is broadly adequate, but that further and increased funding will be required for the next period (which could cover 2014/15-2017/18). We will provide more detailed analysis of this area in future progress reports.

For the ECO, our previous analysis suggests that there would be scope for delivery of insulation measures required to meet carbon budgets within the current funding envelope (i.e. around £1.3 billion annually), subject to use of blended financing across the ECO and Green Deal, together with detailed policy design to minimise costs (without which we have previously expressed concern these policies will fail to achieve the required uptake of loft, cavity wall and solid wall insulation)[7].

Our assessment of the current Levy Control Framework suggests that it is broadly consistent with what is required to deliver the renewable power investments in our indicator framework to 2015. However a high-level agreement is needed now on the broad funding envelope that will be available for the next period, given that the Framework is anticipated to cover support for low-carbon investments under the EMR in future, and that decisions about this support are required now.

In this respect, we have previously estimated that policies to meet carbon budgets will add around £110 per year to the average consumer bill in 2020 compared to 2010, the majority of which is due to support for investments in low-carbon power generation (including renewables). Consistent with this, our analysis suggests a total funding envelope of around £8bn in 2020 in real terms, with a range of £6-£10bn, reflecting a range of technology costs and projected gas prices (Box 1.9).

It is important that the funding envelope available under the Framework is sufficiently high and sufficiently flexible to deliver the required investments to 2020 and beyond:

7 Letter by Lord Adair Turner to Secretary of State 20 December 2011. http://www.theccc.org.uk/news/latest-news/1134-ccc-expresses-concern-about-green-deal-proposals-20-december-2011

- The level of funding available should be broadly consistent with the £8bn required support for low-carbon power investments in 2020 that we have identified. A significant departure from this level of funding would not be appropriate as this would risk failing to decarbonise the power sector sufficiently.
- The Framework should provide sufficient flexibility to respond to changes in technology costs and the gas price (i.e. based on our analysis, there should be headroom of +/- 20-25% around the central figure).

Funding will be a crucial determinant of whether future carbon budgets will be achieved, with the need to ensure that commitments made for the current Spending Review period are maintained, and that adequate funding is provided for the next Spending Review period. This is required under the Climate Change Act (Section 13) which states that policies must be in place – and by implication funded – to meet carbon budgets. We will continue to monitor and provide more detailed analysis of funding in future progress reports.

Box 1.8: The Levy Control Framework

The framework sets, for each Spending Review period, annual caps on certain DECC policies that entail levy-funded spending. Current caps are shown in Table B1.8.

Table B1.8: Annual caps under the Levy Control Framework

LEVIES BUDGETS, £m	11/12	12/13	13/14	14/15
Renewables Obligation	1,750	2,156	2,556	3,114
Feed-In Tariffs	94	196	328	446
Warm Home Discount	250	275	300	310
Total	2,094	2,627	3,184	3,870

Source: DECC (2011) Control Framework for DECC levy-funded spending Questions and Answers

Key features of the framework include:

- Flexibility for DECC to make changes to policies within the Framework, provided forecast spend remains within the cap overall.
- Introduction of new policies on a case-by-case basis, but usually confined to a Spending Review process.
- An 'acceptable headroom' limit for spending (initially 20% of the total cap).
- Requirement for plans to address any overspend (especially beyond the acceptable headroom) – notwithstanding the duty to follow appropriate procedures before making policy adjustments, and the need to maintain levels of support where a commitment to do so has been made.
- No change to the cap as a result of policy changes which reduce forecast spend, leaving headroom for future cost increases due to policy changes.
- Tightening of the cap if forecast spend falls below the cap on a sustained basis for non-policy reasons – unless there is agreement that Government objectives are at risk due to deployment undershooting expectations.

Box 1.9: Estimating required support for low-carbon generation under the Levy Control Framework

Our estimates of the cost of supporting low-carbon capacity consider the costs of supporting renewables, nuclear and CCS demonstration projects. For renewables, we assume costs and deployment in line with proposed support in the Renewable Obligation Banding Review consultation up to 2016/17. Thereafter, further renewables, as well as new nuclear and CCS, will be supported by Feed-in Tariffs with Contracts for Difference (FiT CfDs) under the Electricity Market Reforms.

We estimate support provided under FiT CfDs as the difference between the 'strike price' (assumed to match the levelised cost of generation, as estimated in our modelling with Mott MacDonald for our 2011 Renewable Energy Review) and the price index (wholesale electricity price). There is uncertainty over low-carbon technology costs, but also over the electricity price, which will vary with the gas price as gas CCGT is likely to remain the marginal (price-setting) source of generation. Our estimates assume an electricity price range of 5.3-9.2 p/kWh in 2020, with a central estimate of 7.0 p/kWh (real £2011), based on modelling with Redpoint Energy (described in Box 2.9 in Chapter 2).

We assume that the quantity of low-carbon generation supported is in line with our indicators:

- **Renewables**. We assume 15 GW of onshore and 12 GW of offshore capacity installed by 2020/21, generating 38 TWh and 41 TWh respectively, at a levelised cost of 8.1-9.4 p/kWh and 10.7-15.7 p/kWh. Other renewables (e.g. biomass, marine) are also brought online, such that total renewable generation is 110-120 TWh by 2020 (i.e. just over 30% of generation).
- **Nuclear**. We assume one new nuclear reactor (1.6 GW) generating at baseload (12.6 TWh per year) from 2018/19 onwards, at a cost of 6.2-10.3 p/kWh.
- **CCS**. We assume four demonstrations projects coming online and running at baseload from 2017/18 onwards, at a cost of around 17-18 p/kWh.

As a result we estimate that the total funding envelope for supporting low-carbon generation in 2020/21 will be around £8 billion in real terms (£2011/12) with a range of £6-10 billion, reflecting the range for electricity prices set out above (under high-low gas prices) and a range for technology capital costs as set out in our Renewable Energy Review.

Key findings

- Economy-wide emissions **fell by 7%** in 2011.
- The **mild winter weather** in 2011 (relative to very cold winter weather in 2010) reduced emissions by around 3%. Rising fuel prices, falling incomes and transitory factors in power generation also had an impact.
- Carbon-saving measures reduced emissions by around 0.8%. **Progress against indicators was mixed**, with some areas still lagging behind.
- To remain on track for future carbon budgets, there is now an **urgent need to move from policy planning to delivery**, and to accelerate the pace at which measures are implemented.
- There is a need to do more across almost the **full range of measures** including low-carbon power generation, energy efficiency, renewable heat, electric vehicles, and travel behaviour change.
- There has been **progress on policies** to drive delivery, but a number of **challenges remain**, most pressingly around Electricity Market Reform, the Green Deal and residential renewable heat.

Introduction and key messages

1. Power sector emissions
2. The Committee's power sector indicator framework
3. Investment in renewable generation
4. Commercialisation of CCS
5. Deployment of new nuclear
6. Electricity market reform

Chapter 2: Progress decarbonising the power sector

Introduction and key messages

In our last progress report[1] we showed that the increase in power sector emissions of 4% in 2010 was largely due to transitory factors, including unusually cold weather and an increase in the carbon intensity of generation due to temporary nuclear outages.

In this report we consider the latest data on emissions along with progress investing in new low-carbon capacity. We assess progress investing in renewables, nuclear and carbon capture and storage (CCS) against our indicator framework. We also outline priorities for taking forward the Electricity Market Reform given its crucial role in driving future low-carbon investments.

Our key messages are

- Emissions in 2011 fell by 7% to 146 $MtCO_2$, mainly due to favourable weather conditions, and as nuclear plants returned to operation after outages. There was also a small improvement in carbon intensity as renewable capacity was added to the system.
- New wind capacity was added to the system in 2011, but a higher rate of investment will be needed in future to meet renewable energy targets and carbon budgets. Looking ahead, the project pipeline is weak for nuclear, and although it is healthy for wind, major challenges remain translating this to actual investments. These include ensuring that there is adequate financial support and financing for investments and that onshore wind projects receive planning approval. It is also vital that the new CCS programme is delivered as a matter of urgency.
  - **Renewables.** Investment in wind generation in 2011 was one-third the rate required annually by the end of the decade. The forward pipeline remains strong, with sufficient projects in planning, awaiting construction or in construction to meet our indicators to at least 2017. But delivering investments will require resolution of current policy uncertainties (e.g. relating to the Renewables Obligation, the Electricity Market Reform, transmission pricing) and that financing barriers are addressed (e.g. the Green Investment Bank to mobilise project finance for offshore wind). Both biomass and solar delivered strongly in 2011.
  - **CCS.** The first CCS competition failed to award funding to any project. A second competition has been launched aiming to fund four commercial-scale demonstration projects and incorporating lessons from the first. It is crucial now to maintain momentum through to timely delivery of these projects (i.e. towards the beginning of the 2016-2020 period) to ensure CCS can contribute towards sector decarbonisation in the 2020s. This requires that projects are selected and funding is awarded this year, with FEED studies and contracts to follow in 2013 ahead of construction starting by 2014. The demonstration programme should be supported by development of a strategy for follow-on CCS projects and CO_2 infrastructure.

1 CCC (2011) *Meeting Carbon Budgets – 3rd Progress Report to Parliament*

  - **Nuclear.** Progress has been made in approval of the nuclear National Policy Statement, interim approval of the generic reactor designs and the submission of the first planning application for new nuclear. The final Weightman report[2] on the implications of Fukishima was published and concluded that the UK had displayed a strong safety culture and existing procedures were adequate. However, the project pipeline is weak, reflecting significant risks related to the financial viability of investments. The key determinant of whether nuclear investment proceeds will be the successful implementation of Electricity Market Reform.

- Progress has been made on Electricity Market Reform (EMR), most notably through the Government stating that this will be based on long-term contracts for low-carbon power generation and, more recently, publication of the Draft Energy Bill for pre-legislative scrutiny. Long-term contracts offer the best chance to bring forward required investment in low-carbon technologies at least cost to the consumer. It is important now that a clear carbon objective is set for the EMR (i.e. to achieve carbon intensity of the order of 50 gCO_2/kWh in 2030 through investment in low-carbon technologies), to provide investor confidence that there will be a market for low-carbon technologies built to schedule and cost, and that there will not be a second 'dash for gas'. Specific commitments on minimum levels of less mature technologies should be made, subject to cost reductions being achieved. There are also a number of detailed design questions which should be resolved as a matter of urgency so that the EMR can be implemented from 2014.

We set out the analysis underpinning these messages in six sections:

1. Power sector emissions
2. The Committee's power sector indicator framework
3. Investment in renewable generation
4. Commercialisation of CCS
5. Deployment of new nuclear
6. Electricity market reform

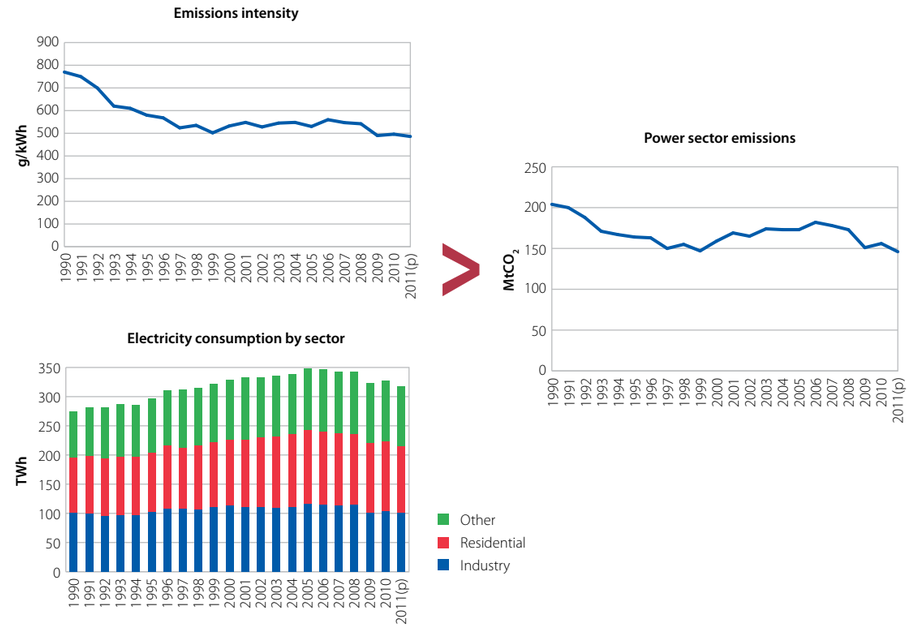
1. Power sector emissions

Emissions in 2011

In 2011, power sector emissions accounted for 27% of total UK greenhouse gas emissions. Provisional data suggest power emissions fell by 7%, from 156 $MtCO_2$ in 2010 to 146 $MtCO_2$ in 2011. This was driven both by a fall in demand and a reduction in the carbon intensity of power generation (Figure 2.1):

2 HM Chief Inspector of Nuclear Installations (September 2011) *Japanese earthquake and tsunami: Implications for the UK nuclear industry, Final Report.*

Figure 2.1: Emissions intensity of electricity supply, electricity demand and CO_2 emissions from the power sector (1990-2011)



Source: CCC calculations, DECC (March 2012) *Energy Trends*, DECC (March 2012) *Provisional 2011 results for UK greenhouse gas emissions and progress towards targets.*
Note: 2011 data are provisional.

- Demand fell by 4% to 317 TWh, largely as a result of falling consumption in the residential (-5%) and industrial (-4%) sectors. The fall in demand is mainly due to higher than average temperatures during 2011. After adjusting for changes in temperature, residential demand fell by around 1% in 2011.

- The carbon intensity of electricity supplied fell by 2%, from 496 gCO_2/kWh in 2010 to 486 gCO_2/kWh in 2011. This reflects an increase in low-carbon generation.

  – Nuclear generation increased 11%, from 56 TWh in 2010 to 63 TWh. This was the result of several plants which experienced maintenance outages during 2010 returning to normal operation (i.e. generation went back to 2009 levels).

  – Generation from renewables continued to increase, rising by 31% from 26 TWh in 2010 to 34 TWh in 2011 (10% of total generation). This increase was due in part to favourable weather conditions for wind and hydro (higher wind speeds and rainfall). Adjusting for variable weather conditions, renewable generation increased from 7.4% (28 TWh) to 9.0% (33 TWh) of the mix, reflecting an increase in installed capacity[3].

3 DECC (March 2012) *Energy Trends*. This is measured on the 2008 Renewable Energy Directive (RED) basis, which specifies the normalisation of wind and hydro generation. Normalisation calculates generation by applying an average load factor to current capacity. For wind, the load factor is calculated as the average of the past five years (including the present one), with current capacity taken as an average of the start and end of year capacity. For hydro, the load factor is the average of the past 15 years, applied to capacity at the end of the current year.

– Reflecting the increase in low-carbon generation, gas generation fell, from 159 TWh in 2010 to 130 TWh in 2011, and therefore made up a smaller share of the mix (40% compared with 47% in 2010). Meanwhile, coal generation maintained a constant share (30%). This is likely to reflect commodity prices that were broadly favourable to coal relative to gas over the year – the carbon price fell in the latter half of the year (e.g. from just over €16/tCO_2 in June to €7/tCO_2 in December 2011), and gas prices were higher than in 2010.

– Had there been more fuel switching (i.e. a reduction in coal, rather than gas generation) carbon intensity could have fallen by 14%.

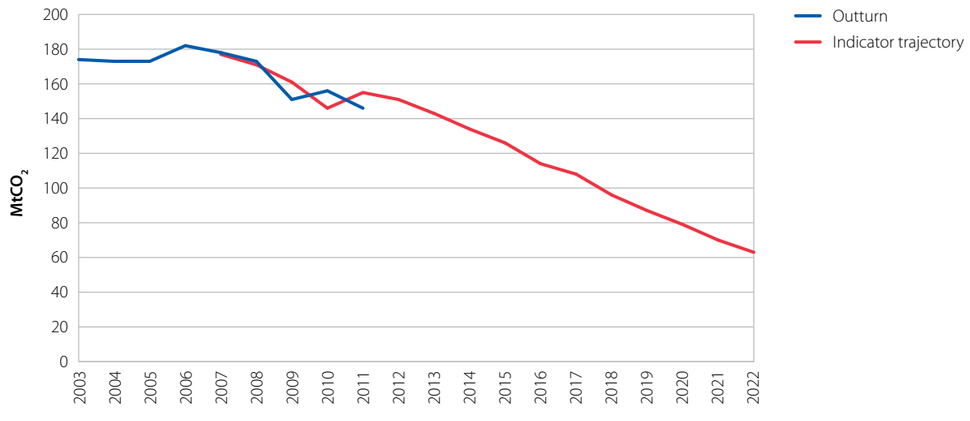
Emissions in 2011 are now roughly back at their level of 2009, when temperatures and nuclear outages were at similar levels.

Prior to 2009, when emissions fell sharply during the recession, power sector emissions had been on a slowly increasing trend since 2000 as demand increased steadily and emissions intensity remained relatively constant. That followed a period of rapidly falling emissions intensity during the 'dash for gas' of the 1990s.

Looking forward, our indicator framework for the power sector reflects the need for energy efficiency improvements to offset demand growth and for significantly reduced carbon intensity of power generation through investment in low-carbon capacity.

Last year we reported that the increase in emissions in 2010 put the UK behind the decarbonisation trajectory set out in our indicator framework. The fall in emissions in 2011 now brings emissions back in line with the trajectory (Figure 2.2).

Figure 2.2: Outturn emissions versus indicator trajectory for the power sector (2003-2022)



Source: CCC calculations; DECC (March 2012) *Energy Trends*. DECC (March 2012) *Provisional 2011 results for UK greenhouse gas emissions and progress towards targets*.
Note: 2011 data are provisional.

However, we have always emphasised that progress in the power sector should be judged based on deployment of low-carbon capacity, as well as emissions (i.e. since emissions will tend to fluctuate with fuel prices and weather). This can be measured through the *achievable emissions intensity*, to which we now turn, and through progress adding low-carbon capacity, which we consider in sections 3-5.

Achievable Emissions Intensity

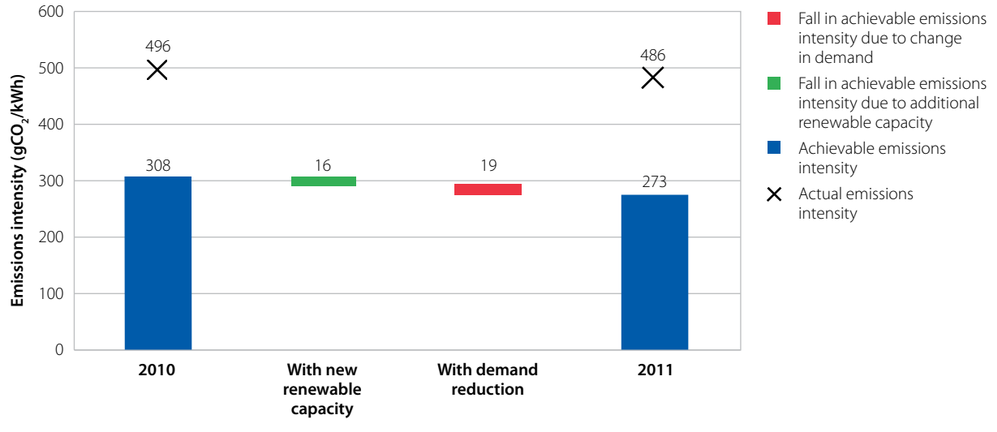
Achievable emissions intensity is the carbon intensity of electricity supply that would be achievable if power plants were despatched to the grid in order of least emission rather than least cost, and if they were available to generate as often as in an average year.

In practice this means meeting demand with nuclear and renewables first, followed by gas and finally coal plant. Reductions in achievable emissions intensity therefore reflect investment in low-carbon generating capacity, and are not affected by short-term fluctuations in fuel and carbon prices (which can determine whether coal generates before gas) or by load factors for nuclear and renewables varying between years (e.g. due to weather conditions).

In 2011 achievable emissions intensity improved by 35g (11%) compared to 2010[4], decreasing from 308 gCO_2/kWh to 273 gCO_2/kWh (Figure 2.3).

- Just over half of the reduction (19g) is due to the 4% reduction in demand – which reduces the need for marginal, coal-fired, capacity.
- Renewable capacity added to the system contributed a 16g reduction, including the addition of 1.1 GW of wind, 0.9 GW of biomass and 0.9 GW of solar.

Figure 2.3: Achievable emissions intensity (2010-2011)



Source: CCC calculations based on various sources including DEFRA *GHG Conversion Factors*; DECC (March 2012) *Energy Trends*; DECC (June 2011) *DUKES*.
Notes: Achievable emissions intensity is the minimum average emissions intensity that could be achieved in a year, given the installed capacity, demand and the profile of that demand. Emissions intensity is estimated on an end use basis (includes transmission and distribution losses).

4 Note that we have also recalculated the 2010 figure based on revised outturn data for demand and capacity.

This indicator shows that there is scope to reduce current emissions intensity by over 200g (40%) through fuel-switching within existing capacity, primarily from highly carbon-intensive fuels (i.e. coal and oil) to gas. This is achievable at relatively low cost – for example, had the carbon price been €10-15 higher (e.g. around €25/tCO_2 compared with around €13 on average for 2011), a further 50 MtCO_2 could have been saved via fuel switching in 2011. This low-cost option, which is available today without any requirement for new investment, emphasises the missed opportunity for delivering low-cost emissions reduction that is available through tightening the EU ETS (see Chapter 1).

We show in section 3 that this investment in renewables is broadly on track with our indicators. However, it is important to note that the indicator framework includes a significantly accelerated pace of investment from 2015, along with deployment of nuclear capacity and capacity fitted with carbon capture and storage (CCS) in the longer term.

2. The Committee's power sector indicator framework

The Committee's power sector indicator framework sets out a trajectory towards a largely decarbonised power sector, aimed at reducing emissions and developing a range of low-carbon options for future sector decarbonisation (Table 2.1).

The indicators set out timelines for key stages of investment, including policy milestones:

- **Renewables.** Our indicators cover capacity on the system and progression through the project cycle (i.e. in and entering construction, in planning etc.), generation output, planning approval rates and progress for the transmission network (required reinforcements, access to the network, investment in the onshore and offshore grid) – see section 3.
- **CCS.** Our indicators for the first three budget periods focus on progress with the UK's programme of demonstration projects – see section 4.
- **Nuclear.** We monitor progress towards building a new generation of plants, including indicators on planning and regulation – see section 5.
- **Electricity Market Reform.** We have previously proposed that new market arrangements are required to support low-carbon investment – see section 6.

The indicators therefore enable us to track not just the impact of investments on emissions in the latest year, but also the expected impacts in future years. They are designed to provide early warning of problems in the pipeline and to identify areas where action is required.

The level of ambition as set out in our indicator framework is broadly in line with the overall level envisaged in the Government's 2011 Renewable Energy Roadmap and Carbon Plan (both published last year). The Roadmap suggested a reduction in ambition for onshore wind (to no more than 13 GW, compared to the 15 GW included in our indicators and in the Government's previous National Renewable Energy Action Plan, published in 2010). Our analysis below suggests that the 15 GW in our indicators remains achievable, and would save £0.3 billion a year compared to a 2 GW reduction in onshore ambition compensated by more offshore generation. There is a political judgement in trading off these potential savings with adverse local landscape effects perceived by some groups.

3. Investment in renewable generation

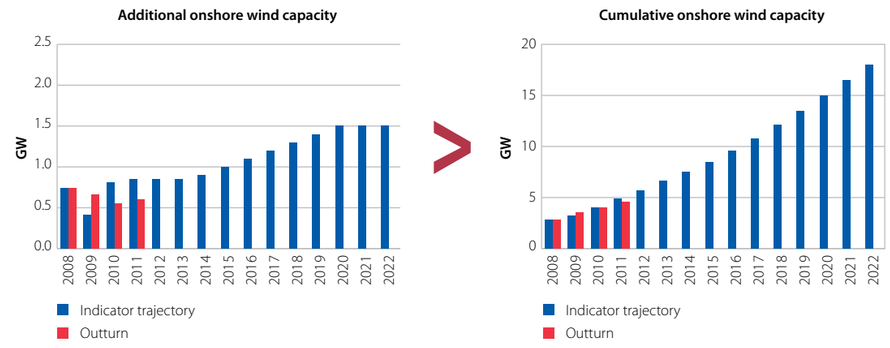
Progress adding new wind capacity

Our approach to monitoring progress reducing underlying emissions focuses on how much wind capacity has been added to the system, and how much is likely to be added based on forward indicators (i.e. capacity entering construction, capacity moving through the planning system, supply chain investment and investment in transmission infrastructure to support the required increase in wind generation).

The overall picture for wind capacity is one of continuing steady investment, although with some under-delivery with respect to our indicators on onshore wind, with a need for significantly higher rates of investment in future years.

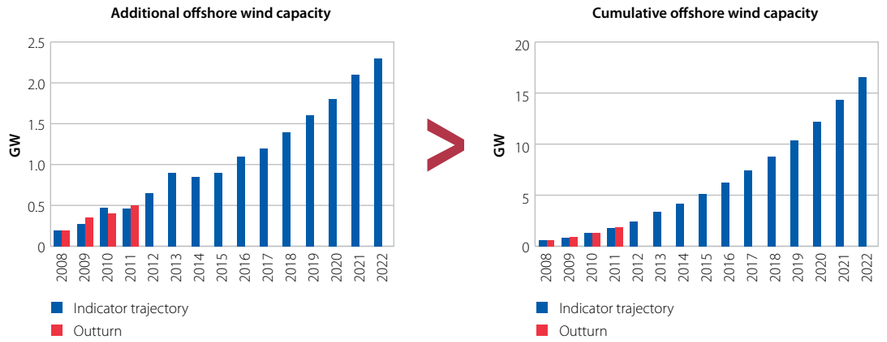
- **Capacity added to the system.** Additional onshore capacity fell somewhat short of our indicators for a second year in a row, whilst offshore wind capacity added to the system was broadly on track with our indicators (Figures 2.4 and 2.5).
  - In 2011, 0.6 GW onshore wind was added to the system. Although this represents a small increase on capacity added in 2010 (0.55 GW), it still falls short of the level envisaged in our indicators (0.8 GW). Two consecutive years of underperformance in terms of incremental capacity has meant that total installed capacity of onshore wind was around 0.3 GW lower than envisaged in our indicators at 4.6 GW at the end of 2011.
  - Around 0.5 GW offshore wind capacity was added to the system in 2011, slightly exceeding our indicator for 2011. This brings total offshore capacity installed broadly on track at 1.8 GW at end-2011, after additions fell short in 2010.
  - Looking forward, there needs to be a considerable increase in build rates for both onshore (to 1.5 GW each year by 2020) and offshore (to 1.8 GW each year by 2020) to achieve the 27 GW of wind capacity by 2020 set out in our indicator framework.

Figure 2.4: Annual additional and cumulative onshore wind capacity (2008-2022)



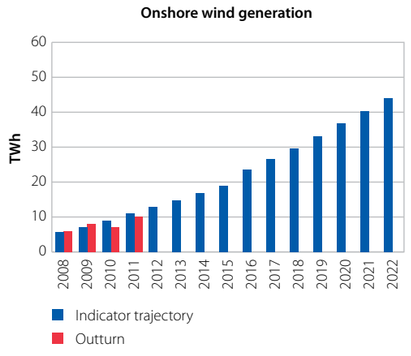
Source: DECC (March 2012) *Energy Trends*.
Notes: 2011 data are provisional.

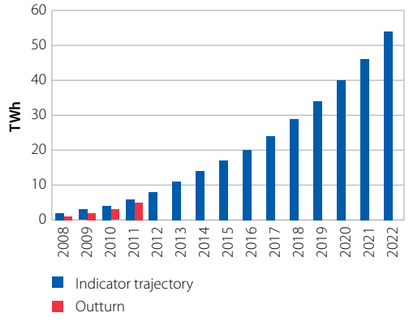
Figure 2.5: Annual additional and cumulative offshore wind capacity (2008-2022)

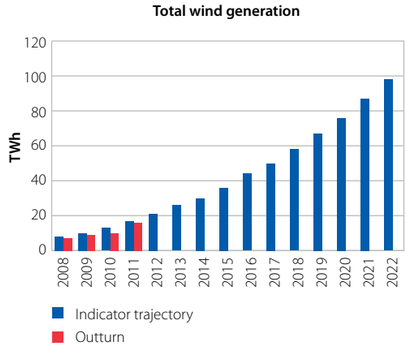


Source: DECC (March 2012) *Energy Trends*.
Notes: 2011 data are provisional.

Figure 2.6: Onshore, offshore and total wind generation (2008-2022): Outturn against indicator trajectory







Source: DECC (March 2012) *Energy Trends*.
Note: 2011 data are provisional.

- **Wind generation.** Generation in 2011 was lower than envisaged in our indicators for both onshore and offshore wind (Figure 2.6). For onshore this shortfall was in line with the shortfall in capacity added to the system. For offshore it may be due to projects coming on later in the year (i.e. capacity added in 2011 would only provide a part-year of generation), although there may also have been a more general underperformance in terms of achieved load factors (Box 2.1). This is an area we will continue to monitor carefully, given the importance of performance for the economics of offshore wind and policies to support investment.

Box 2.1: Wind speeds and generation in 2011 compared with our indicators

For 2011, our indicators assume load factors of 26% for onshore and 37% for offshore (average across the regions of the UK) assuming installed capacity is generating for a full year (i.e. from January 1st). For onshore this is broadly comparable with what has been achieved historically (27.1%), whilst limited data are available for offshore.

Last year we reported that, due to low wind speeds, total wind generation was below our indicators, increasing by just 9% (0.8 TWh) despite a 22% increase in capacity. Since we published our report, data have been published[5] confirming that, at 21.5%, the achieved load factors for onshore projects operating throughout 2010 was well below the historical average (27.1%). For offshore the figure for 2010 was 29.6% – over 7 percentage points lower than the assumption in our indicators.

Data are not yet available on the achieved load factor of wind projects operating throughout 2011. However, the large increase in offshore generation in 2011 – up by over 65% (2.1 TWh), compared to the capacity increase of around 35% – suggests that load factors may have returned to around the level assumed in our indicators. This is in the context of more favourable weather conditions – wind speeds were 1.4 knots higher in 2011 than in 2010[6].

Reports from generators confirm increased output as a result of favourable weather conditions, with no evidence of reduced reliability:

- Scottish and Southern saw average onshore wind load factors rise above 30% (compared with 24% in 2010/11), whilst availability remained at 97% (as in the previous year). This increase in generation reflected 'windier conditions'[7].
- Centrica's wind generation increased by 21% due to 'weather conditions [being] generally more favourable than in 2010'. The average load factor for offshore assets increased to 36%, compared with 32% in 2009 and 29% in 2010[8].

Low aggregate generation can also reflect that projects added in the relevant year may not have operated for a full year. This is particularly an issue offshore, where some projects became operational towards the end of the year (e.g. Walney 2, Ormonde and Sheringham Shoal projects all came online in the second half of the 2011).

We will continue to monitor the performance of capacity in respect to our indicators, particularly for offshore projects where historical data are more limited.

5 DECC (2011), *Regional Renewable Statistics*. Load factors by region for onshore and offshore are available at: https://restats.decc.gov.uk/cms/regional-renewable-statistics/ Figures quoted are load factors on an 'unchanged configuration basis' i.e. only taking into account projects that have been operating for a full year. Onshore historical average across all regions for the period 2000 – 2010 inclusive.
6 DECC, *Energy Trends* March 2012.
7 SSE plc's financial report for the year to 31 March 2012, available at http://www.sse.com/uploadedFiles/Controls/Lists/Press_releases/Press_releases/2012/FY1216May.pdf
8 Centrica's Annual Report and Accounts 2011, available at http://files.the-group.net/library/centrica/annualreport2011/pdfs/centar11_annualreport.pdf

The project pipeline for wind appears to be strong (Box 2.2), with the caveat that relatively few onshore projects are flowing into construction, and that construction periods are longer than expected. This could be due to a number of factors (set out below), and there is limited information about the precise status of projects (e.g. how close they are to entering construction, or for those projects in construction, to reaching completion). Planning approval for onshore wind projects remains slow, and 2011 saw a slight drop in approval rates.

- **Projects in or awaiting construction.** As in last year's progress report, the project pipeline currently appears to be strong. There are sufficient projects in or awaiting construction to cover required capacity additions in the next five years for onshore wind and four years for offshore wind. However, there is already evidence that onshore projects are moving slowly into construction. This is likely to reflect current uncertainties over support mechanisms and difficulties with radar and grid connection, given that the supply chain appears healthy. We would expect a similar bottleneck for offshore wind going into construction unless uncertainties and barriers are addressed.
  - As of March 2012, there was 1.8 GW of onshore wind and 2.3 GW of offshore wind under construction. There was also a further 3.8 GW onshore wind and 1.6 GW offshore wind awaiting construction, having already received planning approval.
  - It is not clear exactly how far these projects have progressed (e.g. how close they are to entering construction, or for those projects in construction, how close they are to completion). Relatively few onshore wind projects appear to be flowing into construction (e.g. less than 0.3 GW out of the 3.8 GW stock with approval) or completing construction (e.g. around one third of those in construction, even though in theory construction times can be under a year for some projects).
  - **Support mechanisms and finance constraints.** Current uncertainties over project returns may be holding back projects from proceeding or securing finance.
    - **Renewables Obligation (RO).** Delays to the publication of the RO Banding review have led to uncertainty over support for wind and other renewables to be added to the system between 2013 and 2017.
    - **Electricity price uncertainty.** Uncertainty over the RO is compounded by the uncertainty of the electricity price that will ensue under the EMR, which has resulted in a lack of Power Purchase Agreements (PPAs) for independent onshore generators.
    - **Transmission charging.** Onshore wind developers do not yet have clarity over transmission charging (up to around 10% of costs for onshore wind), and are therefore unable to fully assess project economics. After a lengthy review process, Ofgem's preferred option was published in May 2012 (Project Transmit), but details of the option are still to be set out.
    - **Finance.** There may be limited appetite to finance projects, given these revenue uncertainties, the new banking regulatory framework and the limited balance sheet strength of utilities.
  - **Radar.** The Aviation Fund was established in 2008 to develop technical solutions to radar interference. Although solutions have since been identified and developed (e.g. software to eliminate interferences), for onshore wind in particular radar remains a barrier for many projects, with 5 GW affected by radar issues in 2011[9]. Given these problems, a more strategic approach to dealing with radar issues onshore may be appropriate (e.g. as successfully overseen by the Crown Estate offshore).
  - **Grid access.** Connect and Manage has had some success in bringing forward the dates of renewable projects, and many projects with planning approval have connection dates in 2012 or 2013 (42% onshore and 63% offshore for projects with published connection dates). However, connection remains a potential delay for some projects that already have approval, with at least 1.5 GW of onshore capacity in or awaiting construction not due to be connected until 2015 or later.
  - **Supply chain.** The UK supply chain is strengthening for both onshore and offshore wind. A new UK manufacturing facility for onshore towers opened in 2011 (Mabey Bridge), with capacity to support up to 0.5-1 GW of capacity (i.e. 300 towers) each year. Several UK manufacturing facilities for offshore turbines progressed in the development cycle (e.g. Siemens and Vestas have received planning approval for factories capable of supporting up to 2 GW of capacity a year, and Gamesa have chosen a site location although are yet to apply for planning permission). Investment in offshore installation vessels has also been forthcoming, with two delivered in 2011 and a further four expected this year, with 11 either in construction or on order (enough to install several GWs per year).
- **Capacity moving through planning.** Whilst there were a significant number of new wind planning applications in 2011 (particularly onshore), there were limited determinations. As a result, a large stock of projects awaiting approval remains, particularly onshore (Figures 2.7 and 2.8). The average approval rate for onshore projects was low in 2011, with long determination periods. Offshore approval rates remain high.
  - **Onshore.** There was a continued flow of projects into the planning system, with 2.3 GW of new projects submitted for approval in 2011. Of the stock of projects awaiting approval, only 1.5 GW were determined, increasing the stock of projects awaiting approval to 8.7 GW at the end of 2011. The majority (64%) of this capacity is in Scotland. This stock of onshore projects (added to those already deployed and in or awaiting construction) would be more than sufficient to deliver the 2020 capacity in our indicator trajectory (i.e. 15 GW) if historic approval rates continue.

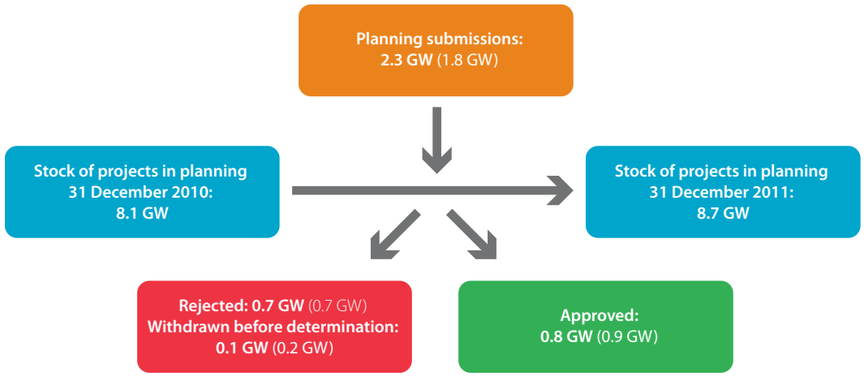
9 DECC (July 2011) *UK Renewable Energy Roadmap*

– **Offshore.** Last year we reported that in 2010 there were no planning applications or determinations for offshore projects. In 2011, around 0.5 GW of capacity was submitted for approval, and 0.5 GW determined, with the total stock of projects awaiting approval totalling 2.5 GW at the end of 2011. All of this capacity is large-scale (over 50 MW) and in English waters. This stock of offshore projects (added to those already deployed and in or awaiting construction) would be sufficient to deliver our indicators to 2017. At least a further 4 GW of applications and approvals are required to 2020. This is unlikely to be problematic given licensing of projects in deeper waters and new applications in 2012 – there have been just over 2 GW of offshore applications submitted into planning in January-May 2012 alone.

– **Planning approval rates.** The UK-wide approval rate for onshore wind has fallen, from around 60% in 2010 to around 50% in 2011. The approval rate does, however, differ by size and location of project, for example with all large-scale capacity (over 50 MW) determined in Scotland being approved, but just 34% of small-scale capacity (less than 50MW) determined in England being approved (Box 2.3). Decisions regarding offshore wind applications are infrequent and lumpy; the approval rate in 2011 was 100%, with all three determined projects being approved (two in England, one in Scotland).

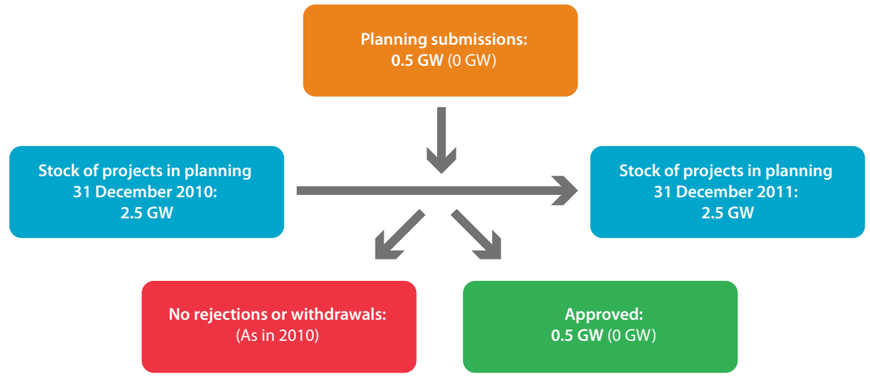
– **Determination periods.** Overall, determination periods (the time taken from when projects enter planning to when a decision is actually made, excluding projects that went to appeal) increased for onshore wind to average well over the 12 months assumed in our indicators (Figure 2.9). Large-scale onshore projects, determined by the Secretary of State (with advice from the Major Infrastructure Planning Unit) were particularly slow, with the average determination period increasing to 55 months (from 36 months in 2010). Small-scale projects were on average determined sooner (17 months), but still look longer than in 2010 (15 months) , with some projects (just over 50 MW in total) waiting over five years (60 months) for determination. Offshore wind determination periods increased slightly to 28 months in 2011 (compared with 27 months in 2008 – the last year with determinations).

Figure 2.7: Planning flow chart for 2011 (onshore wind)



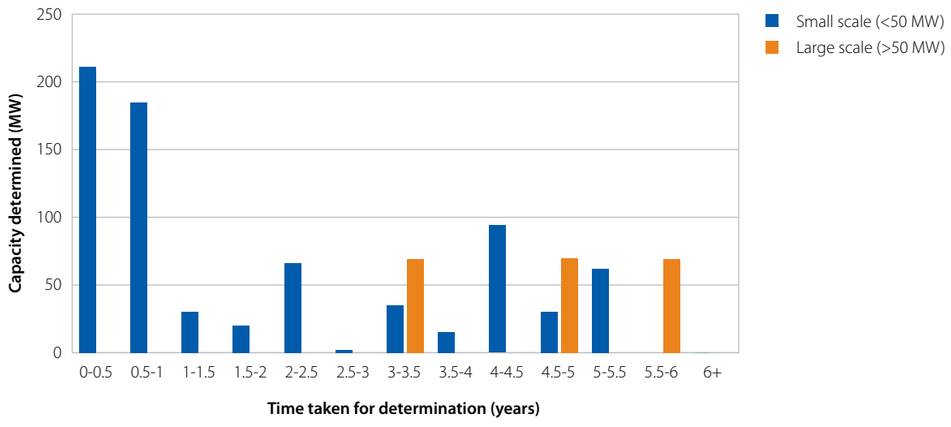
Source: CCC calculations based on DECC *Renewable Energy Planning Database.*
Notes: Data current as at March 2012. Figures may not sum due to rounding. Numbers in brackets refer to 2010.

Figure 2.8: Planning flow chart for 2011 (offshore wind)



Source: CCC calculations based on DECC *Renewable Energy Planning Database.*
Notes: Data current as at March 2012. Figures may not sum due to rounding. Numbers in brackets refer to 2010.

Figure 2.9: Decision time for onshore wind capacity determined in 2011: small and large scale



Source: CCC calculations based on DECC *Renewable Energy Planning Database.*
Notes: Data current as at March 2012. Determination time refers to the period between an application being submitted to the relevant planning body and an initial planning decision being made. It includes projects that later went to appeal, but excludes the time taken during the appeal process.

In order to provide confidence that the pipeline will translate into installed capacity, a number of actions are required from the Government and the regulators:

- Confirm support for projects under the Renewables Obligation (RO). Announcement of the support for projects commissioned in 2013-2017 has been delayed because of ongoing debate about support for onshore wind. Any decision to reduce support from the initially proposed level of 0.9 ROCs should be made based on a full assessment of investment prospects (e.g. across the distribution of projects in the pipeline). To the extent that lower support would reduce the number of viable projects, assessment of alternative means for meeting the 2020 renewable energy target should be undertaken, including cost and energy bill impacts, and allowed for in the Levy Control Framework.
- Ensure clarity over the details of support under EMR. CfDs for renewables should be designed to be as close to feed-in tariffs as possible so as to limit investor risks.
- Allow renewable projects to be considered for early eligibility for Contracts for Difference (e.g. in 2013) under proposals for transitional support in the Draft Energy Bill (2012), to mitigate uncertainties over wholesale electricity prices.
- Explore options to address barriers to finance, such as intervention from the Green Investment Bank (GIB).
- The planning process should appropriately account for the benefits of onshore wind, in order to avoid higher levels of investment in more expensive technologies that would have adverse affordability impacts. For example, costs of onshore wind could be up to 50% lower than those of offshore wind (e.g. 8-9p/kWh in 2020, compared with 10-16p/kWh for offshore wind).
- Bring forward grid connection dates for projects and confirm final arrangements for transmission pricing.
- Continue to work with industry, the Ministry of Defence and others to address radar interference strategically and collaboratively.

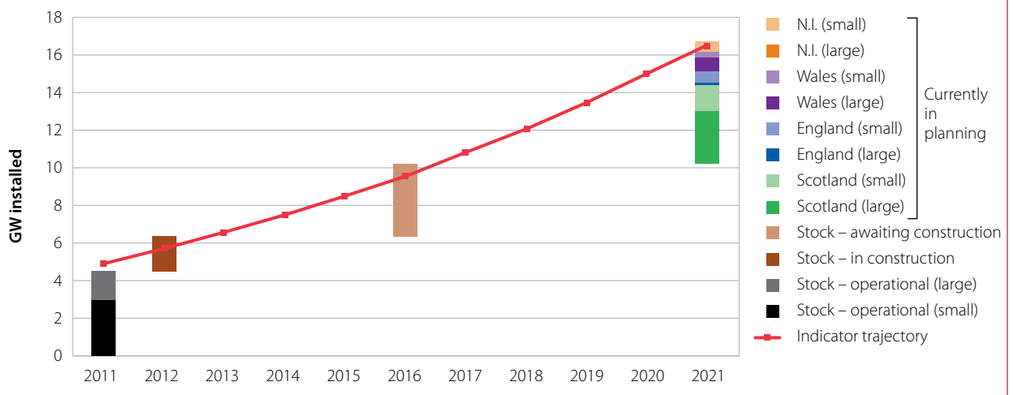
Given appropriate actions, it is realistic that ambitious renewable energy targets for 2020 can be achieved, and that wind generation can make a valuable contribution to power sector decarbonisation required to meet carbon budgets.

Box 2.2: Project pipeline for wind

There are sufficient projects in or awaiting construction to cover required capacity additions in the next five years for onshore wind and four years for offshore wind, with projects in planning that could go beyond this.

- **Onshore.** Based on the current pipeline of projects, there is potentially sufficient onshore capacity to exceed our indicator of 15 GW of installed capacity by 2020 (Figure B2.2a).
  - Assuming they are all built, there is enough capacity currently in construction (1.8 GW) to exceed our indicator for installed capacity in 2012 (5.7 GW).
  - Assuming they all proceed to construction and operation, there is enough capacity with planning approval and awaiting construction (3.8 GW) to exceed our 2016 indicator (9.6 GW).
  - If approval rates and determination periods occur as they have historically (e.g. average over the last five years including 2011)[10], around 6.5 GW of the 8.7 GW awaiting planning approval would receive approval and proceed to construction and operation. This would bring total installed capacity to 16 GW (i.e. in line our indicator for installed capacity for 2021).
  - There is also potential to go further, if more projects are submitted for approval and proceed to operation (e.g. in 2011, 2.3 GW of projects were submitted for approval).

Figure B2.2a: Pipeline of onshore wind projects compared to indicator trajectory



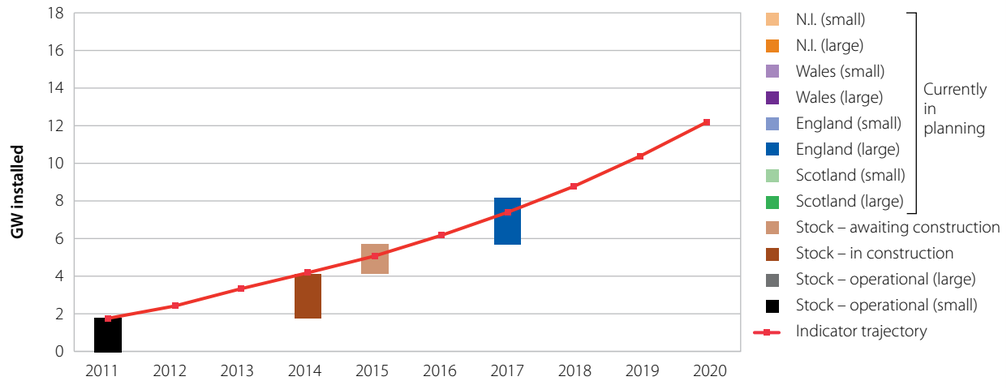
Source: CCC calculations based on DECC *Renewable Energy Planning Database* and DECC (March 2012) *Energy Trends*.
Notes: Data current as at March 2012. Assumes continuation of historical approval rates (average based on the past 5 years including 2011) for projecting approvals for the stock of projects in planning. Small projects (<50 MW) are determined at Local Authority level. Large projects (>50 MW) are determined by the Secretary of State.

10 Based on past five years from 2007-2011, the average rate of approval (by capacity) for small- (<50 MW) and large-scale (>50 MW) projects was 59% and 78% for England, 73% and 77% for Wales, 61% and 85% for Scotland and 91% and 77% for Northern Ireland, respectively.

Box 2.2: Project pipeline for wind

- **Offshore.** There is enough capacity to potentially meet our indicator of just over 7 GW for installed capacity by 2017 (Figure B2.2b).
  - Assuming they are all built, there is enough capacity currently in construction (2.3 GW) to meet our indicator for 2014 (4.2 GW).
  - Assuming they all proceed to construction and operation, there is enough capacity awaiting construction (1.5 GW) to exceed our indicator for 2015 (5.1 GW).
  - The approval rate for offshore projects in all regions in the UK has been 100% (based on 13 projects determined since 2007). If this high rate continues, and all of the 2.5 GW currently awaiting planning approval proceed to construction and operation, this would bring total installed capacity to 8.2 GW (i.e. exceeding our indicator for 2017 and just short of our indicator for 2018).
  - A further 4 GW of new installed capacity will be required in addition to this, in order to meet our indicator of 12 GW by 2020. This represents around 10% of the combined capacity that has been leased by the Crown Estate for Round 3 (32 GW), and the potential in the Scottish Territorial Waters (6 GW).

Figure B2.2b: Pipeline of offshore wind projects compared to indicator trajectory



Source: CCC calculations based on DECC *Renewable Energy Planning Database* and DECC (March 2012) *Energy Trends*.
Notes: Data current as at March 2012. Assumes all capacity awaiting determination is approved, based on the historical approval rate of 100%. Small projects (<50 MW) are determined at Local Authority level. Large projects (>50 MW) are determined by the Secretary of State.

Box 2.3: Trend in approval rate by UK nation – onshore wind

Around half of the 8.7 GW of onshore capacity awaiting planning approval at the end of 2011 is considered 'large scale' (i.e. project is over 50 MW), with the other half considered 'small scale' (< 50 MW).

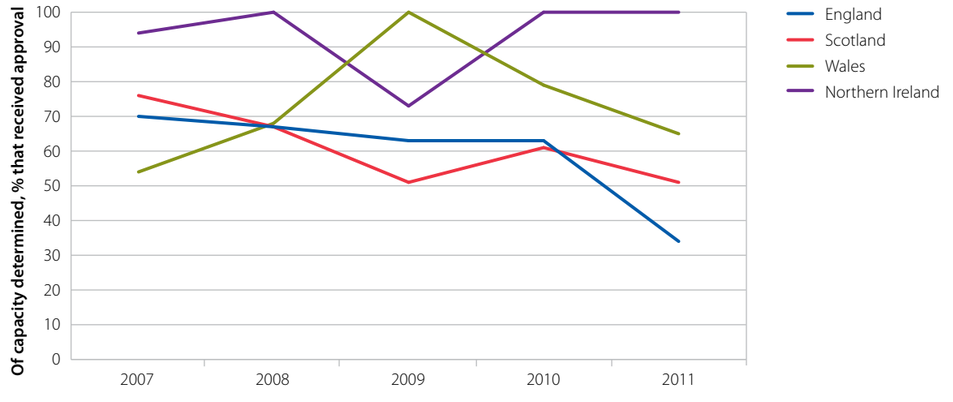
Large onshore wind projects are determined at the national level by the Secretary of State, with advice from the Ministerial Infrastructure Planning Unit (MIPU). There are relatively few large-scale projects and determinations, therefore approval rates can vary widely. In 2011, 100% of large-scale projects determined in Scotland were approved (based on three projects); meanwhile, there were no determinations for large-scale projects in other nations. In 2010 (the last year of determinations in England) the rate of approval was just over 30% (of capacity), compared with 100% in 2007 and 2008.

Small (<50MW) onshore wind projects are determined at the local authority level. The UK-wide approval rate for these small projects has fallen from 69% in 2010 to 46% in 2011. Whilst approval rates differ by region, a downward trend has generally been observed across all of the UK except Northern Ireland (Figure B2.3).

- **England.** Around 24% of small-scale capacity awaiting approval at the end of 2011 (1.0 GW) are projects in England. There has been a downward trend in the approval rate since 2007, with a substantial drop in 2011 (just 34% of capacity determined in 2011 received positive approval in 2011, compared with 63% in 2010). England now has the lowest approval rate for small-scale projects out of the UK nation.
- **Scotland.** Around 50% of small-scale capacity awaiting determination at the end of 2011 (2.2 GW) is in Scotland. Approval rates also fell, from 61% in 2010 to 51% in 2011.
- **Wales.** 11% of small-scale capacity awaiting determination at the end of 2011 (0.5 GW) is in Wales. The approval rate in 2011 was 65% in 2011, compared with 100% in 2009 and 79% in 2010.
- **Northern Ireland.** In contrast to other nations, Northern Ireland has enjoyed relatively high approval rates which over the last two years has been increasing, with 100% of small-scale projects determined in 2011 being approved. Around 13% of small-scale onshore capacity awaiting approval is in this region (0.6 GW).

The fall in approval rates could be due to a number of factors, including uncertainty in the national planning framework, an increase in the number of applications, local opposition, and/or reductions in planning board capacity at the local level.

Figure B2.3: Approval rate (by capacity) for small-scale onshore wind by UK nation



Source: CCC calculations based on DECC Renewable Energy Planning Database.

Progress on other renewables

Biomass generation

Our indicator trajectory includes 4.2 GW of biomass power generation by 2020, in line with the Government's 2010 National Renewable Energy Action Plan, and within the Government's central range in the 2011 Renewable Energy Roadmap.

In our Bioenergy Review (December 2011), we concluded that in the near term, the most economic use of biomass in power is through co-firing and conversion of existing coal plant rather than large-scale new dedicated plant. We also noted risks of indirect land use change associated with use of biomass. We therefore recommended that support for new dedicated plants should be limited and that the maximum lifecycle emissions threshold for support under the Renewables Obligation should be tightened, from 285 to 200 gCO_2/kWh. The Government responded in the Bioenergy Strategy (April 2012), and is exploring taking forward these recommendations.

In 2011, around 900 MW of dedicated biomass generation was added to the system, most of this due to the conversion of Tilbury coal power station to run solely on biomass (i.e. consistent with our recommendation in the Bioenergy Review).

We will continue to monitor the addition of all types of biomass capacity as part of our annual progress reports.

Marine generation

In our review of renewable energy (May 2011), we noted that whilst marine technologies such as wave and tidal stream are currently relative expensive, financial support and deployment in the near term is desirable, given the UK's large potential resource, the diversity marine renewables could add to the generation mix and scope for significant learning and cost reductions. We therefore included around 4 TWh of marine generation (1.3 GW of installed capacity) by 2020, consistent with the Government's National Renewable Energy Action Plan (2010).

Marine remains at a very early stage, with prototype devices being tested at sites in Orkney and Pentland Firth. In 2011, 0.6 MW was added to the system, taking the total figure for installed capacity to 3.1 MW (i.e. 0.003 GW). Reflecting the limited progress to date, in their more recent Renewable Energy Roadmap (July 2011), the Government now envisage in their central range up to 300 MW of marine deployment (0.9 TWh) by 2020.

In terms of financial support, the Government have proposed in their October consultation[11] to increase the level of support for projects coming online 2013-17, bringing England and Wales into line with Scotland in awarding up to 5 ROCs/MWh to tidal stream and wave generation. Capital will also be required during the demonstration phase. For example, the £20 million Marine Energy Array Demonstrator scheme (MEAD) was launched in April this year, with the aim of supporting up to two pre-commercial projects.

11 DECC (2011) *Consultation on the Renewables Obligation Banding Review.* http://www.decc.gov.uk/en/content/cms/consultations/cons_ro_review/cons_ro_review.aspx

Solar

There was a large increase in installed solar capacity in 2011 – 0.9 GW (compared with 0.1 GW added in 2010) – driven by support under the Feed-in Tariff (FiT), which turned out to be more generous than originally intended as solar costs fell rapidly.

Domestic solar PV costs in 2011 were around 45% lower than anticipated when the FiT was designed in 2009. This unexpected reduction in costs prompted a review process in 2011, which ultimately led to lower tariffs for solar installations from April 2012. Tariffs are now 15.2 p/kWh (for installations 10-50 kW in size), with further reductions scheduled for August 2012, and on a regular basis thereafter.

There is a risk that higher than intended deployment of solar could divert resources from more cost-effective low-carbon technologies under the Levy Control Framework (see Chapter 1). However, if costs continue to decline, there may be a greater role for solar PV than envisaged in our scenarios.

Transmission investment

Our indicator framework includes development of the UK's transmission network to support increased renewables (and other low-carbon) capacity. These are based on reinforcements identified by the Electricity Networks Strategy Group (ENSG) (Box 2.4).

- **Onshore investments.** Regulatory approval of investment by Ofgem is ongoing (with over £400 million of funding for pre-construction work approved to date). However, as the recent ENSG report[12] sets out, further significant approval is needed (up to £8.8 billion – Box 2.4). There has been some progress on the planning approval of new investments (e.g. reinforcements in the North of Scotland – Beauly-Denny – approved and now under construction). The reinforcements required in mid Wales remain a concern. Our indicators envisaged a beginning to construction this year, but there have been continued delays in planning, largely due to local public opposition.
- **Offshore transmission.** Whilst a number of offshore connections and licences have been progressed in 2011, this continues to be under the transitional regime, with connections under the enduring regime not expected to be operational until 2014 at the earliest (compared with 2012 in our indicators). Finer details of the enduring regime need clarification before offshore projects are able to proceed (e.g. details on network integration).

Progress continues to be slower than envisaged in our indicators, although delivery of infrastructure when required remains feasible.

12 ENSG (2012) *Our Electricity Transmission Network: A Vision For 2020 – An Updated Full Report to the Electricity Network Strategy Group.*

Box 2.4: Electricity Networks Strategy Group (ENSG) update

In 2009 the Electricity Networks Strategy Group (ENSG) identified that £4.7 billion worth of transmission investments would be needed to deliver decarbonised electricity out to 2020[13]. Our indicators for transmission are based on these identified reinforcements.

An update of this report, made available earlier this year[14], suggests that nearly double the initial amount estimated will be needed (£8.8 billion) to deliver the required transmission infrastructure in 2020. This increase in costs is largely due to updated information on cost as well as identification of further reinforcement options.

In our analysis to date we have assumed transmission and distribution (T&D) costs associated with supporting low-carbon would add a further 0.1p/kWh to bills by 2020, based on the 2009 ENSG report. This revised estimate of the required scale of investments suggests T&D costs will now add 0.2p/kWh, equivalent to around £5-7 in total on the typical domestic dual-fuel bill.[15]

4. Commercialisation of CCS

CCS technologies are of crucial importance to meeting targets for emissions reduction in the medium to long term, for use in the power sector with fossil fuels, in industry on carbon-intensive processes, and in conjunction with bioenergy (Box 2.5).

Box 2.5: The importance of CCS in meeting longer-term emissions targets

The Committee's recent reports on bioenergy[16] and on meeting the 2050 target (as part of the International Aviation & Shipping review)[17] highlighted the crucial importance of CCS in meeting long-term targets for emissions reduction. It has the potential to play three key roles:

- **Industrial CCS.** For some carbon-intensive industries, CCS is one of the main options to achieve the large reductions in emissions needed to meet the 2050 target. It is especially important for those sectors, such as steel and cement production, where CO_2 is produced via chemical reactions as well as fossil fuel combustion.
- **Bioenergy CCS.** Given limited availability of sustainable bioenergy resources, it will be important in the long term to maximise its contribution to overall emissions reductions. As we set out in our Bioenergy Review, this is likely to mean using it in conjunction with CCS for negative emissions, whether in electricity generation or production of hydrogen, aviation biofuels or biomethane.
- **Gas CCS for power.** By 2050 it will be necessary for almost all generation to be from low-carbon sources. It is likely that there will be a need for some of this low-carbon generation to come from dispatchable capacity that can operate flexibly (e.g. with load factors of less than 70%); as it has a relatively low capital intensity, gas CCS is well placed to assume this role.

The past year has seen two major developments in CCS: the failure of the first demonstration competition to award funding and the launch of the process for the subsequent projects (originally intended to cover projects 2-4, but now covering all four).

13 ENSG (2009) *Our Electricity Transmission Network: A Vision For 2020*
14 ENSG (2012) *Our Electricity Transmission Network: A Vision for 2020 – An Updated Full Report to the Electricity Network Strategy Group.*
15 Based on our estimate for consumption in our December report *Household Energy Bills: Impacts of meeting carbon budgets.* In that report we concluded that electricity consumption for lights and appliances in the typical dual fuel household is around 3,400 kWh in 2010, but with further energy efficiency could fall to around 2,800 kWh.
16 CCC (2011) *Bioenergy Review*
17 CCC (2012) *Scope of carbon budgets | Statutory Advice on Inclusion of International Aviation and Shipping*

The failure of the first competition represents a setback, but a number of lessons have been learnt:

- Following a protracted procurement process, it was announced that the competition for the first CCS demonstration project could not be successfully concluded, because the Longannet proposal was considered too expensive.
  - The competition was launched in 2007, with the aim of delivering a demonstration plant to be operational by 2014. The criteria for the demonstration plant were very specific, mandating post-combustion CO_2 capture on 300 MW of coal-fired capacity.
  - Of the four entrants that passed the pre-qualification test, two went forward to make bids: proposals for a new-build coal plant at Kingsnorth and CCS retrofit to the existing plant at Longannet. Detailed front-end engineering and design (FEED) studies were undertaken on both proposals.
  - Towards the end of the four-year process, the Longannet project was the only proposal remaining on the table (the Kingsnorth project withdrew citing broader conditions that were unfavourable to new build). The judgment that Longannet did not provide sufficient value for money therefore led to the failure of the competition to proceed with construction of a demonstration plant.
- The reasons for the failure of the process to deliver a CCS demonstration are many and complex. A recent National Audit Office (NAO) report[18] highlights key factors, including:
  - Narrow project specifications, limiting the number of bidders as well as the technical project options they could submit, and the inflexibility of the negotiations.
  - Following a traditional procurement process unsuited to a complex, first-of-a-kind project with multiple providers of infrastructure.
  - A failure to engage at a sufficiently early stage in the process with the commercial risks involved, and their consequences for the cost of the project.
  - The sheer length of time taken, during which time the investment climate for coal changed, partly due to new policies such as the carbon price floor and electricity market reform, and partly due to broader conditions such as the financial crisis.
- Whilst the project will not go ahead, there has nonetheless been some important learning during the process:
  - Failures identified in the first project should enable more effective design of the new process (see below).
  - The two FEED studies on Longannet and Kingsnorth have been made publicly available. The resultant learning could be of considerable value in making other projects more viable, technically and/or economically.

18 NAO (2012) *Carbon capture and storage: lessons from the competition for the first UK demonstration.*

The Government has reinforced its commitment to the delivery of four commercial-scale CCS projects during this decade. It recently launched a new process for their selection, designed to reflect lessons learned from the experience of the failed first competition.

- Projects are to be selected for funding towards the end of 2012. This timing is aligned with the process being run by the European Investment Bank (EIB) to award funding from the NER300 – the sale of 300 million allowances from the EU ETS New Entrant Reserve (Figure 2.10).
- Aside from funding for any projects selected by the NER300 process, the mechanisms to support UK CCS projects are a share of the £1 billion capital rolled over from the previous competition, together with Contracts for Difference (CfDs) on the electricity price.
- The selection criteria for the new process are less prescriptive than previously – emphasising the need to drive CCS towards cost-effectiveness for large-scale deployment in the 2020s, rather than specifying particular characteristics. This provides greater freedom for project developers to tailor decisions to their particular project.
- Clustering and sharing of transport/storage infrastructure is now encouraged, as such solutions are likely to be lower cost than point-to-point infrastructure approaches. The sizing of pipeline infrastructure at a scale that anticipates future demand ('oversizing') will also be considered where a strong case can be made.
- Industrial CCS projects are also eligible for funding, as part of a cluster approach with power projects. This approach is appropriate, aiming to ensure that infrastructure costs are not excessive, given that volumes of CO_2 available from industrial sites tend to be lower than those for power projects.

Given the urgent need to prove the viability of CCS, it will now be crucial to maintain the focus on delivery and the momentum that currently exists, and to deliver these projects towards the beginning of the 2016-2020 period set out (e.g. 2017). This will enable the potentially valuable role of CCS in contributing to power sector decarbonisation in the 2020s to be exploited.

Key milestones in ensuring early delivery of demonstration projects are:

- Selection of the four winning projects under the new competition in 2012.
- FEED studies, where not already done, to be undertaken during 2013.
- Contracts to be signed by the end of 2013.
- Construction to commence in 2014, with operation commencing around three years later.

Figure 2.10: Indicative timeline for selection of CCS projects by DECC and EIB

Source: Office of Carbon Capture and Storage (OCCS).

In order to deliver these and future milestones for CCS, progress is needed on Electricity Market Reform (EMR) and a strategy for commercialisation and infrastructure:

- **EMR.** Early delivery will require that the reforms, or transitional funding arrangements, are in place to enable contracts to be signed in 2013; we discuss EMR in section 6 below. Delivery of the four projects will require that the Levy Control Framework for the period to 2020 is set at an appropriate level (see Chapter 1).
- **Commercialisation.** Going beyond the initial projects, and depending on what is learned from them, it will be important that ambition is sustained and that further projects follow. In order to provide confidence for supply chain investment, greater clarity should be provided on the scale of such investments, and the circumstances under which they would proceed.
- **Infrastructure.** Once DECC's CO_2 storage strategy is published later in 2012, it would then be appropriate to go further in developing a strategic approach to CO_2 infrastructure, including development of scenarios for the scale and location of CCS deployment to 2030, and the associated design of infrastructure (similar to the ENSG exercise for electricity transmission). Such an exercise would help to identify 'least regret' sizing of pipeline infrastructure and would also provide greater credibility to carbon capture readiness assessments.

The appropriate mix of projects selected will depend on the bids received. However, given the need to demonstrate a range of CCS solutions, the UK projects should be viewed in the context of the portfolio of projects proceeding internationally (Box 2.6). Given the lack of gas CCS projects globally and the strategic importance of post-combustion gas CCS for UK power sector decarbonisation, the UK portfolio would ideally include at least one such project.

Given timely implementation, including progress on EMR and a broader CCS strategy, and selection of a range of technologies, the planned demonstration programme could be compatible with a major role for CCS in decarbonising the UK power sector through significant investment in the 2020s and beyond.

Box 2.6: International developments in CCS demonstration

There are currently two commercial-scale full-chain CCS power projects under construction globally, both on coal-fired plants:

- **Boundary Dam, Saskatchewan, Canada.** A post-combustion coal CCS project, expected to capture up to 1 $MtCO_2$ per year from 2014. The CO_2 will be used for enhanced oil recovery (EOR).
- **Kemper County, Mississippi, USA.** A pre-combustion coal IGCC plant, expected to capture 3.5 $MtCO_2$ per year from 2014. Again, the CO_2 will be used for EOR.

In its 2011 status report[19], the Global CCS Institute (GCCSI) listed 35 projects outside the UK for CCS power generation, at various stages of development. Of these, 31 were for coal-fired generation, dominated by an even mix of pre-combustion and post-combustion, supplemented by three oxy-fuel plants. The remaining four were for gas-fired generation: two post-combustion, one pre-combustion and one oxy-fuel. This list of 35 includes proposals in the relatively early stages of development, so it is not expected that all will be constructed.

5. Deployment of new nuclear

Low-carbon generation from new nuclear power stations can potentially play a significant role in the decarbonisation of the power sector. Questions regarding safety and regulation were raised given events at Fukushima in Japan in March 2010, and addressed in detail by Dr. Weightman in his final report: *Japanese earthquake and tsunami: Implications for the UK nuclear industry* (September 2011). This reinforced the findings of his interim report, and found that the UK had displayed a strong safety culture and the current arrangements are adequate (Box 2.7).

Box 2.7: Summary of key findings of Dr. Weightman's report – Japanese earthquake and tsunami: Implications for the UK nuclear industry.

The Weightman review final report was published in September 2011[20]. It re-iterated conclusions from the Interim report[21], as well as drawing further conclusions:

1. *Consideration of the accident at Fukushima-1 against the [UK Office of Nuclear Regulation] Safety Assessment Principles for design basis fault analysis and internal and external hazards has shown that the UK approach to identifying the design basis for nuclear facilities is sound for such initiating events.*
2. *The Fukushima accident reinforces the need for the Government, the Nuclear Decommissioning Authority and the Sellafield Licensee to continue to pursue the Legacy Ponds and Silos remediation and retrievals programme with utmost vigour and determination.*
3. *The mandatory requirement for UK nuclear site licensees to perform periodic reviews of their safety cases and submit them to [the Office of Nuclear Regulation] to permit continued operation provides a robust means of ensuring that operational facilities are adequately improved in line with advances in technology and standards, or otherwise shut down or decommissioned.*
4. *The circumstances of the Fukushima accident have heightened the importance of Level 2 Probabilistic Safety Analysis for all nuclear facilities that could have accidents with significant off-site consequences.*

Information considered for the final report further validated the overall conclusion in the interim report – that the current arrangements for ensuring the safe operation of existing and future nuclear plants are adequate, and the Government's response to issues raised by events in Japan are adequate.

19 Global CCS Institute (2011) *The Global Status of CCS: 2011.*
20 HM Chief Inspector of Nuclear Installations (September 2011) *Japanese earthquake and tsunami: Implications for the UK nuclear industry, Final Report.* http://www.hse.gov.uk/nuclear/fukushima/final-report.pdf
21 HM Chief Inspector of Nuclear Installations (May 2011) *Japanese earthquake and tsunami: Implications for the UK nuclear industry, Interim Report.*

Our indicators track progress against development and deployment of the first new nuclear power station, based on a number of policy and project milestones. Following the approval of the justification of two reactor designs by Parliament in November 2010 (Westinghouse AP1000 and Areva EPR), and the commencement of regulations for the treatment of nuclear waste and funding for decommissioning in April 2011, several further milestones were due in the last year. These were broadly met, including the first planning application being lodged by developers:

- **National Policy Statement.** The nuclear National Policy Statement was approved by Parliament in July 2011.
- **Approval of reactor designs.** Our indicators set out that these should be issued in 2011, but progress was delayed awaiting the outcome of Dr. Weightman's report (Box 2.7). The generic reactor designs received interim approval by the regulator in December 2011, with final approval expected towards the end of 2012.
- **Planning application.** We envisaged that approval of the first new nuclear plant would be required in 2011 to support civil works in 2012. In November 2011, EDF submitted their application for Hinkley C plant, with determination expected towards the end of this year. Preliminary works on the Hinkley C site have started in anticipation of approval.

Whilst there has been some progress, significant risks remain, and the project pipeline is weak. For example, the Horizon venture to build new plants in Wylfa and Oldbury – which were expected to move forward, is now up for sale, and a buyer is yet to come forward. This 5 GW investment is important in the context of delivering required power sector decarbonisation.

The key determinant of whether projects will proceed – Hinkley C, Wylfa, Oldbury and others, will be the clear and effective resolution of the EMR process and a timely transition to awarding contracts.

There is scope for life extensions of existing nuclear plants to help manage the transition (e.g. extensions of 5-7 years on existing lifetimes of seven of the eight existing nuclear plants have been proposed).

Looking more broadly, a recent enquiry by the House of Lords Science and Technology Committee[22] raised questions over the UK's R&D capabilities and expertise to support new nuclear energy. The Committee proposed that the Government should develop a long-term strategy for nuclear energy, including support for R&D through an R&D Roadmap and establishment of a Nuclear R&D Board. The Government have agreed to the recommendations and in the summer of 2012 will publish a long-term strategy on the role of nuclear energy in the UK.

22 House of Lords Science and Technology Committee (November 2011) *Report: Nuclear Research and Development Capabilities.*

6. Electricity market reform

We have previously proposed that new market arrangements are needed to support investment in low-carbon capacity in the UK. We therefore included an indicator for review of the existing market arrangements and introduction of new arrangements during the first budget period.

Draft legislation for the Electricity Market Reform (EMR) was published for pre-legislative scrutiny in May 2012. As recommended by the Committee, the key element of the market reforms is the introduction of long-term contracts ('Contracts for Difference') for low-carbon generating capacity, which will provide stable revenue streams upon which to secure investments.

In this section we recap the need for power sector decarbonisation, including new analysis commissioned for this report, and consider the implications for the objectives of the electricity market reform. We then consider progress on EMR more generally.

The need to decarbonise the power sector and develop a portfolio of low-carbon technologies

In our advice on the fourth carbon budget, we set out analysis suggesting that the cost-effective path to power sector decarbonisation would reduce carbon intensity from current levels of around 500 gCO_2/kWh to around 50 gCO_2/kWh in 2030.

In order to achieve cost-effective power sector decarbonisation, we argued in our Renewable Energy Review that it is appropriate to deploy a portfolio of technologies including nuclear, various renewable technologies and CCS, all of which could become cost-effective over time.

Decarbonisation to around 50 gCO_2/kWh in 2030 through a portfolio of technologies would make an important contribution to carbon budgets, prepare effectively for challenges beyond 2030 and minimise costs of electricity over the lifetime of plants (Box 2.8):

- It would reduce power sector emissions to around 16 $MtCO_2$ in 2030, from 146 $MtCO_2$ in 2011 – this would make up over half of the 240 $MtCO_2e$ reductions required across the economy in the context of the fourth carbon budget.
- It would provide a source of low-carbon energy to the end-use sectors of transport, buildings and industry. In our previous analysis on options for meeting the 2050 target we have shown that given growth in electricity demand from these sectors, low-carbon capacity is likely to be needed at a similar rate from 2030 to 2050 (i.e. with deployment of up to 4 GW of baseload-equivalent capacity each year).[23]
- It would reduce exposure to risks associated with any individual technology (e.g. site availability and public acceptability for nuclear, technology effectiveness and storage capacity for CCS and cost effectiveness of offshore wind).

23 See, for example, our technical report *The 2050 target – achieving an 80% reduction including emissions from international aviation and shipping.* http://hmccc.s3.amazonaws.com/IA&S/CCC_IAS_Tech-Rep_2050Target_April2012.pdf

- It would minimise costs by deploying low-carbon technologies in preference to unabated coal or gas generation where they have lower lifetime costs – under our central cost expectations, nuclear and onshore wind would be cost-competitive with gas from around 2020, and CCS towards the end of the 2020s, along with offshore wind if costs fall towards the low end of the expected range.

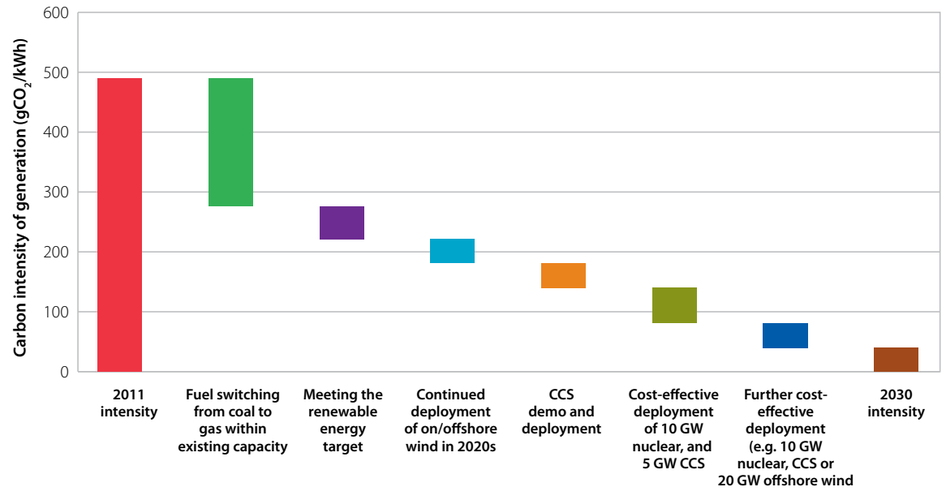
Box 2.8: From 500 gCO_2/kWh to 50 gCO_2/kWh

Reducing emissions from 500 gCO_2/kWh to around 50 gCO_2/kWh can be achieved through a combination of fuel switching away from coal (to reach 250-300g), technology policy aimed at developing future options for renewable and CCS generation (to reach around 150g) and cost-effective investment in low-carbon plant (nuclear, onshore wind and CCS) during the 2020s (to reach around 50g – Figure B2.8).

The precise outcome of these steps in terms of emissions intensity will depend on various factors that remain uncertain, including the availability of sustainable bioenergy for use in the power sector, the level and shape of demand, the balance between coal and gas CCS.

The interaction with interconnected markets could also be important. For example, if the UK decarbonises more quickly than its electricity trading partners then the marginal cost of generation could be lower (e.g. the marginal UK plant will often be a relatively new and efficient gas plant, or even a CCS plant). This could lead to a net export of electricity and increased UK emissions (offset by reduced emissions in the interconnected markets).

Figure B2.8: Getting from 500 gCO_2/kWh to 50 gCO_2/kWh – high level illustration



Source: CCC calculations.

In this report we present new analysis which reinforces our previous conclusions, suggesting that early power sector decarbonisation is an appropriate objective across a wide range of scenarios for gas and carbon prices (Box 2.9).

- Investing in low-carbon technologies over the next two decades offers significant cost savings under central case assumptions about gas and carbon prices compared to the alternative of investing in unabated gas-fired generation.
- Even under extreme assumptions about low gas prices, cost penalties from investment in low-carbon technologies are limited if any.

Given this strong evidence that a strategy based on low-carbon investment through the 2020s is a low-regrets option, we now consider the implications for the objectives of Electricity Market Reform.

Box 2.9: Optimal trajectory for generation and investment to 2030

We commissioned Redpoint Energy[24] to explore the optimal trajectory for investment and generation in the UK power sector under alternative assumptions. Recognising uncertainty over key assumptions (e.g. gas price, technology costs), the modelling explored the costs of committing to a particular trajectory based on expectations that turn out to be wrong. The analysis showed that:

- Under plausible 'central' assumptions of costs, fuel prices, carbon prices (e.g. in line with the Government's proposed trajectory to 2030 under the carbon price floor, rising to £200/tCO_2 in 2050) and minimum levels of support for less mature technologies, the cost-optimal pathway for the power sector is to decarbonise to around 50 gCO_2/kWh by 2030 (Figure B2.9a).
- Following this strategy of investment focused on low-carbon offers significant cost savings (versus investing in unabated gas) under central and high gas price scenarios, and has only a small cost penalty under an extreme scenario for low gas prices (Figure B2.9b).
  - In a 'central' gas price scenario, where prices stabilise at around 70p/therm by 2030, consumers face significantly lower costs overall (equivalent to a saving of £23 billion in present value terms) in pursuing the low-carbon scenario (i.e. to reach around 50 gCO_2/kWh in 2030), compared to investing predominantly in gas during the 2020s. Further savings would occur under the low-carbon strategy if the gas price turns out higher (e.g. up to £40 billion in present value terms in a 'high' price scenario of 100 p/kWh).
  - If gas prices turn out very low (e.g. 45 p/therm, compared with around 60 p/therm in 2011, and far lower than anticipated in Europe by the IEA in a scenario with extensive extraction of unconventional (shale) gas reserves), investing predominately in low-carbon may incur higher costs in the short term compared to investment in gas. However, in the longer term, as the carbon price rises (assumed to reach £70/tCO_2 in 2030 and £200/tCO_2 in 2050), savings of over £3 billion per year are incurred by the end of the lifetime of a gas plant (2045). Over the period to 2045, consumers incur additional costs of only £1 billion in present value terms (equivalent to less than 0.2% of present value costs over the period) from following the low-carbon investment strategy compared to investing predominantly in gas.
  - These estimates assume the costs of low-carbon technologies evolve as in our 'central' scenario from our cost modelling with Mott MacDonald. A low-carbon investment strategy under central gas prices could save more over the period (e.g. £50 billion in present value terms) if low-carbon technology costs turn out lower; (e.g. if EMR reduces the cost of capital to below 10%). Conversely, the additional costs of low-carbon relative to a gas strategy under very low gas prices could be higher (present value of £18 billion) if low-carbon technology costs turn out higher.

24 Redpoint Energy (2011) *Modelling the trajectory of the UK power sector to 2030 under alternative assumptions.* http://www.theccc.org.uk

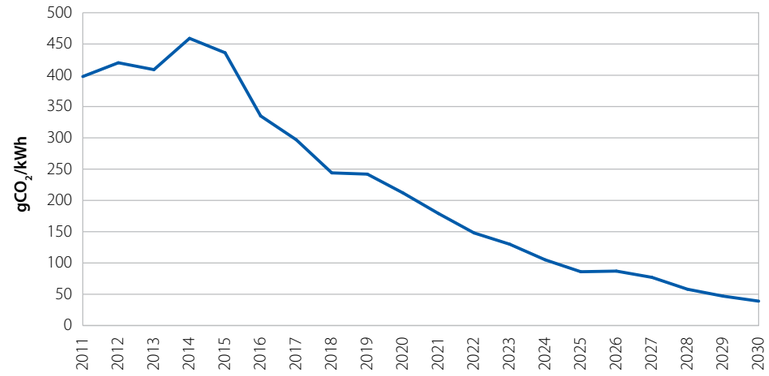
Box 2.9: Optimal trajectory for generation and investment to 2030

Our recent modelling with UCL[25] reinforces our finding that low-carbon investment appears relatively 'least regrets' together with a rising carbon price, even under low gas prices:

- The medium-term global carbon price is higher in a world with low gas prices, compared with a central price scenario, as a higher price is required to bring forward low-carbon to meet climate objectives;
- Even under low gas prices and a range of trajectories for global action (e.g. late action paths with low reductions in the 2020s), the cost-effective path for the UK is to decarbonise to around 60 gCO_2/kWh.

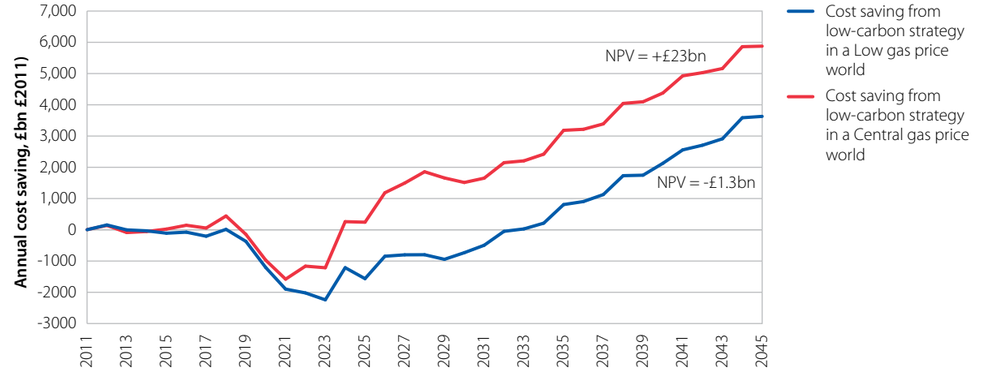
Therefore, investment in low-carbon generation to levels consistent with around 50 gCO_2/kWh in 2030 appears a robust strategy to a wide range of gas prices, and provided low-carbon generation can be delivered cost-effectively in the long term relative to unabated fossil fuel facing a carbon price.

Figure B2.9a: Carbon intensity given cost-optimal investment under central assumptions (2011-2030)



Source: Redpoint modelling.
Notes: Carbon intensity of generation for Great Britain (GB) power system. Northern Ireland is modelled separately and achieves comparable intensity by 2030 (e.g. around 50g CO_2/kWh)

Figure B2.9b: Cost saving from investment strategy focused on low-carbon rather than gas during the 2020s – central and low gas price worlds



Source: Redpoint modelling.
Notes: Low-carbon strategy decarbonises to around 40g CO_2/kWh by 2030. Scenario with investment in predominantly gas achieves 130g CO_2/kWh by 2030. Both scenarios achieve at least 30% renewable generation by 2020 and assume technology policy continues to support minimum levels of offshore wind and CCS in the 2020s. Negative values imply a cost penalty from investing in low-carbon, while positive values imply a cost saving. NPV = Net Present Value, discounted at 3.5%.

25 UCL Energy Institute (2012) *Modelling Carbon Price Impacts of Global Energy Scenarios.* http://www.theccc.org.uk

Setting an objective for Electricity Market Reform

Despite the clear advantages of a path focused on low-carbon investment, there remains a perceived risk that there will be a second 'dash for gas'. This perception was heightened with the announcement in March 2012 of an Emissions Performance Standard (EPS) that would allow continued operation of unabated gas-fired plant through to 2045.

This uncertainty undermines the investment climate and should be resolved. This could be achieved through a clear statement that the objective of EMR is to decarbonise the power sector to 2030 through delivering a portfolio of low-carbon technologies provided these can be built to schedule and cost.

An appropriate objective would be:

- To reduce the carbon intensity of the UK power generation sector to a level of the order of 50 gCO_2/kWh by 2030.
- To achieve this via a portfolio of technologies, including minimum deployment levels for less mature technologies (e.g. we suggested in our Renewable Energy Review that a minimum ambition for around 25 GW of offshore wind by 2030 would be appropriate).
- To retain some flexibility over the precise path, to be determined as current uncertainties are resolved over costs, carbon prices, achievable build rates, and the level and shape of demand.

Delivering on these objectives will require that low-carbon investments are pursued where these are cost-competitive with unabated plant over their lifetimes given a rising carbon price, and that technology support will be provided for less mature technologies.

We therefore recommend that an objective should be set and a process put in place to ensure that this objective is achieved (i.e. a set of checks and balances so that the delivery plan proposed by the System Operator and approved by the Government is consistent with the objective). There should also be a clear statement as part of the Government's planned Gas Generation Strategy that there will not be a second 'dash for gas', but rather sufficient low-carbon plant will be contracted to ensure that gas plays only a back-up and balancing role by 2030.

In addition, it is important that technology policy objectives are set to resolve current uncertainties about the future for less mature technologies. For example, the current lack of visibility around the offshore wind market beyond 2020 is a barrier to required supply chain investment. This could be addressed through setting targets for minimum levels of offshore wind (and other technologies that may be at a earlier stage of development) to be supported through the EMR subject to cost conditionalities being met (e.g. the Government's commitment that 18 GW of offshore wind would be supported by 2020 subject to costs being reduced to £100/MWh could be extended out to 2025, by which time there is more chance that this level of cost reduction can actually be achieved).

Progress implementing electricity market reform

The central element of the EMR design to provide long-term contracts for low-carbon generation is in line with our previous recommendations and is a significant step forward. It will provide a stable and secure return to low-carbon generators, reducing risks to both investors and consumers from volatile gas prices.

In May 2012, the Government published the draft enabling legislation for pre-legislative scrutiny. Following this, the Bill is due to be introduced to Parliament in late 2012, with approval towards the end of 2013. Consultation on secondary legislation is also expected towards the end of 2013, so that it is in place and in force by around mid 2014.

There are a number of currently unresolved and detailed EMR design issues (Box 2.10). These should be resolved as a matter of urgency, so that the EMR can be implemented from 2014 and support investments across the range of low-carbon technologies becoming operational in the second half of this decade.

Finally, even with a clear objective and well designed implementing arrangements, there would remain a risk of insufficient investment in low-carbon technologies, with investors instead favouring a strategy based around unabated gas-fired generation. Recognising that this is the case, implementation of the EMR will have to be monitored very closely, and the introduction of further incentives for investment in low-carbon generation (e.g. limiting running hours of unabated gas-fired generation) should not be ruled out at this stage.

Box 2.10: EMR design

There are currently a number of risks related to contract design which the Government needs to address:

- **Financial security.** Investors have raised concerns about the financial security of Contracts for Differences. For example, in the absence of Government guarantees, there are questions about how investors would be protected against future changes in legislation. In addition, if contracts are to be multi-party (i.e. between a generator and all suppliers in the market) this could make resolution of disputes problematic.
- **Price risk.** There is a risk of divergence of prices paid to generators in the market and reference prices in Contracts for Difference (e.g. a wind generator is likely to be paid a lower average price on a given day than the average market price for that day, given that the market price is likely to be lower in periods when wind is generating). This risk could be mitigated by choosing the reference price for intermittent generation so as to make Contracts for Differences equivalent to feed-in tariffs.
- **Cost risk.** Investors have limited control over various cost components. For example, at least some of construction cost is exogenous to investors (e.g. the wage rate), as are fossil fuel prices (i.e. these are relevant for CCS projects). There are economic arguments that such costs should be shared between investors and consumers, through indexing of prices in Contracts for Differences, which would result in reduced cost of capital and overall benefit to consumers.
- **Demand risk.** There is uncertainty over the future load factor of low-carbon plant, given uncertainty over how much baseload demand will grow. Given this uncertainty, Contracts for Differences which remunerate generators only through operating payments would result in unnecessarily high prices. The alternative, to provide both fixed and operating payments would result in lower overall prices paid.
- **Storage risk.** This is an issue in the context of CCS investment, where generators will not operate storage facilities, and will have limited ability to manage storage risk. Offering a payment to generators which relies on successful storage would raise risks for generators, at best increasing costs and possibly stopping investment. This could be mitigated by designing Contracts for Differences in a way that carves out storage risk.

These risks need to be addressed to ensure that EMR can fulfil its key objective of bringing forward low-carbon investment at least cost.

Key findings

- Power sector **emissions fell by 7%** in 2011, driven by reductions in demand and the carbon intensity of generation.
- **Carbon intensity of electricity fell** from 496 g/kWh to **486 g/kWh**, reflecting an increase in nuclear and renewable generation.
- **Achievable emissions intensity fell** from 308 g/kWh to **273 g/kWh**, reflecting investment in 2.9 GW of renewable capacity.
- **Wind capacity increased** by 1.1 GW, bringing total installed capacity to 4.6 GW onshore and 1.8 GW offshore. A **higher rate of investment is needed** in the future, and there is a risk that the strong project pipeline will not translate into operational capacity.
- The **first CCS competition failed** to award funding, but a second competition has been launched. It is vital now to maintain **momentum** and award funding for projects in 2012 to ensure CCS is available at scale in the 2020s.
- Progress has been made on **nuclear**, but **significant risks remain** and the project pipeline is weak.
- **Electricity Market Reform** will be based on **long-term contracts** for low-carbon capacity. Successful completion of the EMR is **crucial** to bringing forward investment in low-carbon power generation.
- **A clear objective** for EMR is needed (i.e. to **decarbonise** to a level of the order of **50 g/kWh by 2030**, through investment in and development of a low-carbon portfolio) to provide confidence in the long-term market for low-carbon plants that are built to schedule and cost.

Table 2.1: The Committee's Power sector indicators

POWER		Budget 1	Budget 2	Budget 3	2011 trajectory	2011 outturn
Headline indicators						
Emissions intensity (g/kWh)		509	390	236	523	486
Total emissions (% change from 2007)		-15%	-39%	-64%	-13%	-18%
Generation (TWh/year)	Wind	21	50	98	16.8	15.5
	Nuclear	58	30	48	58.2	62.7
	CCS	0	5	11	0	0
Supporting indicators						
Transmission						
Agreement on incentives for anticipatory investment for Stage 1 reinforcements		2010			In place	Scottish TO's business plans agreed, National Grid (NGET) expected to gain approval by end of 2012
Implementation of enduring regime for accessing grid		2010			In place	In place
Transitional OFTO regime in place		2009			In place	In place
Enduring OFTO regime in place		2010			In place	In place, but yet to be implemented
Grid reinforcement planning approval		2011: Scotland Stage 1, Wales Stage 1 (Central), South East	2013: Wales Stage 1 (North), English East Coast Stage 1, South West 2014: Scotland Stage 2		Scotland on track, South East slight delay, Central Wales a serious concern	
Grid reinforcement construction begins		2012: Scotland Stage 1, Wales Stage 1 (Central), South East	2014: Wales Stage 1 (North), English East Coast Stage 1, South West 2015: Scotland Stage 2		n/a in 2011	

Table 2.1: The Committee's Power sector indicators

POWER		Budget 1	Budget 2	Budget 3	2011 trajectory	2011 outturn
Grid reinforcements operational			2015: Scotland Stage 1, Wales Stage 1 (Central), South East 2017: Wales Stage 1 (North), English East Coast Stage 1, South West	2018: Scotland Stage 2	n/a in 2011	
Tendering for first offshore connections under enduring OFTO regime		2010			In place	Continuing to tender under transitional regime. Enduring regime tenders now expected later in 2012 or 2013.
Construction of first offshore connections under enduring OFTO regime begins		2011			Still under transitional regime	
First offshore connections under enduring OFTO regime operational		2012			n/a in 2011	
Planning						
IPC set up and ready to receive applications		2010				Replaced by MIPU in April 2012
Market						
Review of current market arrangements and interventions that will help deliver low-cost, low-carbon generation investment		To begin in first budget period				White Paper (July 2011) confirmed long-term contracts for low-carbon capacity; clear decarbonisation objective required
Wind						
Generation (TWh/year)	Onshore	13	26	44	11.0	10.4
	Offshore	8	24	54	5.9	5.1
Total capacity (GW)	Onshore	5.7	10.8	18.0	4.9	4.6
	Offshore	2.5	7.4	16.6	1.8	1.8

Table 2.1: The Committee's Power sector indicators

POWER		Budget 1	Budget 2	Budget 3	2011 trajectory	2011 outturn
Capacity entering construction (GW/year)	Onshore	0.9	1.3	1.5	0.9	Data not yet available
	Offshore	0.9	1.6	2.6	0.9	Data not yet available
Capacity entering planning	Onshore	New planning applications will be required from the end of the second budget period at the latest to maintain flow into construction			No trajectory	2.3
	Offshore	New planning applications will be expected in line with site leasing			No trajectory	0.5
Average planning period (months)		<12	<12	<12	<12	18
Nuclear						
Regulatory Justification process		2010			In place	In place
Generic Design Assessment		2011			Interim approval received, final approval expected by end 2012	
National Policy Statement for nuclear (including Strategic Siting Assessment)		2010			In place	Approved July 2011
Regulations for a Funded Decommissioning Programme in place		2010			In place	In place
Entering planning		First planning application in 2010	Subsequent applications at 18 month intervals		In place	Planning application for Hinkley C plant submitted in 2011
Planning approval; site development and preliminary works begin		First approval and site development and preliminary works begin in 2011	Subsequent application approvals, site development and preliminary works at 18 month intervals		Determination expected late 2012	
Construction begins			First plant in 2013, subsequent plants at 18 month intervals		n/a for 2011	
Plant begins operation				First plant in 2018, with subsequent plants at 18 month intervals*	n/a for 2011	

Table 2.1: The Committee's Power sector indicators

POWER	Budget 1	Budget 2	Budget 3	2011 trajectory	2011 outturn
CCS					
Front-End Engineering and Design (FEED) studies for competition contenders initiated	End 2009			Initiated	Initiated early 2010
FEED studies for competition contenders completed	2010			Completed 2010	Completed 2011
Announce competition winner	2010			Announced 2010	Funding not awarded, 2011
Second demonstration competition	Launch 2010, announce winners 2011			Initiated 2010	Initiated 2012
Quantification of saline aquifer CO2 storage potential		No later than 2015		n/a for 2011	
Review of technology and decision on framework for future support		No later than 2016**		n/a for 2011	
Strategic plan for infrastructure development		No later than 2016		n/a for 2011	
Planning and authorisation approval, land acquisition, and storage site testing completed, construction commences	First demo in 2011	Subsequent demos 2012/13		First demo not yet commissioned	
Demonstrations operational		First demo in 2014, subsequent demos 2015/16***		n/a for 2011	
First new full CCS plants supported via the post-demonstration mechanism			2022	n/a for 2011	
Other drivers/wider monitoring					
Total demand (TWh), coal and gas prices, nuclear outages.					
Average wind load factors, availability of offshore installation vessels, access to turbines.					
Nuclear supply chain, availability of skilled staff.					
International progress on CCS demonstration and deployment.					
Planning approval rates and frequency of public inquiries to decisions of Infrastructure Planning Commission.					

Notes: Budget numbers indicate the number in the last year of budget period e.g. 2012, 2017, 2022

* Up to 3 nuclear plants by 2022.
** The Energy Act 2010 requires a rolling review of CCS progress, to report on the appropriate regulatory and financial framework by 2018.
*** Total of 4 CCS demonstration plants by 2020.

Key: Headline indicators | Implementation indicators | Forward Indicators | Milestones | Other drivers

Chapter 3: Progress reducing emissions from buildings

Introduction and key messages

In this chapter, we look at emissions from buildings which account for 35% of total UK greenhouse gas emissions. In our 2011 progress report to Parliament, we documented an increase of 7% in buildings emissions in 2010. We showed that this was largely driven by a rise in energy demand for heating due to cold winter weather both in early and late 2010.

We consider 2011 data on buildings emissions and energy consumption, as well as data on the implementation of key abatement measures, with a focus on energy efficiency improvement and investment in low-carbon heat. We also discuss progress against policy milestones, given that we have previously highlighted the need for policy innovation to deliver the required abatement measures.

The key messages in the chapter are:

- Buildings CO_2 emissions in 2011 fell by 12% to 186 $MtCO_2$. This was mainly as a result of the milder winter weather compared to the unusually cold 2010 winter months – temperature-adjusted emissions only fell by 4%. Rising gas prices also had an impact that can explain much of the remaining reduction.
- In terms of the implementation of energy efficiency measures, there was good progress on cavity wall insulation, professional loft insulation and the installation of new boilers, but very limited progress on solid wall insulation. Going forward, there are major challenges in continuing to deliver high rates of cavity wall insulation, and significantly increasing the rate of solid wall insulation. There is also a high degree of risk around whether rates of loft insulation can be sustained under the new market-based policy, with DECC projecting a much lower level of uptake than required in our trajectories, leaving a potential carbon gap of at least 3 $MtCO_2$. Options to strengthen incentives should be developed (e.g. consequential improvements as proposed under the recent building regulations consultation could be a very useful lever to support the Green Deal). We will closely monitor the Green Deal and ECO to ensure they deliver sufficient carbon savings.
- In the non-residential sector, the key policy is the CRC Energy Efficiency Scheme which began operating in 2011. The Government has proposed to simplify the scheme further and hinted at its possible abolition. Simplification would be welcome given scope for reducing the administrative burden without weakening incentives. However, abolition would be premature, particularly in view of evidence that the CRC has resulted in a greater focus on measuring energy consumption and the financial incentives it provides. Therefore the scheme should be retained, at least for the time being, while scope for rationalising the full set of policies for the non-residential sector is considered. To complement the scheme, an early date (e.g. January 2013) for the start of the non-residential Green Deal should be confirmed and ambitious standards for the private rented sector should now be announced.

- The Renewable Heat Incentive (RHI) began operating in November 2011, offering support for renewable heat investment in the non-residential sector. The residential sector is covered by the Renewable Heat Premium Payment but uptake has been slow. Given the need to make early progress on residential heat decarbonisation to build supply chains and consumer awareness, the Government should extend the RHI to the residential sector as a matter of urgency. Green Deal finance should also be made available in conjunction with the RHI to cover at least the additional costs of renewable heat investment compared to conventional alternatives. Approaches to address non-financial deployment barriers should be introduced. Additionally, the uncertainty about RHI funding beyond 2015 should be resolved as soon as possible.

We set out the analysis that underpins these conclusions in 5 sections:

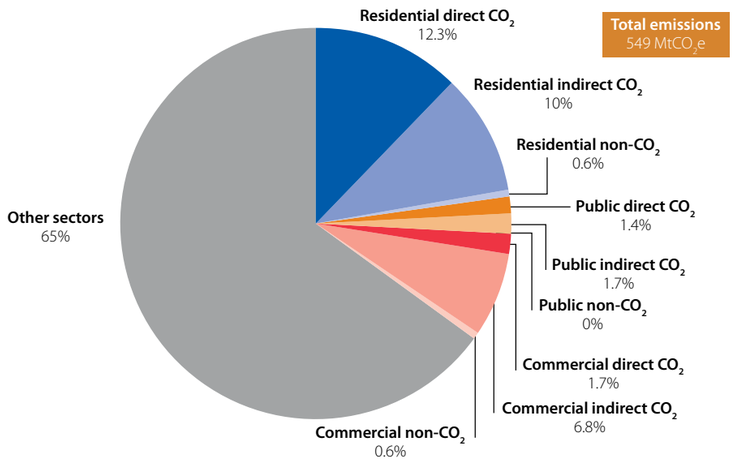
1. Buildings emissions trends
2. The Committee's buildings indicator framework
3. Residential buildings
4. Non-residential buildings
5. Low-carbon heat options

1. Buildings emissions trends

Overview of buildings emissions

Emissions from buildings accounted for 35% of total UK greenhouse gas emissions in 2011 (Figure 3.1). They comprise 49% direct emissions (i.e. from burning fossil fuels for heat) and 51% indirect (electricity-related) emissions. On a sector basis, residential emissions account for 66% of buildings emissions, with commercial and public sector emissions accounting for 25% and 9% respectively.

Figure 3.1: GHG emissions from buildings in the context of total UK emissions (2011)



Source: NAEI (2012); DECC (2011) *Energy Trends* March 2012; DECC (2012) *UK Emissions Statistics 2011 Provisional UK figures*; CCC calculations.
Notes: 2011 emissions estimates are provisional. Commercial sector emissions are based on CCC estimates.

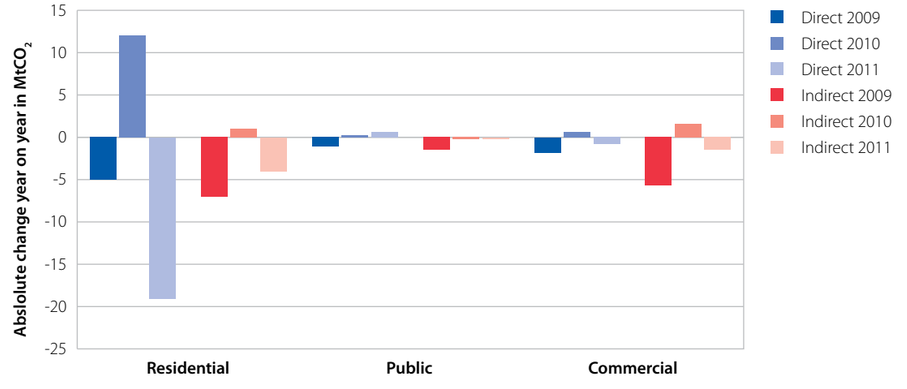
Between 2003 and 2008, buildings CO_2 emissions fell by 3%, mainly due to improved energy efficiency. In 2009, there was a sharp drop of 10%, due mainly to rising fuel prices and the recession. However, in 2010 emissions increased by 8% due to cold weather both early and late in the year.

With warmer winter months in 2011, as well as rising fuel prices, preliminary data suggests that overall buildings emissions fell by 12% to 186 $MtCO_2$ (Figure 3.2). The residential sector experienced the largest emissions decrease (16%), followed by the commercial sector (5%) and the public sector (4%).

The combined effect of significant emission reductions in 2009, increased emissions in 2010 and reductions in 2011 is that emissions in 2011 were 33 $MtCO_2$ below 2008 levels. This is 18 $MtCO_2$ below the level we envisaged when we set out our progress indicators in 2009, due largely to the impact of the recession and the mild weather:

- We first set out indicators in our progress report to Parliament in October 2009. These include emissions trajectories which were broadly consistent with the legislated carbon budgets. They did not allow for the impact of the recession on emissions, which was particularly pronounced in the non-residential sector. They assumed weather as in a typical year (i.e. based on the average of the period 1971-2000), and therefore did not allow for cold weather in 2010 and mild weather in 2011.

Figure 3.2: Change in direct and indirect buildings CO_2 emissions (2009 to 2011)

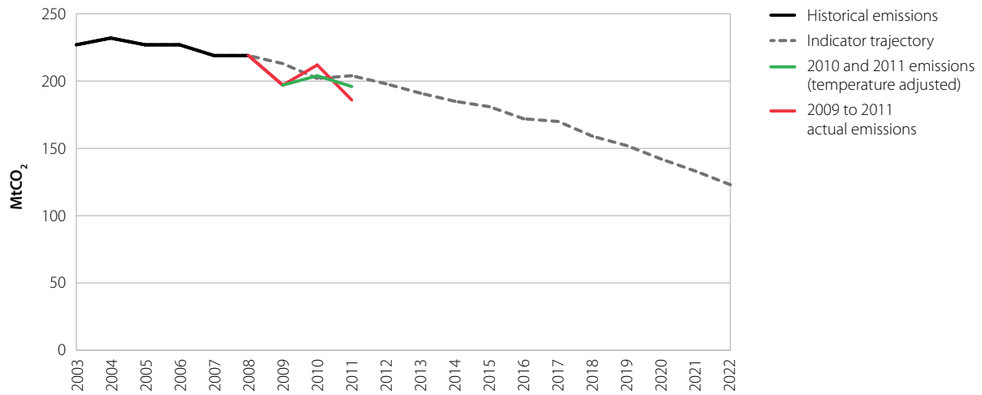


Source: NAEI (2012); DECC (2012) *Energy Trends* March 2012; DECC (2012) *UK Emissions Statistics 2011 Provisional UK figures*; CCC calculations.
Notes: 2011 emissions estimates are provisional. Commercial sector emissions are based on CCC estimates.

- Buildings emissions in 2011 were 18 $MtCO_2$ below our indicator trajectory (Figure 3.3), mainly reflecting the impact of the recession (around 10 $MtCO_2$), together with relatively mild weather in 2011 and increased energy prices.

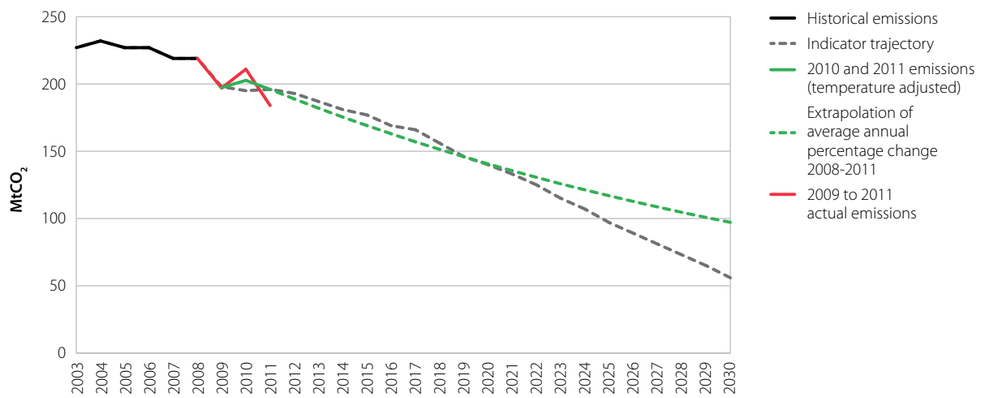
The fact that emissions are below our indicator in 2011, even after adjusting for temperature effects, suggests that the first and second carbon budgets could now be achieved with limited effort. The crucial point is that the implementation of measures at current rates is not sufficient to meet the third and fourth carbon budget (Figure 3.4), notwithstanding the impacts of the recession.

Figure 3.3: All buildings – historical emissions vs original indicator trajectory (2003-2022)



Source: NAEI (2012); DECC (2011) *Energy Trends* March 2012; DECC (2012) *UK Emissions Statistics 2011 Provisional UK figures*; CCC calculations.
Notes: 2011 emissions estimates are provisional. Temperature adjustment is based on CCC estimates..

Figure 3.4: All buildings – fourth carbon budget trajectory vs underlying trend



Source: NAEI (2012); DECC (2011) *Energy Trends* March 2012; DECC (2012) *UK Emissions Statistics 2011 Provisional UK figures*; CCC calculations.
Notes: 2011 emissions estimates are provisional. Temperature adjustment is based on CCC estimates.

Therefore there is still a need for a step change in the pace of emissions reductions, to be achieved by an increase in the pace of implementation of key measures. We consider progress and challenges to the implementation of measures (i.e. energy efficiency and low-carbon heat) below.

Emissions from residential buildings

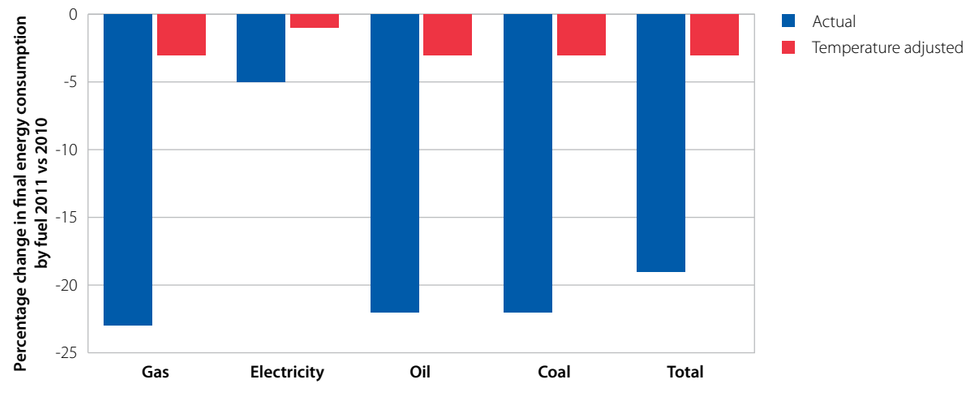
Total residential CO_2 emissions fell by 16% in 2011 to 122 $MtCO_2$ due a combination of energy efficiency measures, higher electricity and gas prices and milder winter months in 2011.

- Direct residential emissions account for 55% of total residential emissions and fell by 22% in 2011. This reduction can be explained largely by the mild weather in 2011 (e.g. this accounts for around 86% of the total reduction) which resulted in a 23% drop in gas consumption (Figure 3.5). The 9.3% increase (6.9% in real terms) in gas prices in 2011 can explain around 7% of the reduction. The implementation of measures (e.g. boiler replacement, loft and cavity wall insulation), can explain around 6% of the reduction.

- Indirect residential emissions account for 45% of residential emissions and fell by 7% in 2011. The three key factors affecting this change are the slightly lower carbon intensity of power generation (see Chapter 2), the milder weather affecting heating-related electricity use (around 20% of total residential electricity use) and a 8.5% increase in electricity prices (6% in real terms).

Although residential emissions were below our indicator trajectory in 2011 (Figure 3.6), there is still a need for a step change in the pace of implementation of measures, in particular for more difficult measures such as solid wall insulation. It remains crucial that the new Green Deal and ECO are effective at delivering loft, cavity and solid wall insulation (see below).

Figure 3.5: Change in residential energy consumption 2011 vs 2010 – actual vs temperature adjusted



Source: DECC (2012) *Energy Trends* March 2012; CCC calculations.
Notes: 2011 estimates are provisional. Temperature adjustment is based on CCC estimates.

Figure 3.6: Residential sector – historical emissions vs original indicator trajectory (2003-2022)

Source: NAEI (2012); DECC (2011) *Energy Trends* March 2012; DECC (2012) *UK Emissions Statistics 2011 Provisional UK figures*; CCC calculations.
Notes: 2011 emissions estimates are provisional. Temperature adjustment is based on CCC estimates.

Emissions from commercial buildings

Following a five year period of broadly flat commercial sector emissions, emissions fell sharply (13%) in 2009 with the recession but increased by 5% in 2010. In 2011, commercial sector emissions fell by 5% to 47 $MtCO_2$, despite a small rise (1.6%) in economic output.

- The vast majority (around 80%) of commercial sector emissions are indirect.
- Indirect emissions fell by 4% in 2011. Similar to the residential sector, this was due to a combination of the milder weather, higher electricity prices and a fall in the carbon intensity of power generation.
- Direct emissions fell by 8% in 2011. This was primarily due to the weather and the rising gas price.

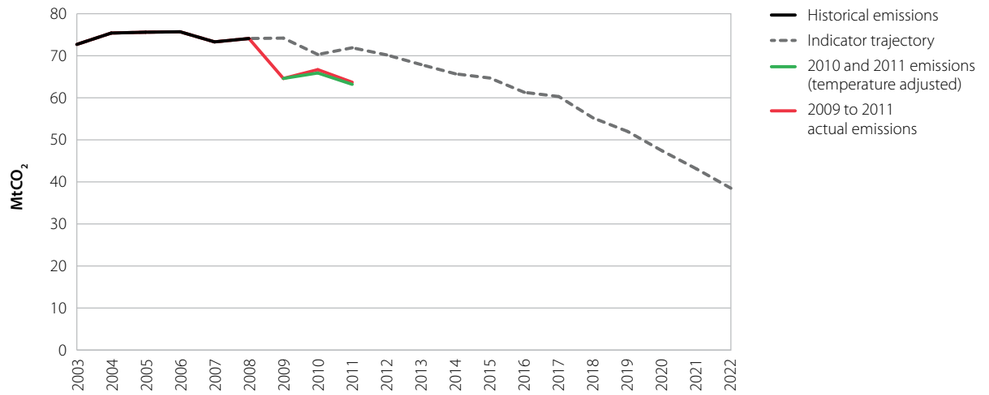
Emissions from the public sector

Public sector CO_2 emissions in 2011 fell 4% to 17 $MtCO_2$. While there is little detailed data on the public sector, it is likely that this reduction is largely weather-related, with the implementation of measures also playing a role in some public sector organisations (see section 4).

- Direct emissions account for around half of public sector emissions. In 2011, they fell 6% primarily because of the reduced use of heating fuels due to the milder winter weather.
- Indirect emissions, accounting for the other half of public sector emissions decreased by 2% in 2011 which is largely due to the improvement in carbon intensity of power generation.

Taken together, the emissions from the non-residential sector are therefore below our indicator trajectory for 2011 (Figure 3.7). This is due to a mix of factors, including the recession. The emissions reduction since 2008 should therefore not be taken to imply that there has been sufficient underlying progress. Much cost-effective abatement potential remains in the non-residential sector, which should be addressed in order to limit the costs of meeting carbon budgets.

Figure 3.7: Non-residential sector – historical emissions vs original indicator trajectory (2003-2022)



Source: NAEI (2012); DECC (2011) *Energy Trends* March 2012; DECC (2012) *UK Emissions Statistics 2011 Provisional UK figures*; CCC calculations.
Notes: 2011 emissions estimates are provisional. Temperature adjustment is based on CCC estimates.

2. The Committee's buildings indicator framework

Our indicator framework – set out in the 2009 progress report to Parliament – includes a range of measures to reduce buildings emissions:

Residential indicators

- Insulation of all lofts and cavity walls by 2015.
- Insulation of 2.3 million solid walls by 2022.
- Replacement of 12.6 million old inefficient boilers by 2022.
- 58% of the stock of wet appliances rated A+ or better and 45% of cold appliances rated A++ or better by 2022.

Non-residential indicators

- Implementation of all cost-effective measures to reduce emissions from lighting, appliances, heating and cooling in the public and commercial sector by 2018.

Low-carbon heat indicators

- Increasing investment in low-carbon heat to achieve a 12% penetration of total heat demand by 2020.

If these measures were implemented, we estimate that there would be emissions reductions of 35% across the whole of the buildings sector in the period to 2020 relative to 2007 (the year before the first carbon budget), with the same level of reduction (35%) in both the residential and non-residential sector. Although the first two carbon budgets could be achieved without the full implementation of measures, these are still required to meet the third and fourth carbon budget.

The indicator framework also includes policy milestones to support the implementation of measures. Key milestones are new policies to encourage the uptake of energy efficiency improvement in the residential sector, the extension of energy performance labelling to all buildings, new measures to encourage small and medium-sized enterprises (SMEs) to reduce their emissions, and new incentives to support investment in renewable heat.

In assessing progress towards meeting carbon budgets in the buildings sector, we first examine the residential sector. We consider implementation rates for measures such as energy efficiency improvement and look at key policy milestones, with a focus on policy innovation to deliver the measures in our indicator framework. We then turn to developments in the non-residential sector. We finish the chapter with our assessment of progress deploying low-carbon heat technologies.

3. Residential buildings

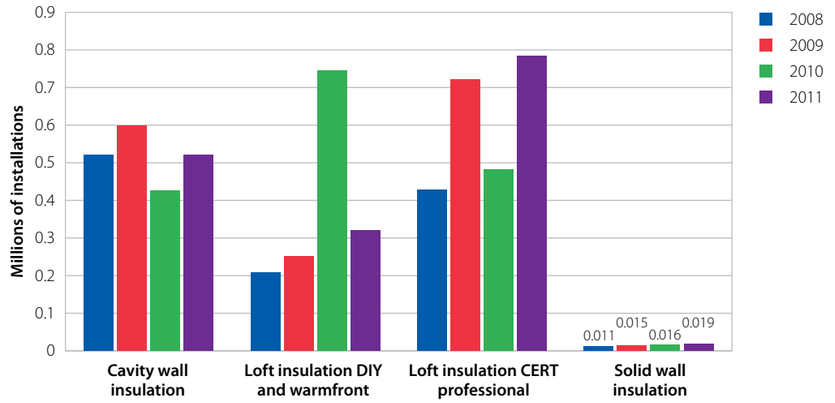
Implementation of insulation measures

Improving the energy efficiency of homes through insulation offers important opportunities for reducing emissions to meet carbon budgets, as well as allowing households to reduce their energy bills. In addition, a better insulated building stock is required to increase the number of properties suitable for low-carbon heat deployment to the levels required over the next two decades.

Delivery increased in 2011 for cavity wall, solid wall and professional loft insulation but fell for DIY loft insulation (Figure 3.8):

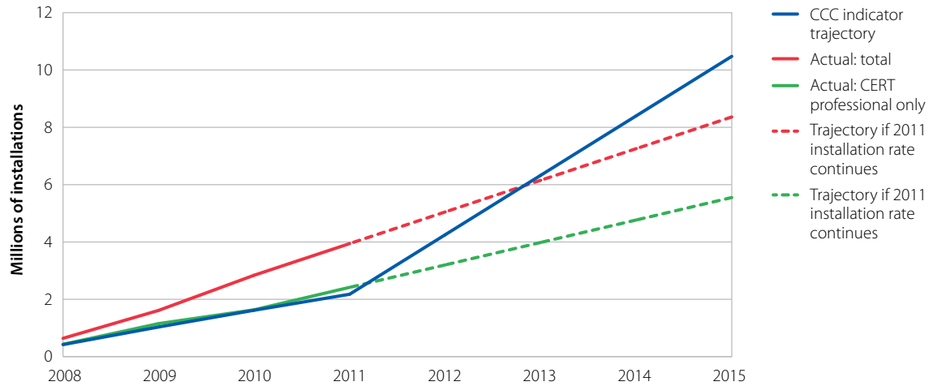
- Rates for professionally installed loft insulation increased by 62%, while DIY installation figures decreased by 57%, leaving overall installation figures (1.1 million) in 2011 down by 10%. However, we noted previously that there was uncertainty about the DIY figures and potential issues of double counting. The increase in the rate and proportion of professional installations thus provides more confidence about associated carbon savings actually being achieved.
- The cavity wall insulation rate increased by 22% to 500,000.
- The rate for solid wall insulation increased by 25%. While delivery under the Carbon Emission Reduction Target (CERT) fell 20%, CESP delivery quadrupled. Overall, however, still fewer than 20,000 solid wall measures were delivered.

Figure 3.8: Installation of residential insulation measures (2008-2011)



Source: Ofgem (2012) CERT update quarter 15; DECC (2012) Estimates of home insulation levels in Great Britain; CESP data; CCC calculations.

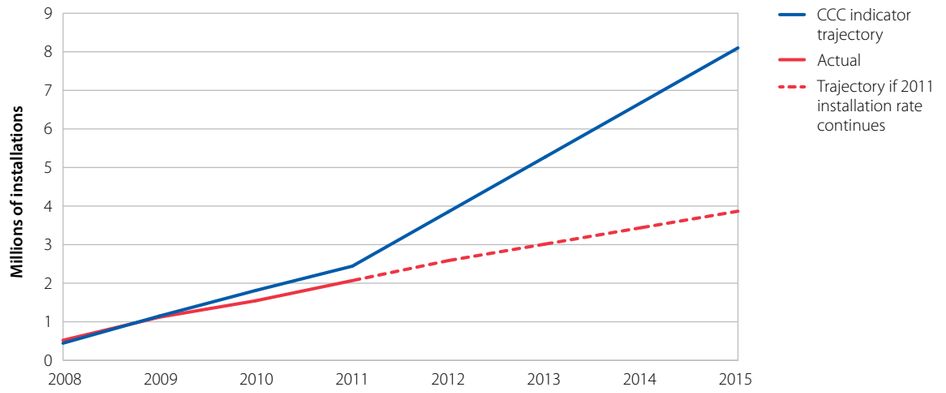
Figure 3.9: Loft insulation cumulative installations (2008-2015)



Source: Ofgem (2012) CERT update quarter 15; DECC (2012) Estimates of home insulation levels in Great Britain; CCC calculations.

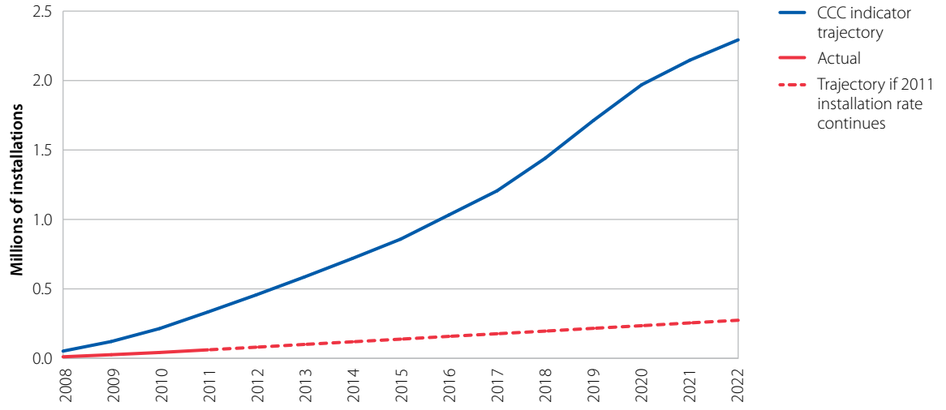
The rate of loft insulation is above our indicator trajectory (Figure 3.9), while cavity wall insulation figures are below the trajectory (Figure 3.10). The trajectories envisage a substantial increase in measures from 2012. While installation figures increased significantly in early 2012 as suppliers accelerated activity to meet their CERT targets (e.g. cavity wall insulation rates almost doubled in the first quarter of 2012), it is unlikely that these rates will be maintained under the Green Deal/ECO (see below). Solid wall insulation is also below the trajectory (Figure 3.11), although we always expected that a major increase in installations would only happen once a new policy support framework is in place.

Figure 3.10: Cavity wall insulation cumulative installations (2008-2015)



Source: Ofgem (2012) CERT update quarter 15; DECC (2012) Estimates of home insulation levels in Great Britain; CCC calculations.

Figure 3.11: Solid wall insulation cumulative installations (2008-2015)

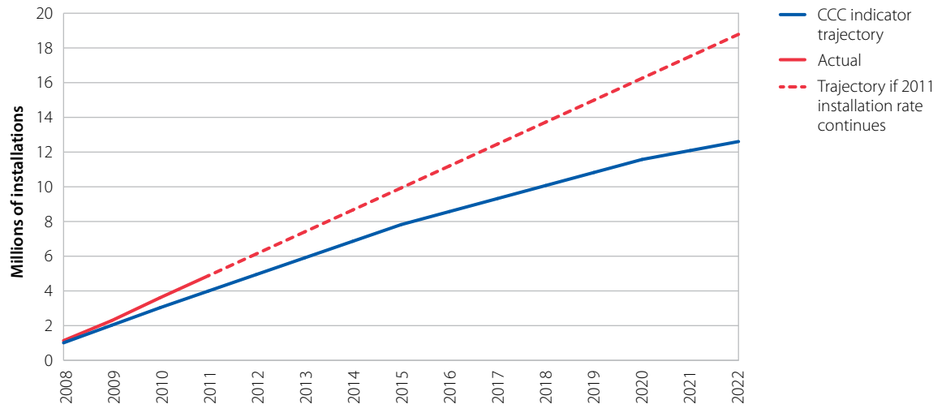


Source: Ofgem (2012) CERT update quarter 15; DECC (2012) Estimates of home insulation levels in Great Britain; CESP data; CCC calculations.

Boiler replacement

Replacement of old with energy efficient new boilers could result in a 6 $MtCO_2$ emissions reduction over the next decade. In order to be on track to deliver this reduction, 1 million boilers would have had to be replaced in 2011. Performance was actually better than that, with 1.3 million efficient boilers installed (Figure 3.12). Although the number of boiler replacements fell by 4% relative to 2010, this is not necessarily of concern, particularly given that uptake in 2010 is likely to have increased due to boiler scrappage schemes operating in that year.

Figure 3.12: A-rated boilers cumulative installations (2008-2015)



Source: DCLG (2012) Housing statistics – Table 241, Heating and Hot Water Industry Council (2012); CCC calculations.

Going forward, we expect continued replacement ahead of our indicators, given that the boiler stock naturally turns over as boilers reach the end of their life. Additionally, efficient boilers are a qualifying measure under the Green Deal and the Affordable Warmth part of the ECO, thus potentially bringing forward additional boiler replacements.

Purchase of energy efficient appliances

It has not been possible to access data on the sale of energy efficient appliances for 2011, due to a lack of monitoring by government or industry. As there is considerable potential for emission reductions from appliances, this lack of evidence should be addressed.

Last year we reported that the penetration of efficient cold and wet appliances in 2010 was below our indicators:

- The share of A++ (or better) cold appliances in the total stock remained very low (i.e. less than 1%).
- Performance on wet appliances was a little better, with A+ appliances achieving a 8.3% share in the total stock. However, we reported a need to increase sales of A+ appliances to get on track to a 58% share of the total stock in 2022.

In late 2011, new minimum energy efficiency standards were introduced under the EU Ecodesign for Energy Related Products Directive. As a result, an A rating is now the minimum for washing machines and a B rating for dishwashers. These standards will be tightened further in the next few years (e.g. to A+ for washing machines in 2013), while fridges and freezers will have to meet tighter standards at the end of 2012 (A to A+). In 2012, standards will also be introduced for televisions and negotiations are on-going about standards for a range of other appliances.

These standards will gradually eliminate inefficient appliances in the shops and reduce the efficiency gap between appliances, but will not ensure uptake of the most efficient appliances. This may require additional incentives as evidence emerges on consumer behaviour.

Policy milestones

Current policy

CERT is the main energy efficiency instrument until the introduction of the Green Deal and ECO in late 2012. CERT requires energy suppliers to deliver measures to reduce emissions, with a focus on insulation measures.

While the level of ambition in CERT is consistent with our indicators, we expressed concern in our 2011 progress report that due to slow progress with CERT delivery in 2010, this ambition may be difficult to achieve.

In 2011, there was an increase in the rate of professional loft and cavity wall insulation under CERT, although much remains to be done in 2012 if CERT targets are to be achieved:

- By December 2011, CERT had achieved 78% of its CO_2 target and 42% of its insulation target.
- However, this still leaves a challenging number of installations to do in 2012 and suppliers have been lobbying DECC for an extension of the CERT period.
- Delivery of the super-priority group sub-target (energy efficiency measures targeted at low-income households) is proving particularly difficult, with suppliers offering additional incentives in a bid to achieve greater uptake (e.g. one company offers a £200 cash reward, in addition to free measures)

Delivery under other schemes has been low:

- Warmfront, the main fuel poverty programme for England had its funding cut by more than two-thirds since 2009. As a result, in financial year 2010-11, the number of homes insulated by the scheme dropped by 55%.
- The Community Energy Saving Programme (CESP) has seen an increase in delivery in 2011, with 58,931 CESP measures installed up to the end of December 2011 (including more than 12,000 solid wall measures). However, with one year left, CESP still had only achieved 15% of its carbon saving target of 19.25 $MtCO_2$.

Even if CERT and CESP fully deliver on their targets by the end of 2012, it is likely that there will still be up to between 6 and 7 million cavities left to insulate, as well as around 7 million lofts with insufficient levels of insulation. There is thus a need for new policies providing incentives to accelerate the implementation of all measures, including those where there has been very limited progress to date (e.g. solid wall insulation).

The new framework for energy efficiency: the Green Deal and the ECO

In October 2011, the Government passed the Energy Act which sets out the new framework for energy efficiency policy[1]:

- **Green Deal:** Provisions in the Act enable a new financing framework to facilitate energy efficiency improvements and low-carbon heat measures in homes and non-residential properties, funded by a charge on electricity bills that avoids the need for consumers to pay upfront costs, with the charge attached to the house rather than the owner. The Green Deal for homes will launch in the autumn of 2012.
- **Energy Company Obligation** (ECO): This obligation on energy suppliers will replace CERT and CESP, as well as (in England) the fuel poverty programme Warmfront. The ECO will have three separate targets (see below) to support energy efficiency measures in fuel poor households, fund carbon-saving measures in low-income areas, and subsidise solid wall insulation and hard-to-treat cavity wall insulation under the Green Deal. The ECO will operate from October 2012 to March 2015.

In addition, the Act includes provisions for minimum energy efficiency standards in the private rented sector, although these will not be introduced until 2018. While such regulation is very useful, it is unclear why this cannot be introduced much earlier to secure emissions reductions and energy affordability benefits.

To improve awareness about energy consumption, the Government has also confirmed that it will require all energy suppliers to complete the roll-out of smart meters by the end of 2019.

When the Government first consulted on the Green Deal and ECO in the autumn of 2011, we expressed concern that insufficient numbers of lofts and cavity walls (the most cost-effective insulation measures) would be insulated[2]:

- DECC's initial impact assessment suggested that the Green Deal and ECO, together with baseline uptake, would only result in the insulation of 700,000 lofts (around 10% of the remaining potential) and 1.7 million cavity walls by 2020 (around 30% of the remaining potential and only 15% of the rate achieved under CERT).
- The primary focus on supporting solid walls under the ECO carbon saving target in the initial proposals (with lofts and cavities restricted to installations in fuel poor households under the much smaller affordable warmth target) would erode affordability benefits and raise the costs of meeting carbon budgets.

We recommended that the ECO should be made more flexible, and that this should include loft and cavity wall insulation, at least for a transition period.

1 The Energy Act applies to England, Scotland and Wales, while Northern Ireland operates the Sustainable Energy Programme. Wales and Scotland also have additional energy efficiency and fuel poverty policies (see Chapter 8).
2 Letter from Lord Adair Turner to Secretary of State 20 December 2011. http://www.theccc.org.uk/news/latest-news/1134-ccc-expresses-concern-about-green-deal-proposals-20-december-2011

The Government announced its final design for the Green Deal and ECO in June 2012, with some significant changes that should result in more cavity walls and lofts being insulated. ECO funding in the order of £1.3 billion per annum (recovered through consumer bills) will be delivered under three separate obligations:

- **Affordable warmth:** around £350 million a year will be available to deliver heating (including new boilers, boiler repairs and district heating) and insulation measures to around 270,000 low-income and vulnerable households by 2015.
- **Carbon Savings Communities:** £190 million will be available for area-based approaches in low-income communities, including lofts and cavity wall insulation measures. 15% of the obligation will be reserved for rural, low-income households in settlements with a population size of less than 10,000.
- **Carbon Savings:** £760 million will be available to support the insulation of solid walls and hard-to-treat cavity walls under the Green Deal. District heating can also qualify for support provided it is part of a package that includes solid wall or hart-to-treat cavity wall insulation.

£200 million has been made available by the Treasury for an incentive scheme during the early phase of the Green Deal, although as yet there are no details on how this will be disbursed.

DECC's final impact assessment estimates that by 2022, the new policies could result in the installation of insulation measures in close to 1 million solid walls, 2.7 million cavity walls and 1.6 million lofts, resulting in savings of 1.8 $MtCO_2$ per year. However, the impact assessment also notes the uncertainty around the likely uptake of measures, given the market characteristics of the Green Deal and ECO policy framework.

While an improvement on the initial policy proposals, incentives for easy-to-treat cavity wall and loft insulation remain weak and the estimated installation numbers are substantially below our insulation indicator trajectories, thus resulting in a potential carbon gap of at least 3 $MtCO_2$. Options to strengthen incentives include:

- using some of the £200 million made available by the Treasury for the initial phase of the Green Deal for support of cavity and loft insulation
- rolling any underperformance against CERT and CESP targets into the ECO
- using the building regulations to drive Green Deal uptake (see below)
- introducing additional financial incentives (e.g. stamp duty or council tax differentiation according to energy rating).

We will closely monitor the Green Deal and ECO to determine whether they deliver sufficient carbon savings.

Supporting drivers – building regulations

Considering the uncertainty over levels of uptake for basic insulation measures under the Green Deal, other drivers may be needed to provide more certainty over the delivery of key measures. We therefore wrote to the Parliamentary Under-Secretary for Communities and Local Government in March 2012[3] about consequential improvements, as proposed in the building regulations consultation which closed in April 2012:

- In the case of buildings extensions, boiler or window replacement, homeowners would have to install cost-effective measures to improve the energy efficiency of their home.
- As we expect up to 1.5 million home extensions and 10 million boilers being replaced by 2020, this measure could result in a substantial number of additional energy efficiency measures.

We concluded that consequential improvements could be a very useful lever for addressing risks of delivering loft and cavity wall insulation under the Green Deal.

Energy affordability and fuel poverty

Over the past year, there has been much debate about rising household energy bills and the extent to which this is or will be due to costs of financing low-carbon investments. As we set out in our Energy Bills Note in December 2011[4], the recent increases in residential energy bills have primarily been due to increased wholesale gas costs, with an increase of around £100 projected for a typical household by 2020 due to funding of low-carbon investments. Energy efficiency offers opportunities to offset bill increases, improving energy affordability and reducing fuel poverty.

With rising fuel prices, the incidence of fuel poverty has increased substantially (from 2 million in 2004 to 5.5 million in 2009, although there was a drop[5] to 4.75 million in 2010 due to a rise in incomes, decrease in fuel prices and energy efficiency measures). However, there has been some concern whether the current definition of fuel poverty (spending more than 10% of household income on energy) adequately captures the problem. For example, it masks underlying changes in poverty and energy efficiency and makes it difficult to see the impact of energy efficiency policies. The Government therefore commissioned the Hills Review into fuel poverty which reported in March 2012 (Box 3.1).

The Hills Review highlighted the regressive nature of the ECO and suggested that for the poorest tenth the average net loss is equivalent to 0.3% of disposable income. To remove this regressive effect, it suggested that more than 50% of the ECO would need to be targeted at the fuel poor. The final design of the ECO includes an additional element focused on low-income households (through Carbon Saving Communities), although only 40% of the ECO will be targeted at fuel poor and/or low-income households.

For England, this represents a substantial cut on the funding currently targeted at low-income households under Warmfront, CERT and CESP, while in the devolved administrations, additional funding is available (see chapter 8).

3 Letter by Lord Adair Turner to Parliamentary Under-Secretary for Communities and Local Government 21 March 2012. http://www.theccc.org.uk/news/latest-news/1159-ccc-supports-changes-to-building-regulations-that-would-link-boiler-replacement-and-building-extensions-with-cavity-and-loft-insulation-21-march-2012

4 CCC (2011) Household energy bills – impacts of meeting carbon budgets. http://www.theccc.org.uk/reports/household-energy-bills

5 Fuel poverty figures are based on modelled rather than actual consumption and are not adjusted for weather. The 2010 figures do not take into account the impact of the cold winter months and higher fuel bills on low-income households.

Minimum standards for the private rented sector could be expected in principle to be of particular benefit to fuel poor households (as the private rented sector has a high incidence of inefficient housing and fuel poverty), although the suggested minimum rating of 'E' is unlikely to bring households out of fuel poverty.

We will review the impact of policies on bills and fuel poverty in our future progress reports.

Box 3.1: Hills Review on Fuel Poverty

The Review found that fuel poverty was a serious concern from a poverty, health and carbon policy perspective. It proposed that 2 indicators should be used to assess the problem:

- The 'Low Income High Costs' (LIHC) indicator, measuring the extent of the problem. Under this indicator, households should be considered fuel poor if they have required fuel costs above the median level and which, if paid, would leave them with a residual income below the official poverty line.
- The 'Fuel Poverty Gap' indicator, measuring its depth. This is the amount by which the assessed energy needs of fuel poor households exceed the median level.

Under the LIHC indicator, the level of fuel poverty in England in 2009 was 2.7 million (compared to 4 million under the current measure), with a Fuel Poverty Gap of almost £1.2 billion. Under the new measure, there was no change in the number of fuel poor between 2009 and 2010. Under the current measure (spending more than 10% of household income on energy), the number of fuel poor decreased to 3.5 million, reflecting the fact that lower-income households saw a lower rise in incomes.

The proposed indicators demonstrates the benefit of improving energy efficiency:

- Almost no households in properties with an energy performance rating of A, B or C have costs above the median costs threshold (and those that are classed as fuel poor have relative small fuel poverty gaps).
- A very large proportion of households in dwellings with E, F or G ratings are fuel poor, with an average fuel poverty gap of £767 per property.
- 52% of the fuel poor live in solid wall houses.
- The review estimates that Warmfront could have been much more effective if targeting had been based on the proposed indicators.

The review concluded that the Government should set out a renewed and ambitious strategy for tackling fuel poverty, reflecting the challenges laid out in the review, and the framework proposed for understanding them.

The government is planning to consult on revising its approach on measuring fuel poverty in 2012. The Committee supports this new approach to measuring fuel poverty, as it provides a more accurate picture of the fuel poverty problem and can help with targeting energy efficiency measures.

The European Energy Efficiency Directive

The EU has a target to save 20% of its primary energy consumption (against business as usual projections) by 2020 through improvements in energy efficiency. However, the Commission has estimated that the EU is currently on track to only achieve half of that target. After a year of negotiations, the Energy Efficiency Directive (EED) was agreed in June 2012 to help fill that gap, although the compromise Directive is expected to only achieve a 17% improvement in energy efficiency. Member states could face mandatory national targets should their progress be deemed insufficient by a Commission review in 2014.

Key provisions of the Directive include:

- Member states should set indicative national energy saving targets.
- Member states must prepare long-term roadmaps for the refurbishment of all buildings.
- Central government buildings are required to meet refurbishment targets (see section 4).
- Member states must establish energy efficiency obligation schemes for energy companies (but can get credit for existing obligations schemes such as CERT).
- National energy regulatory authorities must encourage demand-side resources to participate alongside supply in wholesale and retail markets.
- New power plants should be equipped with combined heat and power where a cost-benefit analysis shows this is a cost-effective option.

The experience of the Renewable Energy Directive has demonstrated that mandatory targets can be very effective in galvanising action, whereas it is not clear at this stage how effective the indicative targets of the EED will be. The EED is unlikely to require major changes to UK policy but should ensure that similar actions are taken across the EU (e.g. obligations on energy companies).

4. Non-residential buildings

Our framework of indicators for non-residential buildings includes high-level emissions trajectories and policy milestones. For example, it includes emissions reductions of around 35% in 2020 relative to 2007, reflecting the uptake of cost-effective emissions reduction potential. It implies the need for annual emissions reductions of around 4% to 2020, compared to broadly flat emissions prior to the recession, and broadly flat underlying emissions during the recession.

We do not include indicators for specific measures, as there is a lack of data on measures being installed in the non-residential sector. Our approach has been to focus on policies that incentivise the uptake of measures, on the basis that if incentives are in place then we can be more confident that cost-effective abatement will follow.

CRC Energy Efficiency Scheme

The main policy covering the non-residential sector is the CRC Energy Efficiency Scheme (previously Carbon Reduction Commitment). In 2010, we published our recommendations for the capped phase of the scheme. Subsequently, the Government decided to postpone the start of the scheme and dropped both the trading aspects and revenue recycling. Participants will have to purchase their first allowances covering their emissions for 2011-12 in June/July 2012.

In addition, in April 2012 the Government published a consultation on proposals to simplify the scheme (Box 3.2) and has said that if no significant reduction in administration costs can be achieved, it would abolish the CRC and replace it with a straight tax.

Box 3.2: The Carbon Reduction Energy Efficiency Commitment (CRC) – consultation proposals

The CRC simplification proposals include:

- A shortening of the CRC qualification process.
- Reducing the number of fuels covered by CRC from 29 to 4.
- Reducing the amount of reporting required by businesses.
- Reducing the length of time participants will have to keep records.
- Removing the requirement on facilities covered by Climate Change Agreements or EU ETS installations to purchase CRC allowances.
- Adopting new emissions factors for the CRC which will align it with greenhouse gas reporting processes.
- Removing the detailed metrics of the Performance League Table from legislation and placing them in government guidance.

The aim of these changes is to cut the administrative burden by two-thirds and they are expected to result in £330 million of savings for businesses by 2030.

In considering the future of the CRC, it is important to recognise that the scheme offers a potentially powerful combination of financial and reputational incentives for energy efficiency improvement. This is in a sector where incentives have traditionally been weak, and where there is a significant opportunity to improve energy efficiency. Dropping revenue recycling has weakened but not totally eroded the financial incentives that the scheme provides.

The Government's proposals would not undermine these incentives, and therefore should be welcomed to the extent that they result in a reduced administrative burden.

However, abolition of the scheme now would risk weakening incentives for energy efficiency improvement. This would be premature, particularly given evidence that the CRC has resulted in a greater focus on measuring and reducing energy consumption. The CRC should therefore be retained, at least for the time being.

In retaining the scheme, it is important that design changes are implemented to ensure that the scheme does actually provide reputational incentives, and that complementary levers are in place:

- **Reputational incentives**. These work through the annual league table, the first of which was published in November 2011 (Box 3.3). However, this table was based only on early action metrics (i.e. achieving the Carbon Trust Standard and installation of automatic meters), and does not rank participants according to changes in emissions. Although in future the table will be based on reductions in emissions, which would better reflect energy efficiency improvement, further changes will be required in order that this provides appropriate reputational incentives. In particular, the table should be disaggregated such that comparable organisations are benchmarked against each other.
- **Complementary levers**. These include a provision in the 2011 Energy Act for minimum energy efficiency standards in commercial rented properties, as well as the non-residential Green Deal (see below).

There may also be opportunities over time to rationalise multiple policies that currently cover or impact on the non-residential sector (e.g. Climate Change Levy, Climate Change Agreements, EU ETS), and to provide financial, informational and reputational incentives through a combination of the Climate Change Levy together with mandatory carbon reporting and league tables.

New mandatory reporting rules for large companies were announced in June 2012, with all companies listed on the London Stock Exchange (LSE) required to report carbon emissions in their annual reports from April 2013. Around 1800 companies will be affected by the new rules but the restriction to LSE-listed companies excludes a number of large emitters captured by the CRC (e.g. only half of the top 10 CRC emitters are LSE-listed companies).

Box 3.3: The first CRC league table

The first CRC league table was published in November 2011, based on 2010-11 emissions. The table ranks participants in terms of their early action to manage their energy, based on reports submitted by the participants in the scheme. 22 organisations jointly rank first in the table, including a number of public sector bodies (e.g. DECC and Ofgem).

The first league table provides a somewhat distorted picture because ranking in the first year is based on an early action metric (whether participants have installed 'automatic meter readings' meters and obtained the Carbon Trust or an equivalent standard) rather than actual emissions.

However, the reporting of actual emissions in the table does provide some useful findings. For example:

- The CRC captures over 2,000 participants and emissions totalled 61 $MtCO_2$ in 2010-11.
- Of all participants, the Ministry of Defence recorded the highest level of emissions with 1.7 $MtCO_2$ (which would have cost the MoD around £21 million if allowance purchase had been a requirement for that year). Four of the six largest emitters are supermarket chains with a combined 4 $MtCO_2$, with refrigeration as a major source of emissions.
- Five of the twenty largest emitters are water companies with emissions totalling 2.3 $MtCO_2$, with water abstraction, water treatment, water distribution and waste water treatment the main processes responsible. The energy used is largely electricity related (e.g. to pump the water).

In future, the CRC league table will provide valuable information about changes in emissions, from which it will be possible to make inferences about the implementation of energy efficiency measures.

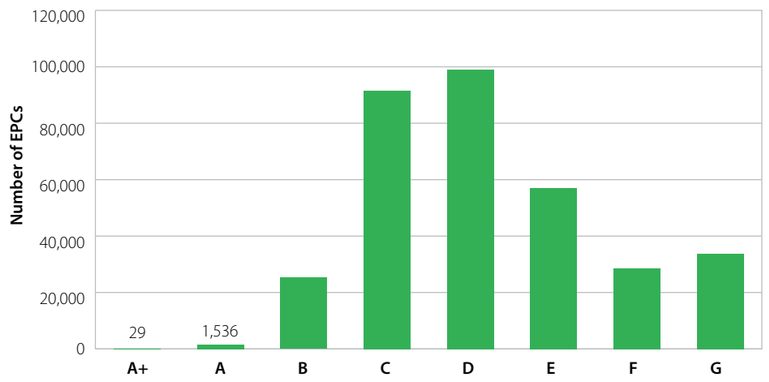
Energy Performance

The latest data on the number of Energy Performance Certificates (EPCs) and Display Energy Certificates (DECs) indicates that there still remains a large potential to reduce emissions in the non-residential sector:

- Of the 336,630 EPCs that had been issued by mid-June 2012, 18% recorded the lowest energy efficiency ratings, receiving either an F or G rating. Improving the ratings of these buildings to at least an E could be achieved through the take-up of cost-effective measures such as heating controls and energy efficient boilers. Only 8% of the EPCs issued achieved a rating of B or higher (Figure 3.13).
- Over 118,000 DECs (which measure the actual energy use of the building and associated emissions) had been issued to public buildings by mid-June 2012. Of this, the lowest G rating was given to around 12% of all DECs lodged, but accounted for over one-third of total emissions from buildings that have a DEC (Figure 3.14). In contrast, just under a quarter of the buildings achieved a rating of C or higher (with only 748 buildings achieving an A rating)

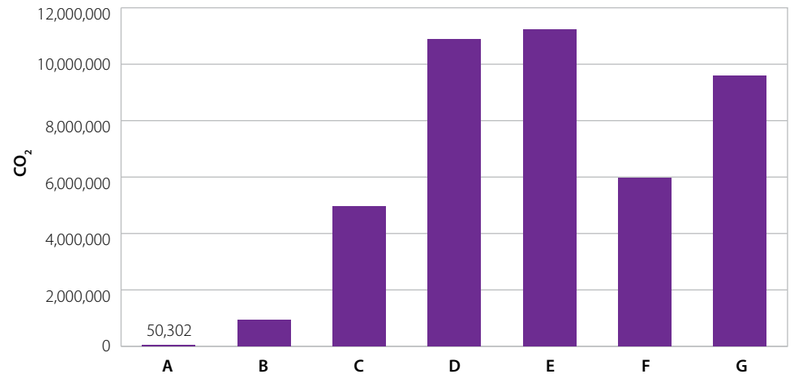
We have previously recommended the roll-out of DECs to non-public buildings, as well as minimum standards for all non-residential buildings. The regulation for privately rented premises under the Energy Act 2011 (see below) offers an opportunity to set ambitious standards and – based on the above evidence on energy performance – to significantly improve energy efficiency.

Figure 3.13: Number of non-domestic EPCs per rating



Source: Landmark.
Notes: Number of lodgements at June 2012.

Figure 3.14: CO_2 emissions per DEC rating



Source: Landmark.
Notes: Number of lodgements at mid June 2012.

Non-residential Green Deal

The Green Deal will also cover the non-residential sector, with a potential start in late January 2013. A range of measures will be available including lighting systems, heat pumps and mechanical ventilation with heat recovery systems. The DECC Impact Assessment estimates that annual savings of 1.3 $MtCO_2$ will be delivered through the non-residential Green Deal and supporting policy.

The uptake of voluntary Green Deal packages is expected to be low, with the vast majority of these savings likely to come from Green Deal take-up related to supporting regulation, i.e. minimum standards for private rented non-residential buildings which the Energy Act provides for from 2018.

However, clarification is still required on what the minimum standards (i.e. minimum EPC/DEC rating) will be, and the potential penalties for non-compliance (e.g. a landlord cannot rent out a building unless it has met the minimum standards). Ambitious standards should be set soon (i.e. by the end of 2013), thereby reducing the uncertainty for landlords who will make investment decisions in the near future with consequences going well beyond 2018.

Public sector buildings

With the CRC, more detailed data has become available for large public sector organisations. The Ministry of Defence and the Ministry of Justice are the largest public sector emitters, followed by the Royal Mail, Scottish Water and Birmingham City Council as the largest local authority emitter.

As we noted in previous reports, it is imperative for government credibility to set an example and reduce its emissions. In 2010-11, central government outperformed its target for a 10%

reduction in CO_2 emissions and reduced emissions by 13.8% in 3000 buildings on the central government estate. Some government departments achieved much larger reductions, for example the Department for Education achieved a 21.5% reduction, closely followed by DECC with a 21.3% reduction.

In 2011, central government set itself a new target to reduce greenhouse gas emissions from the whole estate and business-related transport by 2015 by 25% (from a 2009-10 baseline). Performance data for 2011-12 is not yet available but we will monitor progress against this target in future progress reports to Parliament.

The recently agreed EU EED will require that 3% of the total floor area of buildings owned and occupied by central government must be renovated each year to meet the minimum energy performance requirements set by the Energy Performance of Buildings Directive. Initially, this requirement was to apply to all public sector buildings and could have been a significant driver for public sector energy efficiency improvement. However, in the final agreement this was limited to central government buildings (with further exemptions, e.g. buildings occupied by the armed forces) and is now unlikely to have a major impact on public sector emissions.

Local authorities are also important in this context, both in terms of their direct emissions and in terms of the potential to drive emissions reductions through exercising their functions (e.g. planning control). We have recently provided advice to DECC on the role of local authorities in helping to meet carbon budgets[6]. In this, we stressed that it is important that local authorities act to reduce emissions from their own estate and operations:

- Taken together, local authorities can make a useful contribution to meeting carbon budgets (e.g. the 198 local authorities in the UK captured by the CRC account for 1% of total UK GHG emissions)
- Local authorities' leadership on their own emissions legitimises their wider role in supporting local emissions reductions, while motivating residents and businesses in the area.

5. Low-carbon heat options

Our indicator framework and the Government's Renewable Energy Strategy reflect an ambition to increase renewable heat penetration from current low levels of less than 2% to around 12% in 2020. Although we do not have indicators for specific sectors or technologies, there is a clear opportunity and need for significantly increased penetration of renewable heat in residential and non-residential buildings over the next decade. This would lay the foundations for the deep cuts required in heat emissions through the 2020s, likely to come largely from deployment of renewable heat technologies.

6 CCC (2012) How local authorities can reduce emissions and manage climate risk. http://www.theccc.org.uk/reports/local-authorities

Renewable Heat Incentive

The Renewable Heat Incentive (RHI) was introduced in November 2011. In the first phase, long-term support is available for non-residential schemes only. Currently, data on installations to the end of March 2012 is available from Ofgem, the RHI administrator:

- A total of 376 applications had been received and 20 schemes (5.25 MW of capacity) had been accredited.
- 80% of the installations were biomass boilers (98% in terms of capacity), 15% ground source heat pumps and 5% water source heat pumps.

Reports on RHI uptake and heat generation will allow us to monitor progress against our trajectories in future progress reports.

Residential sector installations currently receive the Renewable Heat Premium Payment (RHPP) which provides an upfront subsidy:

- The RHPP is initially focused on installations in off-grid homes (except for solar thermal which is available in all homes) and funding for projects delivered by registered social landlords (RSLs).
- Grant levels for householders depend on the technology installed: £300 for solar thermal, £850 for air source heat pumps, £950 for biomass boilers and £1250 for ground source heat pumps.
- Phase 1 (August 2011 to March 2012) of the RHPP supported 7,253 projects (excluding RSL projects), 35% of which were air source heat pumps, 33% solar thermal, 19% ground source heat pumps and 13% biomass boilers.
- This phase was significantly undersubscribed (funding was available up to £15m but only £8.6 million was spent). Reasons for the underspent include the relatively low levels of grants available (which were at similar levels to grants available under previous grant schemes) and the lack of uncertainty about future RHI payments for the installations supported under the RHPP.

In March 2012, the Government updated plans for the deployment of the RHI in the residential sector:

- The introduction of a support tariff for residential installations has been delayed to summer 2013, rather than 2012 as was previously envisaged.
- A second phase of the RHPP was announced to run from May 2012 to March 2013, providing up to £25m, including £10 million for a competition for RSLs to bid for support (up to £175,000 per project) and a £8 million competition for community projects.

Low-carbon heat technologies will also qualify under the Green Deal, although RHI payments cannot be used to meet the 'Golden Rule' (i.e. expected financial savings must be equal to or greater than the costs attached to the energy bill). This effectively restricts full Green Deal finance to just a few applications (e.g. replacing inefficient off-grid oil boilers).

There remains a major challenge to support investment in renewable heat in the residential sector. For example, the just over 2500 residential heat pump installations under the first phase of the RHPP can be compared to the 2.6 million installations required by 2025 in our medium abatement scenario for the fourth carbon budget. The very limited progress to date suggests a risk that significantly increased levels of investment will not be achieved.

In order to manage this risk, the Government should extend the RHI to the residential sector as a matter of urgency to provide confidence to industry to build supply chains and provide training and marketing. Tariffs for residential RHI installations should be set at levels that steadily increase the numbers of installations in line with achieving the levels of deployment needed in the fourth carbon budget period.

In addition, and recognising that the relatively high up-front costs may act as a barrier to investment (e.g. heat pumps currently cost around 3 times more than gas boilers), Green Deal finance should also be made available in conjunction with the RHI to cover at least the additional costs of renewable heat investment compared to conventional alternatives.

Finally, it is likely that there will also be non-financial barriers to deployment (e.g. lack of consumer information, lack of trust in renewable heat technologies and installers). The Government should develop approaches to address these.

Heat strategy

In early 2012, Government launched their strategic framework for low-carbon heat in the UK[7] which sets out a high-level direction for decarbonising the heat sector by 2050:

- The strategy recognises the importance of energy efficiency. In particular, Government policy (e.g. the Green Deal and ECO) should ensure that in existing buildings all cavity walls and lofts are insulated where practical and 1.5 million solid wall insulation measures are installed by 2020.
- The strategy identifies heat pumps as the primary building-scale heating option, but notes the significant barriers to delivery (e.g. high capital cost, unfamiliarity to consumers and lack of training to installers). The 2020s and 2030s are identified as the key decades for mass deployment, and by 2050 fossil fuels will be completely phased out. In the nearer term, the challenge is to prepare the market, drive early deployment and build supply chains.
- District heating offers an alternative approach, and is a potentially important part of the strategy, particularly for densely populated urban areas.

7 DECC (2012) The future of heating: A strategic framework for low-carbon heat in the UK. http://www.decc.gov.uk/en/content/cms/meeting_energy/heat_strategy/heat_strategy.aspx

This is consistent with our recommendations which emphasise the importance of heat pumps and district heating based on low-carbon heat sources, but highlights the following challenges and uncertainties which must be addressed:

- Given the lack of a carbon price for heat, and the higher costs of low-carbon heat options, further funding will be required to support investment in low-carbon heat options in the period 2015-20 and in the 2020s. The Government has announced that it will consult on the future of the RHI post-2015 in July 2012. Funding post-2015 needs to be confirmed as early as possible.
- There is scope for district heating based on low-carbon heat sources.
  - As outlined in our local authority report, there is a good opportunity for district heating using local waste and local biomass.
  - There is also a big opportunity for district heating using waste heat from thermal low-carbon power plants but this faces significant challenges regarding the location of low-carbon heat supply, transmission infrastructure and securing adequate demand. Further evidence is required on policy options for overcoming these barriers.

The challenge now is to move from the high-level strategy to detailed implementing arrangements for low-carbon heat, and to further develop the evidence base on the potential for low-carbon district heating. It is important that this challenge is addressed over the next months, given the need for decarbonisation of heat in buildings to meet carbon budgets, and the long lead times (i.e. for policy development and implementation, changing consumer preferences, and investment) for this to be achieved.

Key findings

- Buildings CO_2 emissions **fell by 12% in 2011**, mainly due to the milder weather compared to 2010. Gas consumption in homes also fell – by 23%.
- There was an increase in insulation rates, with **a total of 1.6 million** of lofts, cavity walls and solid walls insulated.
- Our trajectories **require a substantial increase** from 2012 which is unlikely to happen in the case of lofts and cavity walls under the new policy framework.
- There is uncertainty around the likely uptake of measures under the Green Deal and Energy Company Obligation. **Additional measures may be needed**.
- The Government should retain the **CRC Energy Efficiency scheme** and strengthen reputational incentives.
- Ambitious standards should be set for private rented commercial premises to ensure a **high level of uptake** for the non-residential Green Deal.
- There remains **a major challenge to support renewable heat** investment in the residential sector.

Table 3.1: The Committee's buildings indicators

BUILDINGS		Budget 1	Budget 2	Budget 3	2011 trajectory	2011 outturn
All buildings						
Headline indicators						
CO_2 emissions (% change on 2007)	direct	-5%	-19%	-32%	-2%	-18%
	indirect*	-10%	-22%	-51%	-7%	-19%
Final energy consumption (% change on 2007)	non-electricity	-8%	-20%	-25%	-4%	-13%
	electricity (autogen included)	-3%	-2%	-1%	-3%	-6%
	electricity (centrally produced)*	-3%	-2%	-1%	-3%	-6%
Residential buildings						
Headline indicators						
CO_2 emissions (indicative minimum % change on 2007)**	direct	-6%	-18%	-20%	-3%	-14%
	indirect*	-11%	-23%	-53%	-8%	-20%
Final energy consumption (indicative minimum % change on 2007)	non-electricity	-6%	-18%	-19%	-7%	-13%
	electricity (autogen included)	-5%	-4%	-3%	-6%	-8%
	electricity (centrally produced)*	-5%	-4%	-3%	-6%	-8%
Supporting indicators						
Uptake of solid wall insulation (million homes, total additional installations compared to 2007 levels)		0.5	1.2	2.3	0.33	0.06
Uptake of loft insulation (up to and including 100mm) (million homes, total additional installations compared to 2007 levels)		2.3	5.6	5.6	2.2	3.9/2.4 (CERT professional)
Uptake of loft insulation (100mm +) (million homes, total additional installations compared to 2007 levels)		2.0	4.9	4.9		
Uptake of cavity wall insulation (million homes, total additional installations compared to 2007 levels)		3.9	8.1	8.1	2.4	2.1
Uptake of energy efficient boilers (million homes, total additional installations compared to 2007 levels)		4.9	9.3	12.6	4.0	4.9
Uptake of energy efficient appliances – cold A++ rated (% of stock)		3%	18%	45%	1.8%	0.9%
Uptake of energy efficient appliances – wet A+ rated (% of stock)		16%	40%	58%	12.6%	12.1%

Table 3.1: The Committee's buildings indicators

BUILDINGS		Budget 1	Budget 2	Budget 3	2011 trajectory	2011 outturn
Every house offered whole-house energy audit			By 2017			Audits will be carried out for homes taking up the Green Deal.
New energy efficiency financing mechanism budgeted and legislation in place		2011				Final design of Green Deal published June 2012
Post CERT delivery framework legislation in place		2011				Final design of the Energy Company Obligation published June 2012
Accelerate the introduction of minimum standards for privately rented residential properties		by 2012				Energy Act proposes introduction by 2018
Introduce additional financial incentives (e.g. stamp duty rebates)			by 2016			n/a
Other drivers						
Average SAP rating, implementation of behavioural measures, population (by age), number of households (by type – building and occupants), household disposable income, electricity and gas prices, appliance ownership, weather.				See technical annex for these indicators		
Non-residential buildings						
Headline indicators						
CO_2 emissions (indicative minimum % change on 2007)*	direct	6%	2%	-3%	6%	-13%
	indirect**	-9%	-22%	-51%	-6%	-14%
Final energy consumption (indicative minimum % change on 2007)	non-electricity	-4%	-8%	-13%	-4%	-12%
	electricity (autogen included)	-1%	-1%	-1%	-1%	-2%
	electricity (centrally produced)**	-1%	-1%	-1%	-1%	-2%
Supporting indicators						
Develop policy on SMEs		by October 2010				Green Deal will apply to SMEs but not finalized yet
Accelerate the introduction of minimum standards for privately rented non-residential properties			By 2016			Energy Act proposes introduction by 2018
Government decision on the following recommendations for EPCs and DECs:		by October 2010				

Table 3.1: The Committee's buildings indicators

BUILDINGS	Budget 1	Budget 2	Budget 3	2011 trajectory	2011 outturn
– All non-residential buildings to have an EPC		by 2017			No commitment to do this
– All non-residential buildings to have a minimum EPC rating of F or higher			by 2020		No commitment to do this
– Roll out of DECs to non-public buildings		by 2017			No commitment to do this
All public buildings covered by CRC to realise all cost-effective emissions change potential			by 2018		On-going
Other drivers					
Emissions and fuel consumption by subsector, GVA vs. GDP for each sub-sector, electricity and gas prices.			See technical annex.		
Renewable heat					
Headline indicators					
Renewable heat penetration (% of heat demand from renewables) – total buildings and industry**	1%	5%	12% in 2020	<1%	0.6%***
Buildings renewable heat penetration (% of heat demand)	1%	4%	11% in 2020	<1%	1.3%***
Renewable Heat Incentive in operation	From April 2011				Non-residential RHI introduced November 2011. Residential sector RHI due to commence 2013.
Other drivers					
Renewable heat penetration (% of heat demand from renewables) – buildings					
Uptake and costs of renewable heat technologies in buildings, Biomass boilers, Solar thermal, GSHP/ASHP, District heating.					

* Carbon intensity assumed to be equal to new build gas.
** Reflects incremental penetration of renewable heat above a baseline penetration in 2007 of 1.2%.
*** 2010 outturn for renewable heat (2011 figures will be available in July 2012).

Note: Numbers indicate amount in last year of budget period i.e. 2012, 2017, 2022.

Key: Headline indicators | Implementation indicators | Milestones | Other drivers

Introduction and key messages

1. Industry emissions trends
2. Opportunities and challenges reducing industry emissions
3. Managing competitiveness impacts

Chapter 4: Progress reducing emissions from industry

Introduction and key messages

Emissions from industry accounted for around a third of UK greenhouse gas emissions in 2011, of which around 80% are CO_2. Industry CO_2 emissions are 71% direct emissions (of which 92% are from the combustion of fossil fuels and 8% are from chemical processes) and 29% indirect emissions (i.e. electricity-related).

In our 2011 progress report, we reported that industry emissions fell 42% between 1990 and 2010:

- Between 1990 and 2007, restructuring and fuel-switching caused CO_2 emissions to fall 15%, followed by a further 16% reduction to 2009 as a result of the recession.
- Slightly increased emissions (1%) in 2010 reflected increased output.
- Non-CO_2 emissions have fallen significantly (70%) between 1990 and 2011 reflecting the introduction of technologies to abate N_2O emissions in industrial processes and reduced fugitive emissions from the gas distribution network and coal mines.

In this chapter we assess data for 2011, both as regards emissions and drivers. We also identify challenges going forward, and consider whether current polices adequately address these challenges.

The key messages in the chapter are:

- Industry emissions fell by 5% in 2011. CO_2 emissions fell by 6% (to 151 $MtCO_2$), and non-CO_2 emissions fell by 2% (to 35 $MtCO_2e$). Within CO_2 emissions, direct emissions fell by 6% (combustion and process emissions by 6% and 4% respectively), and indirect emissions fell by 6%.
- Estimating the extent to which emission reductions reflect underlying progress on low-carbon measures rather than other drivers (i.e. fuel switching and output changes) is difficult due to current data constraints. It is unlikely that the emissions reduction was driven by either fuel switching or output, suggesting that reductions may have resulted from improvements in energy efficiency. However, there is a lack of direct evidence to substantiate this. To improve the assessment of underlying progress in industry, more disaggregated emissions data is required to track the extent of underlying progress, which will be available for some sectors from DECC in 2013.

- Challenges going forward are to further implement energy efficiency measures, to increase the use of bioenergy, and to invest in low-carbon technologies (e.g. CCS). Although policies in place (e.g. the Renewable Heat Incentive and the CCS demonstration programme) will help, incentives have been weakened through limiting the coverage of Climate Change Agreements to the non-energy-intensive sectors, and due to the low price of carbon in EU ETS. To ensure sufficiently strong incentives are in place, the Government should set out an approach for large-scale biomass and industrial CCS development consistent with meeting carbon budgets and the level of ambition set out in the Carbon Plan.

We set out the analysis that underpins these conclusions in 3 sections:

1. Industry emissions trends
2. Opportunities and challenges reducing industry emissions
3. Managing competitiveness impacts

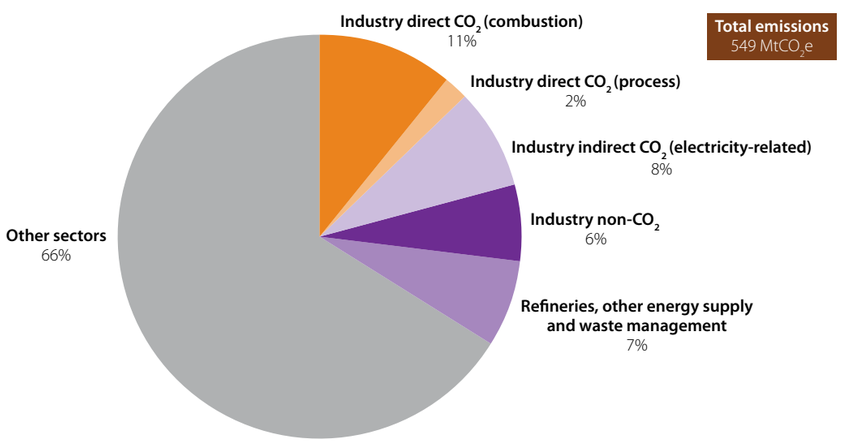
1. Industry emissions trends

Overview of industry emissions

Total emissions from industry accounted for around a third of UK greenhouse gas emissions in 2011 (186 $MtCO_2e$), of which around 80% are CO_2 (Figure 4.1). Industry CO_2 emissions are 71% direct emissions (of which 92% are from the combustion of fossil fuels and 8% are from chemical processes) and 29% indirect emissions (i.e. electricity-related).

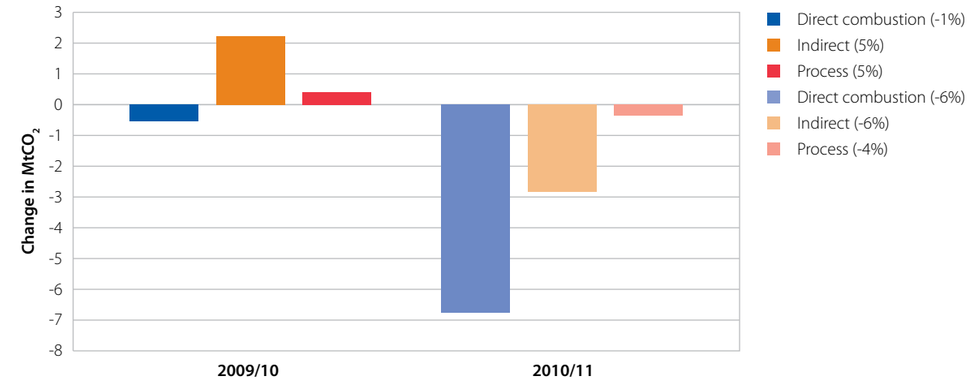
Industry emissions fell by 5% in 2011 to 186 $MtCO_2e$. CO_2 emissions fell by 6% in 2011 to 151 $MtCO_2$, and non-CO_2 emissions fell by 2% to 35 $MtCO_2e$. Within CO_2 emissions, direct emissions fell by 6% (combustion and process emissions by 6% and 4% respectively) and electricity-related emissions fell by 6% (Figure 4.2).

Figure 4.1: Emissions from industry in the context of total GHG UK emissions (2011)



Source: NAEI (2012).
Notes: NAEI (2011). Emissions from waste are shown here, but are discussed and accounted for in Chapter 7.

Figure 4.2: Change in CO_2 emissions (2009, 2010 and 2011)



Source: NAEI (2012); DECC (2012) *Energy Trends* March 2012; DECC (2012) *UK Emissions Statistics 2011 Provisional UK figures*; CCC calculations.
Note: 2011 emissions estimates are provisional. Commercial and Industrial emissions are based on CCC estimates.

The extent to which these reductions reflect underlying progress (i.e. implementation of low-carbon measures), rather than other emissions drivers (i.e. recession related changes in output and temporary fuel switching), is highly uncertain due to data constraints. For example, 2011 emissions data for industry is only available at an aggregate level, and therefore assessing the impact on emissions of changes in output by sector is difficult.

Notwithstanding this, it is unlikely that the emissions reduction was driven by either fuel switching or output, suggesting that reductions may have resulted from improvements in energy efficiency:

- **Fuel switching.** Given that energy demand fell broadly in line with emissions in 2011 (7% and 6% respectively), fuel switching is unlikely to be a significant driver of lower emissions in 2011. This is borne out in data on fossil fuel consumption by industry, where the shares of various fossil fuels remained broadly constant.
- **Output.** Although overall manufacturing output in industry increased by 2%, large differences across industry sectors (i.e. changes in industrial structure) make it difficult to relate output and emissions for 2011. However, an initial assessment of the impact of output on emissions suggests that the net impact across sectors is broadly flat (Table 4.1).
- **Energy efficiency.** There is a lack of direct evidence to substantiate the implementation of energy efficiency measures in industry, although high fuel prices, increased investment, and rationalisation in the iron and steel sector suggests there has been an improvement in energy efficiency in 2011:
  - High fuel prices in 2011 indicate incentives for more energy-efficient production in 2011: gas prices increased by 20% in 2011 (following a drop of 8% in 2010) and fuel oil and coal prices increased by 18% and 9% respectively (following increases of 20% and 13% in 2010).

– New plant and equipment is likely to be more energy efficient and reduce emissions. National Accounts data for 2011 reports that investment in new plant and equipment increased by 8%, following low investment during the recession (investment fell 6% on average from 2008 to 2010).

– In the iron and steel sector, emissions fell by around 8%, whereas output fell by only 1% for basic metals (which includes iron and steel). Data from industry on the production of specific plant suggests that this was due to some plant running at higher load factors and therefore with better energy performance. Additionally, there was a shift towards producing specialised steels made in an electric-arc furnace, at a lower carbon-intensity than the blast furnace route.

To improve the assessment of underlying progress in industry, we are working on analytical approaches that would allow us to gain a better understanding of the drivers of industrial emissions, including the use of more disaggregated emissions data which will be available for some sectors from DECC in 2013.

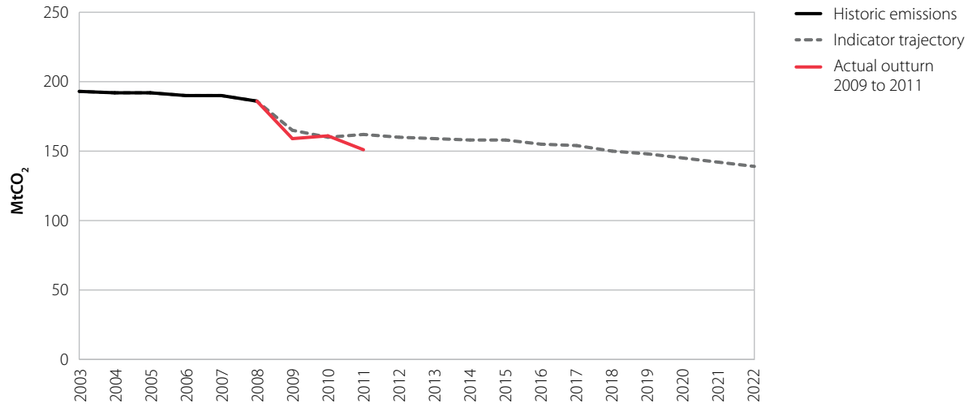
Industry emissions in 2011 were 11 $MtCO_2$ below the level (162 $MtCO_2$) we envisaged when we set our progress indicators in 2009 (Figure 4.3). This is primarily because the indicator trajectory did not incorporate the impact of the recession, which has been particularly pronounced in the industry sector.

Table 4.1: Impact of change in output on emissions 2011

Sector	Change in output 2010 – 2011[1]	2010 direct emissions ($MtCO_2$)[2]	Impact of output on emissions ($MtCO_2$)[4]
Energy-intensive industry			
Refineries	+0.4%	15	+0.06
Iron and steel	-1.4%	14	-0.19
Chemicals	+3.1%	6	+0.20
Food and drink	+6.8%	4	+0.26
Cement	-5.1%	4	-0.22
Rest of industry			
Non-energy-intensive industry	-0.2%	41	-0.09
Other energy supply, off-road and waste management[3]	N/A	30	N/A
Total		114	+0.01

1 ONS (2011) Index of Production.
2 AEA (2012), CCC calculations. Includes combustion and process emissions (auto generation emissions are omitted).
3 Industry categories for which output statistics are not available.
4 Impact does not account for energy efficiency that has occurred in 2011 .

Figure 4.3: Historic emissions vs indicator trajectory (2003-2022)



Source: NAEI (2012); DECC (2012) *Energy Trends* March 2012; DECC (2012) *UK Emissions Statistics 2011 Provisional UK figures*; CCC calculations.
Note: 2011 emissions estimates are provisional.

Looking forward, key emissions drivers will be the extent of recovery in the construction sector and the level of investment in new plant:

- Eurozone uncertainty and low levels of activity in the construction sector during 2011 (new orders were down 14%, and at their lowest level since 1980) may have resulted in reduced output for construction-related industries (e.g. steel and cement). Recovery of production may increase emissions in 2012.

- Although there was some recovery of investment in 2011, low investment in new plant during the recession (investment fell 6% a year on average from 2008 to 2010) indicates the continued use of older and inefficient plant. Depending on the extent of recovery in 2012, low investment could increase emissions in industry.

Further emission reductions are required to meet future carbon budgets (e.g. around a 12% reduction in direct emissions on current levels is required in 2027 under the legislated fourth carbon budget). This will be particularly challenging given the expected increase in emissions as the economy recovers.

2. Opportunities and challenges reducing industry emissions

We have previously highlighted scope for emissions reduction in industry in the first four budget periods from 77 $MtCO_2$ in 2008 to 94 $MtCO_2$ in 2030:

- **Energy efficiency improvement.** The ENUSIM model used by Government suggests scope for reducing industry emissions by around 6 $MtCO_2$ in the period to 2020 through energy efficiency measures.

- **Low-carbon heat and use of bioenergy.** Modelling conducted by NERA suggests the potential to reduce industry emissions by 6 $MtCO_2$ by 2020 and further reductions through the 2020s. This is primarily through biomass and biogas, with smaller contributions from heat pumps and CHP.
- **CCS.** CCS could be feasible and cost-effective for deployment in the iron and steel sector and the chemicals industry during the 2020s, and by 2050 could contribute to cost-effective reductions of around 40 $MtCO_2$.
- **Radical options in energy-intensive industry.** Further cost-effective options for energy-intensive industry include recycling of steel, increased use of clinker substitutes in the cement sector and reduction of flaring in refineries, providing around 12 $MtCO_2$ abatement by 2030.
- **Product substitution.** Use of wood in construction provides the opportunity to both sequester carbon and to displace the use of carbon-intensive construction materials, and could provide up to 6 $MtCO_2$ abatement by 2050.

It is important now to plan for investment in these measures given long project lead times, and the need to synchronise investment with the refurbishment cycles of the capital stock.

In order for firms to plan in this way, policies will have to be in place that offer a premium to low-carbon investment, and ensure that this is prioritised in a capital-constrained world.

Current policies include the EU ETS, Climate Change Agreements, the Renewable Heat Incentive, the CCS demonstration programme, and carbon reporting requirements:

- **EU ETS.** Verified emissions continue to be below the level of allocated allowances. This has been exacerbated by the recession, and resulted in a weak price signal from the EU ETS (Chapter 1). As suggested in our 2011 progress report, this is particularly problematic for energy-intensive industries that require long-term certainty in order to make investments in line with the fourth carbon budget.
- **Climate Change Agreements (CCAs).** In our 2011 progress report, we suggested that new CCAs should include the full range of abatement options, require the implementation of options which are cost-effective compared with the carbon price (e.g. £30/tCO_2 in 2020 and rising through the 2020s), and include milestones around long-term investments to reduce emissions (preparing for CCS, recycling in iron and steel, product substitution etc). In March 2012, the Government announced new simplified CCAs which will begin operation in 2013. These reduce the scope of emissions covered by CCAs to non-EU ETS emissions only (previously they covered both EU ETS and non-EU ETS) and results in around a 60% reduction in emissions covered compared with the previous design. However, energy used across the entire site (i.e. traded and non-traded) will remain eligible for the CCL discount, suggesting the signal to industry from this policy will be weakened.

- **The Renewable Heat Incentive (RHI).** Uptake of renewable heat in industry was broadly on track in 2010[1], and in November 2011 the RHI commenced operation offering tariffs to commercial and industrial installations. In our 2011 Renewable Energy Review, we suggested that the support levels indicated in the RHI consultation document were broadly aligned with requirements. However, in response to concerns about state aid, the tariff level for large biomass installations (>1MW) was reduced in the final design (from 2.7p/kWh to 1.0p/kWh), resulting in a reduction in the projected level of uptake by around 50%.
- **CCS demonstration.** In April 2011, the Government announced a competition to encourage the development of CCS in the UK (see Chapter 2). The competition is open to applications from industrial applications when these form part of a cluster (i.e. the application must also contain at least one power sector installation). The costs of some industrial CCS applications are expected to be in the range £30-80/tCO_2 – competitive with installations in the power sector – once CCS has been demonstrated and when installations are served by a CO_2 infrastructure at sufficient scale to benefit from economies of scale (i.e. also serving power stations). Therefore including industrial applications may be a cost-effective option for the CCS competition, and is of increasing importance given limited progress internationally (Box 4.1).
- **Carbon reporting requirements.** From May to July 2011, Government conducted a consultation on whether regulations should be introduced to make it mandatory for some UK companies to report on their greenhouse gas emissions. New mandatory reporting rules for large companies were announced in June 2012, with all companies listed on the London Stock Exchange (LSE) required to report carbon emissions in their annual reports from April 2013. The restriction to LSE-listed companies excludes a number of large emitters.

Given this combination of policies, we can expect some progress on energy efficiency improvement and use of bioenergy, and possible progress on CCS demonstration.

However, incentives are unlikely to be sufficiently strong to unlock all cost-effective abatement potential, particularly as regards deployment of more expensive measures. In order to ensure sufficiently strong incentives are in place, Government should set out an approach for:

- **Large-scale biomass applications in industry.** This is particularly important given that large biomass installations are likely to be a priority for the use of scarce sustainable biomass to meet future carbon budgets (as also identified in the Government's Carbon Plan and Heat Strategy). Additionally, uncertainty about RHI funding beyond 2015 needs to be resolved as soon as possible.
- **Industrial CCS development.** In order to be compatible with carbon budgets and the Government's carbon plan, this approach should set out in detail how deployment could be achieved in the late 2020s.

The Government's forthcoming industry strategy provides an opportunity to set out how gaps in the current policy framework can be filled, and more confidence provided over the implementation of the measures that we have highlighted, and that are also included in the Government's Carbon Plan.

1 Data for 2011 was not available at time of publication.

Box 4.1: International progress on industrial CCS

The IEA 2011 CCS roadmap[2] forecasts that around half the mitigation potential from CCS could be from industrial applications in 2050. In the UK, the Committee's 2010 Fourth Carbon Budget report identified CCS applications in industry as feasible and cost-effective from 2030, with potential to abate up to around 40 $MtCO_2$ by 2050.

Demonstration of CCS in industry, either in the UK or elsewhere, is crucial to resolving current uncertainties. However, there are currently only a small number of projects that are set to demonstrate industrial CCS at scale:

- ArcelorMittal steelworks, France: feasibility study into CCS at a steelworks to abate around 0.8 $MtCO_2$/yr, to commence construction in 2012/13.
- Air Liquide hydrogen, Netherlands: 0.5 $MtCO_2$ on a hydrogen plant, with the potential to expand CCS further in the region in future, to commence construction in 2014.
- Masdar steelworks, Abu Dhabi: 0.8 $MtCO_2$ on direct reduced iron plants, which is currently out to tender.

Support for industrial CCS is offered under the New Entrants Reserve (NER 300), which will generate funds through selling 300 million EU ETS allowances. The European Commission is expected to communicate the final award decision by the end of 2012.

If progress continues to be limited internationally, domestic demonstrations of CCS will be important to meet the timetable of 2027-2030, set out in the Carbon Plan to start CCS roll out in industry.

In monitoring progress reducing industry emissions in future, we introduce new indicators for renewable heat and energy intensity (Box 4.2) to complement the existing indicator framework. We will also continue to monitor progress developing policies, given the need to strengthen incentives if measures are to be implemented and emissions reduced.

Box 4.2: Industry indicator framework

The indicator framework we set out in our 2009 progress report to Parliament was developed to monitor progress in meeting carbon budgets. Previously, we had a limited set of indicators for industry due to data constraints. However, we are now giving this further attention, partly reflecting recent improvements to the evidence base for energy-intensive industry.

The key drivers of industrial emissions in the UK are fuel switching, energy-intensity and output, and this forms the conceptual basis for developing new indicators of progress in industry (full indicator set at the end of the chapter):

- **Fuel switching.** A new indicator trajectory is introduced for the uptake of renewable heat in industry, consistent with the existing ambition for 12% penetration in buildings and industry. Fuel switching may also involve coal to gas during periods of low gas prices. However, given that switching from coal to gas is not compatible with meeting the 2050 carbon reduction target (unless fitted with CCS), we do not propose to develop an indicator at this stage.
- **Energy intensity.** New indicator trajectories are introduced for the energy intensity of industry overall, and for energy-intensive industry (energy-intensive industry is separated out as it has different barriers and opportunities to the rest of industry). This will give an indication of the implementation of energy efficiency measures (e.g. efficient motors and drives, and more radical measures such as optimisation of refineries). Evidence of other factors that impact energy intensity, such as changes in industrial structure, will also be assessed to interpret this indicator.
- **Output.** Changes in the output of industry overall and of specific sectors is a driver of emissions, but does not form part of our strategy for meeting carbon budgets. Therefore we monitor output (GVA) overall and of specific sectors in order to understand changes in emissions, but do not propose an indicator trajectory for this driver.

2 IEA (2001) Technology roadmap – Carbon Capture and Storage. http://www.iea.org/papers/2009/CCS_Roadmap.pdf

Box 4.2: Industry indicator framework

Table B4.2: New indicators in industry for renewable heat and energy-intensity.

Indicator	Budget 1	Budget 2	Budget 3
Industry renewable heat penetration (% of heat demand)	1%	6%	16% in 2020
Energy intensity overall (% change compared with 2007)	-7%	-18%	-24%
Energy intensity for energy-intensive sectors	Methodology under development		

In future, switching to low-carbon construction materials, fuel switching to electrification, and more radical improvements (e.g. CCS) will become important and indicators may be developed to track progress. At this stage, a milestone indicator is developed for CCS to track development in time for deployment in the late 2020s.

3. Managing competitiveness impacts

The Climate Change Act requires that carbon budgets are designed to account for "the likely impact of the decision (on carbon budgets) on the economy and the competitiveness of particular sectors of the economy".

In our 2008 report *Building a low-carbon economy,* we set out analysis showing that competitiveness risks are limited to energy-intensive sectors and could be managed (e.g. through design of the EU ETS). The current design of the EU ETS allocates free allowances to much of the energy-intensive sector.

In our 2011 Renewable Energy Review, we highlighted a specific risk that power sector decarbonisation could entail risks for a small number of electricity-intensive sectors (e.g. iron and steel, aluminium). These risks were acknowledged in the agreement to legislate the fourth carbon budget, as part of which the Government committed to introduce new measures to limit competitiveness risks for electricity-intensive companies.

The Government followed through on this commitment with a package worth £250 million announced in November 2011:

- Up to £100m is compensation for impacts from the Carbon Price Floor pass-through. The Government is currently consulting on eligibility criteria, with a view to making this available from 2013, subject to state aid approval.
- Up to £110 million is compensation for indirect impacts of the EU ETS on electricity prices, in line with European Commission state aid guidelines. EU rules for eligibility will be set in 2012 and compensation will be available from 2013.
- A £40 million uplift on relief from the Climate Change Levy (from 65% to 90%) is to be introduced from April 2013.

We will provide a full assessment of this package, together with competitiveness risks more generally, in our report on competitiveness and carbon leakage to be published in Spring 2013.

Key findings

- Industry emissions **fell by 5% in 2011**.
- It is unlikely that the emissions reduction was driven by fuel switching or output, suggesting that **energy efficiency improvements may have been implemented in 2011**.
- **Incentives for abatement have been weakened** through limiting coverage of CCAs to non-energy-intensive sectors, and the low price of carbon in the EU ETS.
- Government should set out an approach for **large-scale biomass applications in industry** in line with meeting future carbon budgets, and closely monitor uptake.
- Government should set out an approach to **industrial CCS development** to achieve deployment in the late 2020s.
- The Governments **forthcoming industry strategy** is an opportunity to fill the gaps in the current policy framework and provide more confidence over implementation of measures in line with carbon budgets.

Table 4.2: The Committee's industry indicators

INDUSTRY		Budget 1	Budget 2	Budget 3	2011 trajectory	2011 outturn
Headline indicators						
CO_2 emissions (indicative minimum % change on 2007)	direct	-14%	-9%	-7%	-13%	-21%
	indirect*	-12%	-35%	-66%	-11%	-20%
Final energy consumption (indicative minimum % change on 2007)	non-electricity	-19%	-20%	-18%	-18%	-18%
	electricity (autogen included)	-16%	-11%	-5%	-16%	-12%
	electricity (centrally produced)	-6%	-19%	-30%	-7%	-10%
Supporting indicators						
Renewable heat						
Buildings and industry renewable heat penetration (% of heat demand)**		1%	5%	12% in 2020	<1%	0.6%***
Industry renewable heat penetration (% of heat demand)		1%	5%	13% in 2020	<1%	1.4%***
CCS						
In light of outcome of CCS competition, set out an approach for industrial demonstrations compatible with deployment in the late 2020s			No later than 2013		N/A for 2011	
Energy intensity						
Energy intensity (% change compared with 2007)		-7%	-18%	-24%	Reporting will commence in 2013	
Energy intensity for energy-intensive sectors		Methodology under development			Reporting will commence in 2013	
Other milestones/drivers/wider monitoring						
Publish industry strategy including detail and milestones for meeting carbon budgets, incentives and mechanisms for overcoming barriers			No later than 2013		N/A for 2011	
Uptake by renewable heat technology ; International development of CCS; For industry: Fuel prices , fuel and electricity consumption , GVA ; For energy-intensive industry: Emissions, fuel consumption and GVA by sector					See technical annex	

* Carbon intensity assumed to be equal to new build gas.
** Reflects incremental penetration of renewable heat above a baseline penetration in 2007 of 1.2%.
*** 2010 outturn for renewable heat (2011 available in July 2012).

Key: Headline indicators Implementation indicators Milestones Other drivers

Chapter 5: Progress reducing transport emissions

Introduction and key messages

Domestic transport emissions account for 20% of UK GHG emissions and 24% of UK CO_2 emissions. Emissions from international aviation and shipping were around 40 $MtCO_2$ in 2010 but are not currently counted in UK carbon budgets.

This chapter focuses on trends in domestic transport CO_2 emissions.

Our analysis is based on final emissions and other data for 2010 and preliminary data on key emissions drivers for 2011. We assess high-level emissions trends and identify underlying progress in reducing emissions. We focus in particular on new car and van emissions, electric vehicle market development and progress towards changing travel behaviour.

Our key messages are:

- **Domestic transport CO_2 emissions** were broadly unchanged in 2010. A preliminary assessment suggests that surface transport emissions may have fallen slightly in 2011, with reduced emissions from cars but increased emissions from vans and heavy goods vehicles (HGVs).
  - Surface transport emissions remained unchanged in 2010, following two years of decline. Reduced distance travelled for cars, improved vehicle efficiency and increased use of biofuels was offset by increased distance travelled for vans and HGVs.
  - A preliminary assessment for 2011 suggests that surface transport emissions may have slightly decreased, with the effect of reduced carbon intensity of cars offsetting increased distance travelled by cars, vans and HGVs. However, there is a risk that surface transport emissions increase as the economy recovers, with the possibility that people purchase higher emitting vehicles and travel more.
  - Domestic aviation and shipping emissions fell by 4.7% in 2010, to 4.1 $MtCO_2$.
- **Carbon intensity of vehicles.** There has been good progress in reducing new car emissions, but less progress in reducing new van emissions, and significant cuts are required across vehicle modes in order to achieve future carbon budgets.
  - CO_2 intensity of new cars fell from 144.2 gCO_2/km in 2010 to 138.1 gCO_2/km in 2011 (a 4.2% reduction), and are on track to meet our indicator of 95 gCO_2/km in 2020. Whether there has been a fundamental shift in car purchase behaviour needs to be closely monitored as the economy recovers and fossil fuel prices change, with use of fiscal levers (e.g. VED differentiation) as required to ensure continued progress.

- CO_2 intensity of new vans fell only 0.5% between 2010 and 2011 relative to the 3.1% annual reduction required between 2010 and 2020. We would expect emissions to fall more quickly as manufacturers work to meet the recently agreed EU new van target for CO_2 intensity. However, it may be necessary for the Government to provide additional fiscal incentives for purchase of more efficient vans.
- Although there were limited purchases of electric vehicles in 2011, conditions are in place to support market development (i.e. Government support for purchase of electric vehicles, investment in battery-charging infrastructure, and manufacturers launching new models). The announcement in Budget 2012 that the company car tax exemption for zero and ultra-low emission vehicles would be withdrawn in 2015 will limit incentives for uptake in this key sector while raising only very limited revenues, and should be reversed.
- Biofuels penetration remained broadly constant between 2010 and 2011. It will be important to ensure that increased biofuels penetration is sustainable through strengthening safeguards against indirect land use impacts. With a more robust sustainability framework, increased penetration is likely to be feasible and desirable to 2020.

- **Progress on changing behaviour** has been mixed, with good progress on roll out of sustainable travel programmes, but limited progress on eco-driving training and a risk that the motorway speed limit will be increased.
  - The **Local Sustainable Transport Fund** is sufficient to roll out Smarter Choices to around 25% of the UK by 2015. The Government should now set out its approach to fully rolling out Smarter Choices by 2020.
  - **Eco-driving** training can make a significant and cost-effective contribution to meeting carbon budgets but progress has been limited. To encourage eco-driving, the Government should consider including this as a key element of the practical driving test, and consider options to increase eco-driving training and other opportunities to provide information on fuel consumption and the benefits of eco-driving.
  - **Speeding on motorways and dual carriageways.** Government proposals to increase the speed limit on motorways and potentially dual carriageways would significantly increase emissions relative to the alternative of enforcing the current speed limit, and provide a negative signal about the Government's commitment to meeting carbon budgets. Given the need to reduce emissions from cars and vans, the Government should consult on enforcing the existing speed limit, including a full assessment of the costs and benefits of this option.

The analysis that underpins these messages is set out in seven sections:

1. Transport emissions trends
2. Opportunities for reducing emissions – the indicator framework
3. Progress in reducing car emissions
4. Progress in reducing van emissions
5. Progress in developing electric vehicle markets
6. Progress on biofuels in surface transport
7. Progress in changing travel behaviour

1. Transport emissions trends

In 2010, domestic transport emissions were around 117 $MtCO_2$. These are dominated (96%) by surface transport (113 $MtCO_2$), with domestic aviation and shipping accounting for roughly equal shares of the remaining 4% of emissions.

In the last few years surface transport emissions, as well as those from aviation and shipping have been falling. The recession has been a key driver, together with EU standards for new vehicles and fiscal policy.

In this section we assess 2010 emissions data (i.e. the latest year for which final data are available) and data on emissions drivers for 2011. We consider in turn:

(i) Emissions from surface transport

(ii) Emissions from aviation and shipping

(i) Emissions from surface transport

Surface transport emissions trends

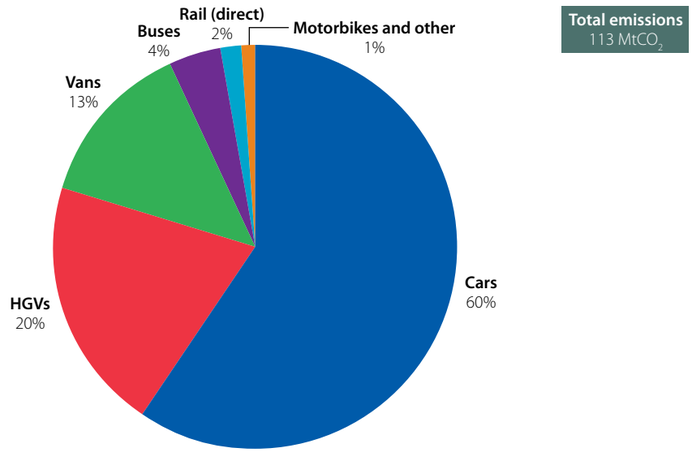
Surface transport (road and rail) CO_2 emissions are dominated by cars (accounting for 60% of emissions), followed by HGVs (20%), vans (13%), buses (4%), mopeds and motorcycles (1%); rail (direct) emissions account for the remaining 2% of emissions (Figure 5.1).

At 113 $MtCO_2$ in 2010, surface transport emissions remained broadly unchanged from the previous year. Within this, it is likely that car and motorcycle emissions decreased, while van, HGV and bus emissions increased.

While current emissions remain in line with our indicator trajectory significant reductions will be required to meet future carbon budgets (Figure 5.2).

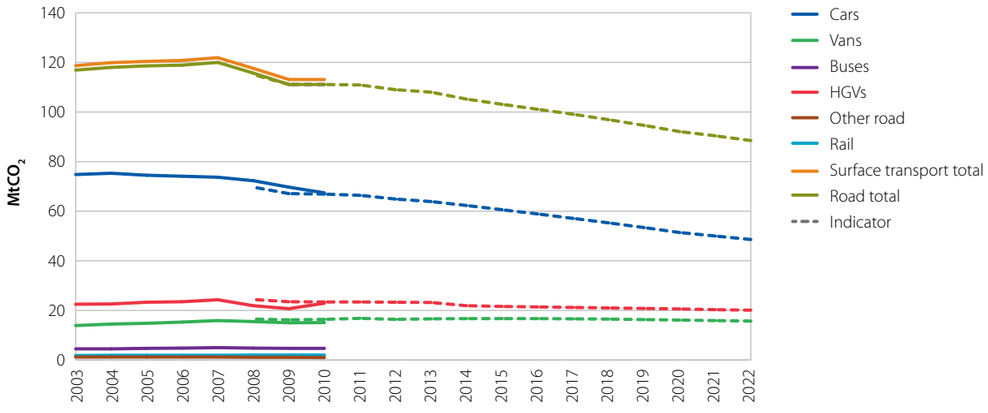
Although emissions have declined by around 7% since 2007, this has been in the context of the recession and increases in fossil fuel prices. The longer-term trend has been one of rising emissions (e.g. between 1990 and 2007 emissions increased by 11%). Therefore there remains a risk that this decline will reverse as the economy recovers and if changes in vehicle purchase and travel behaviour turn out to be transitory.

Figure 5.1: Breakdown of surface transport CO_2 emissions by mode (2010)



Source: NAEI (2012).
Notes: 'Other' includes motorcycles and mopeds, liquefied petroleum gas emissions (all vehicles), and other road vehicle engines.

Figure 5.2: Surface transport emissions: historic and indicator trajectory (2003-2022)



Source: NAEI (2012), CCC modelling.

Data issues in allocating emissions across road transport modes

Total road transport CO_2 emissions are calculated from official statistics on total petrol and diesel sales in the UK.

As the volume of fuel consumed by each road transport mode is not recorded, CO_2 emissions by mode must be estimated. We have reviewed the estimation methodology used in the National Atmospheric Emissions Inventory (NAEI) and conclude that this produces implausible estimates of emissions by mode (Box 5.1).

In this chapter we report the NAEI estimates of emissions by mode. However, we also demonstrate that these estimates lead to implausible implied changes in the fuel efficiency of the vehicle fleets, given data on distance travelled and penetration of biofuels. We therefore recommend that the NAEI moves to a more rigorous estimation methodology based on bottom-up modelling of fleet efficiency. It is important to move forward with this quickly so that accurate monitoring and assessment of emissions trends by mode is possible.

Box 5.1: Estimation methodology for emissions by mode

The National Atmospheric Emissions Inventory (NAEI) includes estimates of road transport CO_2 emissions by mode. CO_2 emissions from each mode are estimated with the following steps:

- Fuel consumption factors are defined for petrol and diesel vehicles, for each type of road.
- Total petrol and diesel consumption is estimated based on fuel consumption factors and vehicle km travelled on each type of road.
- Estimated petrol and diesel consumption is adjusted so that total consumption equals official statistics on total petrol and diesel sales in the UK (corrected for consumption by off-road vehicles and Crown Dependencies).

We have reviewed the estimation methodology and conclude that it is problematic for two reasons:

- While HGV and bus fuel consumption factors are based on available data, car and van fuel consumption factors are assumptions based on speed emissions curves developed prior to enactment of the EU New Car CO_2 regulation (April 2009) and New Van CO_2 regulation (May 2011). They do not reflect reductions in new vehicle CO_2 arising from progress towards meeting the EU targets. Use of these fuel consumption factors is therefore likely to overestimate car and van emissions, requiring correction at a later stage.
- The Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories state that road transport CO_2 emissions should be calculated on the basis of the amount and type of fuel sold. However, estimated petrol and diesel consumption typically does not equate to outturn petrol and diesel sales. The difference between estimated and outturn consumption implies errors in the estimates of either fuel consumption factors or vehicle km travelled. As the true values of these variables are not known, a judgment must be made about how to adjust estimated petrol and diesel consumption for each mode. To derive the NAEI figures, the following adjustments are made:
  - Estimated petrol consumption for each petrol consuming mode is scaled such that total petrol consumption is consistent with total petrol sales.
  - Estimated diesel consumption for HGVs is scaled such that total diesel consumption is consistent with total diesel sales, while estimated diesel consumption for all other diesel consuming modes remain unaffected (i.e. all the difference between estimated and outturn diesel consumption is attributed to HGVs).

  The adjustment of estimated petrol and diesel consumption for each mode will inevitably introduce a measure of distortion. However, by applying the diesel adjustment only to HGVs, the distortion introduced to HGV diesel consumption (and therefore emissions) is significantly larger than would be the case if the diesel adjustment were applied equally and proportionally across diesel consuming modes.

  The distortion of HGV emissions is so great that the estimated emissions are not suitable for year-on-year comparisons. For example, 2009 HGV emissions were scaled down by 9.1%, while 2010 HGV emissions were scaled down by only 0.5%. The scaled emissions estimates imply that HGV fleet CO_2 intensity increased from 757.6 gCO_2/km in 2009 to 836.9 gCO_2/km in 2010, a 10.5% increase. However, the underlying assumption (derived from a survey of haulage companies and reported in Department for Transport Road Freight Statistics) is that HGV fleet CO_2 intensity increased by only 0.5%.

Car emissions

Car emissions in 2010

The NAEI estimate of car emissions in 2010 is 67.4 $MtCO_2$, a 3.3% decrease on the 2009 estimate of 69.7 $MtCO_2$. The change in emissions can be accounted for by changes in total car travel, penetration of biofuels, and the fuel efficiency of the car fleet:

- Total car travel in 2010 was 401.6 billion vehicle km, a 2% decrease on 2009 levels of 410.1 billion vehicle km.
- Combined bioethanol and biodiesel penetration for cars increased from 2.1% (by energy) in 2009 to 3.2% in 2010.
- The implication of data on car emissions, total car travel and biofuels penetration is that the fuel efficiency of the fleet may have improved by 0.1% between 2009 and 2010.

The age profile of the fleet and historical time series of the CO_2 intensity of new cars suggests that the fuel efficiency of the fleet may have improved by 1.7% between 2009 and 2010. The change in fuel efficiency implied by the NAEI estimate of car emissions is not consistent with this figure. This reinforces our recommendation that the NAEI moves to a more rigorous estimation methodology.

Car emissions in 2011

We do not have estimates of car CO_2 emissions in 2011. However, there is provisional data on total car travel, biofuels penetration and new car CO_2:

- Total car travel in 2011 was 403.6 billion vehicle km, a 0.5% increase on 2010 levels of 401.6 billion vehicle km.
- Combined bioethanol and biodiesel penetration for cars increased from 3.2% (by energy) in 2010 to 3.3% in 2011.
- The CO_2 intensity of new cars in 2011 was 138.1 gCO_2/km, a 4.2% decrease on the 2010 value of 144.2 g/km, and a slightly greater reduction than in 2010. The age profile of the fleet and historical time series of CO_2 intensity of new cars suggests that the fuel efficiency of the fleet may have improved by 2.2% between 2010 and 2011.

The implication is that car CO_2 emissions in 2011 may have decreased by around 1.8% between 2010 and 2011.

This should be treated with caution given uncertainties over data on total car travel. In particular, changes in car distance travelled over the year as a whole cannot be explained simply through changes in fuel prices and income using standard elasticities (Box 5.2). This may reflect the preliminary nature of the data, or weather effects, or a structural change in car travel behaviour. We will return to this when final car travel data are published in 2013.

With this caveat on 2011 data, and wider caveats on emissions estimates, Figure 5.3 sets out the historical data on total car travel, CO_2 emissions and the resulting CO_2 intensity of the fleet.

Looking ahead, our indicator trajectory builds in annual car emissions reductions of 2.6% to 2020 from 2010 levels (Figure 5.2). The prospect of economic recovery and potential impacts on car purchase and travel behaviour highlight the need for close monitoring in this area, and possible use of fiscal levers if emissions do not fall as required. The CO_2 intensity of new car emissions will be the key driver of emissions reductions going forward (see Section 3 below).

Box 5.2: Drivers of surface transport emissions 2009-2011

The flattening of emissions in 2010 and initial indications of an increase in distance travelled in 2011 suggests there are risks to achieving the longer term indicator trajectory. It is therefore important that the drivers of emissions are monitored going forward, particularly among the largest emitters – cars, vans and HGVs. Figure B5.2 shows some key drivers of transport trends:

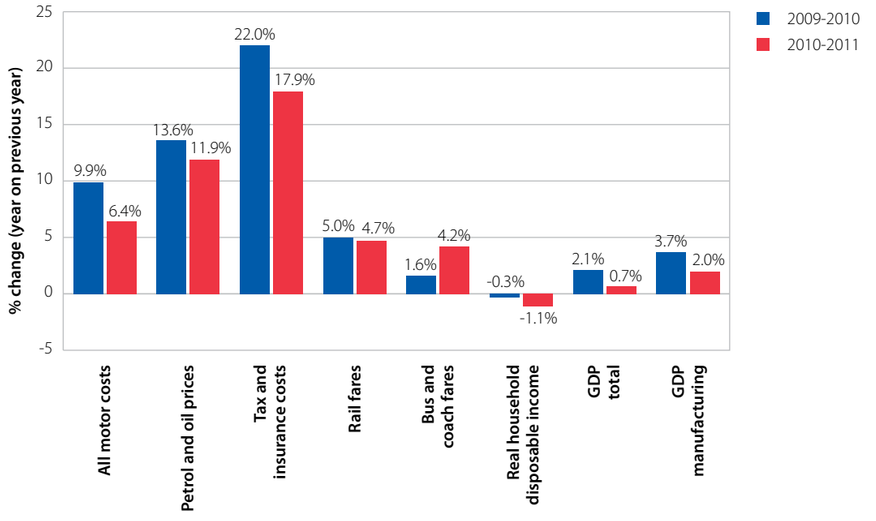
- Prices are taken from the transport components of the Retail Price Index (RPI). These relate to total motoring costs for both public and private transport. Motoring costs, driven by high petrol and oil prices and tax and insurance, grew by 9.9% in 2010, with a slight easing to 6.4% in 2011. Relative to rail fares and bus and coach fares, the overall cost of motor vehicle use rose in both 2010 and 2011.
- Several measures of income are shown: real household disposable income, total GDP and manufacturing output. While passenger demand is likely to be more strongly linked to the former, demand among vans is forecast using total GDP, and HGV demand using manufacturing output.

Rising motoring costs, combined with a fall in real household disposable incomes in 2010 are likely to have contributed to falling car travel demand in 2010. However, these drivers cannot explain all changes from year to year. The continuing fall in real household income in 2011, and strong fossil fuel prices were not enough to stem the positive car travel demand growth in 2011.

Although GDP recovered a little in 2010 and 2011, the continued high fuel prices runs counter to the estimated rise in van travel demand in 2011.

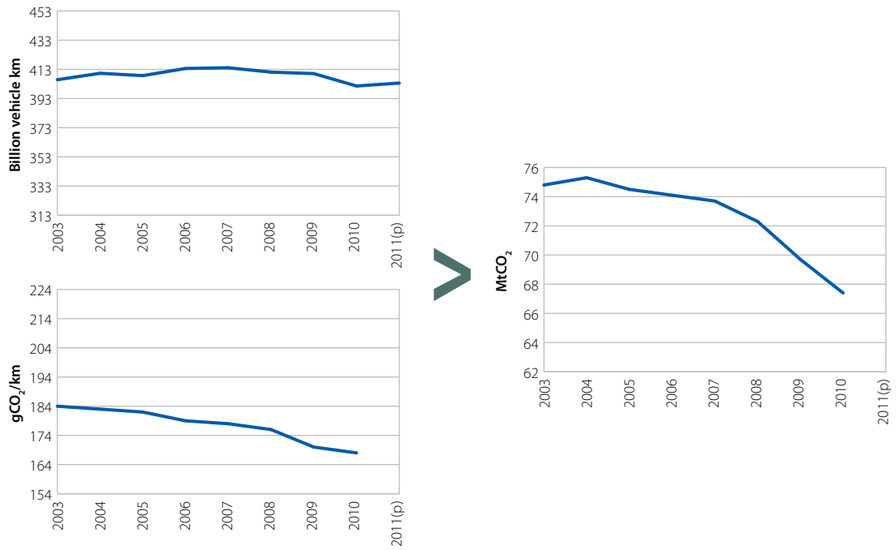
HGV travel is associated with manufacturing output which recovered more strongly than overall GDP in both 2010 and 2011. This would be expected to dominate the price effect for this mode, which is consistent with the outturn data.

Figure B5.2: Economic drivers of transport trends (2009-2011)



Source: Office of National Statistics; DfT (2012), Transport Statistics Great Britain 2011.
Notes: GDP deflated by GDP deflator; disposable income deflated by the NPISH final consumption deflator, as published in the ONS Economics Accounts.

Figure 5.3: Historical trends of vehicle km, $MtCO_2$ and gCO_2/km for cars (2003-2011)



Source: NAEI (2012); DfT (2012), Transport Statistics Great Britain 2011.

Van emissions

Van emissions in 2010

The NAEI estimate of van emissions in 2010 is 15.1 $MtCO_2$, a 0.5% increase on the 2009 estimate of 15.0 $MtCO_2$. The change in emissions can be accounted for by changes in total van travel, penetration of biofuels, and the fuel efficiency of the van fleet:

- Total van travel in 2010 was 68.8 billion vehicle km, a 0.9% increase on 2009 levels of 68.2 billion vehicle km.
- Combined bioethanol and biodiesel penetration for vans remained constant at 3.9% (by energy) in 2010.
- The implication of data on van emissions, total van travel and biofuels penetration is that the fuel efficiency of the fleet may have improved by 0.5% between 2009 and 2010.

The age profile of the fleet and historical time series of the CO_2 intensity of new vans suggests that the fuel efficiency of the fleet may have improved by at least 0.4% between 2009 and 2010. The change in fuel efficiency implied by the NAEI estimate of van emissions is consistent with this figure.

Van emissions in 2011

We do not have estimates of van CO_2 emissions in 2011. However, there is provisional data on total van travel, biofuels penetration and CO_2 intensity of new vans:

- Total van travel in 2011 was 70.9 billion vehicle km, a 3.0% increase on 2010 levels of 68.8 billion vehicle km. As for car travel, this change cannot be explained simply in terms of fuel price and income changes, and should be regarded as uncertain until final data are available.
- Combined bioethanol and biodiesel penetration for vans decreased slightly from 3.9% (by energy) in 2010 to 3.4% in 2011.
- The CO_2 intensity of new vans was 195 gCO_2/km in 2011, a 0.5% decrease on the 2010 value of 196 gCO_2/km, and a smaller reduction than in 2010. The age profile of the fleet and limited historical time series of CO_2 intensity of new vans suggests that the fuel efficiency of the fleet is likely to have improved by at least 0.5% between 2010 and 2011.

These factors imply that van emissions may have increased by up to 3.1% between 2010 and 2011.

Figure 5.4 sets out the historical data on total van travel, CO_2 emissions and the CO_2 intensity of the fleet.

In order to ensure that van emissions are reduced in future, the key driver will be lower CO_2 intensity of new vans; we consider approaches to reducing new van emissions in Section 4 below.

HGV emissions

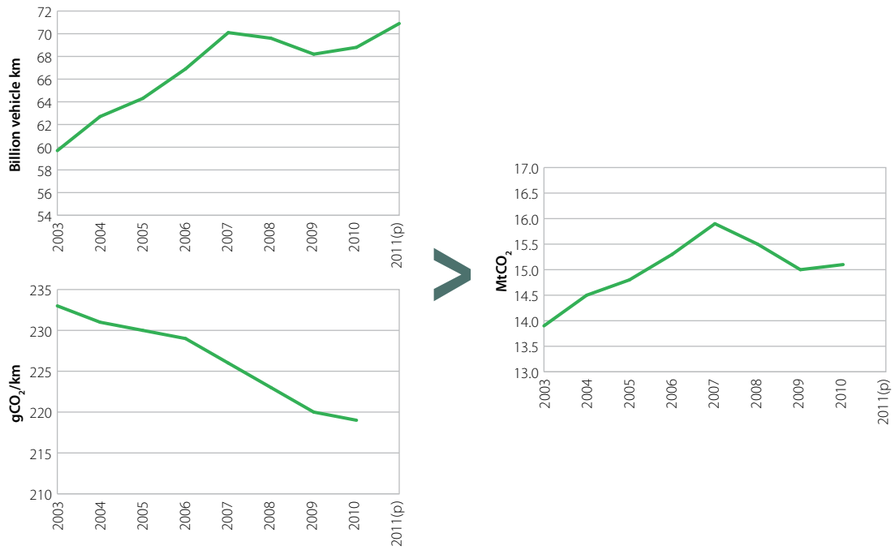
HGV emissions in 2010

The NAEI estimate of HGV emissions in 2010 is 22.9 $MtCO_2$, a 10.9% increase on the 2009 estimate of 20.7 $MtCO_2$. The change in emissions can be accounted for by changes in total HGV travel, penetration of biofuels, and the fuel efficiency of the van fleet:

- Total HGV travel in 2010 was 27.4 billion vehicle km, a 0.4% increase on 2009 levels of 27.3 billion vehicle km.
- Biodiesel penetration for HGVs decreased slightly from 4.0% (by energy) in 2009 to 3.9% in 2010.
- The implication of data on HGV emissions, total HGV travel and biofuels penetration is that the fuel efficiency of the fleet may have worsened by 10.4% between 2009 and 2010.

The survey of haulage companies reported in Department for Transport (DfT) Road Freight Statistics indicates that the CO_2 intensity of the HGV fleet increased by around 0.5% in 2010. The change in fuel efficiency implied by the NAEI estimate of car emissions is not consistent with this figure. This reinforces our recommendation that the NAEI moves to a more rigorous estimation methodology.

Figure 5.4: Historical trends of vehicle km, $MtCO_2$ and gCO_2/km for vans (2003-2011)



Source: NAEI (2012); DfT (2012), Transport Statistics Great Britain 2011.

HGV emissions in 2011

We do not have estimates of HGV CO_2 emissions in 2011. However, there is provisional data on total HGV travel and biofuels penetration:

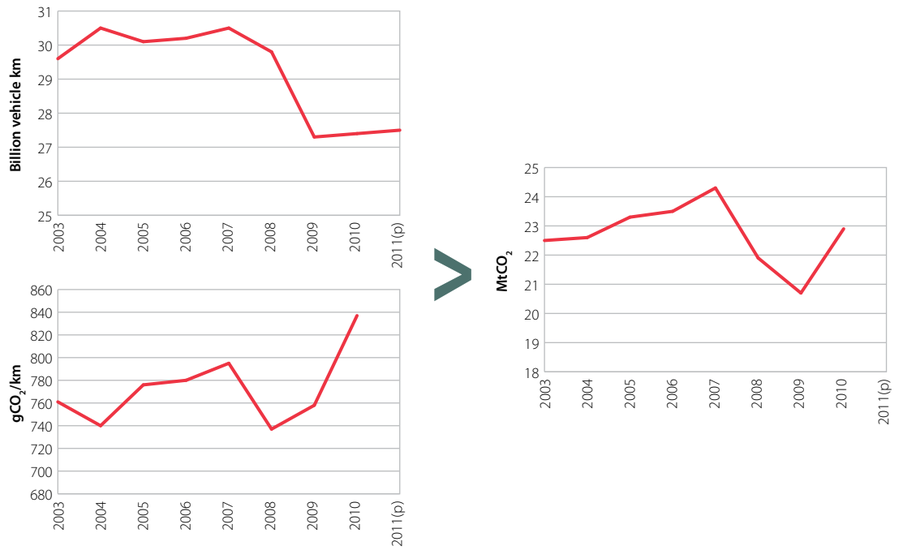
- Total HGV travel in 2011 was 27.5 billion vehicle km, a 0.3% increase on 2010 levels of 27.4 billion vehicle km. This suggests that the impact of the increase in manufacturing output may have more than offset any immediate impacts of higher fuel prices, and possibly longer-term impacts of the recession.
- Biodiesel penetration for HGVs decreased from 3.9% (by energy) in 2010 to 3.4% in 2011.
- We do not have data on the CO_2 intensity of the HGV fleet in 2011.

If there was no change in CO_2 intensity between 2010 and 2011, HGV emissions may have increased by up to 0.8% between 2010 and 2011.

Figure 5.5 sets out the historical data on total HGV travel, CO_2 emissions and the implied CO_2 intensity of the fleet.

The increase in HGV emissions in 2010 and likely increase in 2011 were driven by increased distance travelled as a result of the pickup in manufacturing growth. Our progress indicators for HGVs allow for increased distance travelled but require HGV emissions reductions of around 1.3% per year between 2010 and 2020, through a combination of more efficient vehicles and increased biofuels penetration. The apparent worsening of HGV efficiency is potentially a cause for concern, and warrants close monitoring to determine whether this is due to less efficient vehicles and driving, or a trend towards vehicles with larger capacities and/or higher load factors.

Figure 5.5: Historical trends of vehicle km, $MtCO_2$ and gCO_2/km for HGVs (2003-2011)



Source: NAEI (2012); DfT (2012), Transport Statistics Great Britain 2011.

Over the longer term, it will be important to measure HGV emissions and to establish a regulatory framework for the reduction of new HGV emissions, as exists for cars and vans. This is more challenging than for cars and vans due to the heterogeneity of the HGV market, and the impact of load factors on emissions. Nevertheless, the European Commission recognises the need to address this issue and is due to report on a strategy and methodology for measurement of HGV emissions by early 2013.

Motorcycle emissions

The NAEI estimate of motorcycle CO_2 emissions is 0.56 $MtCO_2$ in 2010, a 9.1% decrease on the 2009 level of 0.61 $MtCO_2$.

In 2010 motorcycle emissions comprised around 0.5% of all surface transport emissions. Motorcycle CO_2 emissions increased by over 20% between 2000 and 2007, but have decreased by around 16% between 2007 and 2010, with motorcycle distance travelled also decreasing by 16%.

Public transport emissions

Public transport emissions increased in 2010, as both bus and rail (direct) emissions rose.

- The NAEI estimate of bus emissions in 2010 is 4.72 $MtCO_2$, a 0.7% increase on the 2009 estimate of 4.69 $MtCO_2$.

- Rail (direct) emissions increased by around 1.5% in 2010, from 1.97 $MtCO_2$ in 2009 to 2.00 $MtCO_2$ in 2010, driven largely by an increase in demand for passenger trains; indirect emissions from electricity generation used in transport are accounted for in Chapter 2.

(ii) Emissions from aviation and shipping

Aviation emissions

Aviation CO_2 emissions (measured on a bunker fuels basis) fell by 5% in 2010. Both international and domestic emissions fell (Figure 5.6):

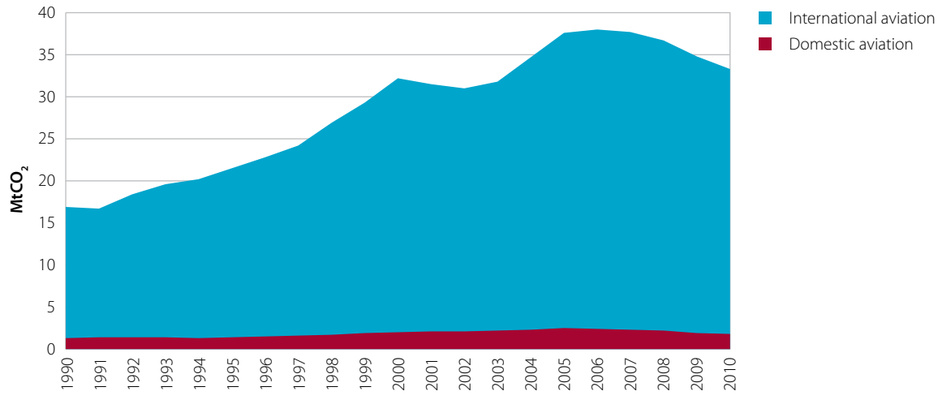
- Domestic aviation CO_2 emissions fell by 8%, from 1.9 $MtCO_2$ to 1.8 $MtCO_2$.
- International aviation CO_2 emissions fell by 4%, from 32.9 $MtCO_2$ to 31.5 $MtCO_2$.

These reductions reflect the 3% fall in passenger numbers in 2010 following the recession. Since emissions fell 5%, this implies some improvement in carbon intensity in 2010 (e.g. due to higher loading factors).

In 2011 passenger numbers rose by 4%, with short-haul demand increasing by 5% and long-haul demand by 2%, suggesting that aviation emissions are also likely to have risen.

In future, whilst net emissions will be constrained given that aviation is now included within the EU Emissions Trading System (ETS) (Box 5.3), gross emissions are projected to continue rising. Gross emissions can be reduced in the longer term through a combination of improvements in fuel efficiency, use of biofuels, and moderations to demand growth. In our recent advice to the Government (Box 1.7 in Chapter 1), we suggested an appropriate planning assumption was for gross UK aviation emissions in 2050 to be at around 2005 levels.

Figure 5.6: UK aviation CO_2 emissions (1990-2010)



Source: NAEI (2012).

Shipping emissions

Shipping CO_2 emissions (measured on a bunker fuels basis) fell by 11% in 2010. Both international and domestic emissions fell (Figure 5.7):

- Domestic shipping CO_2 emissions fell by 2%, to 2.4 $MtCO_2$.
- International shipping CO_2 emissions fell by 13%, from 10.1 $MtCO_2$ to 8.7 $MtCO_2$

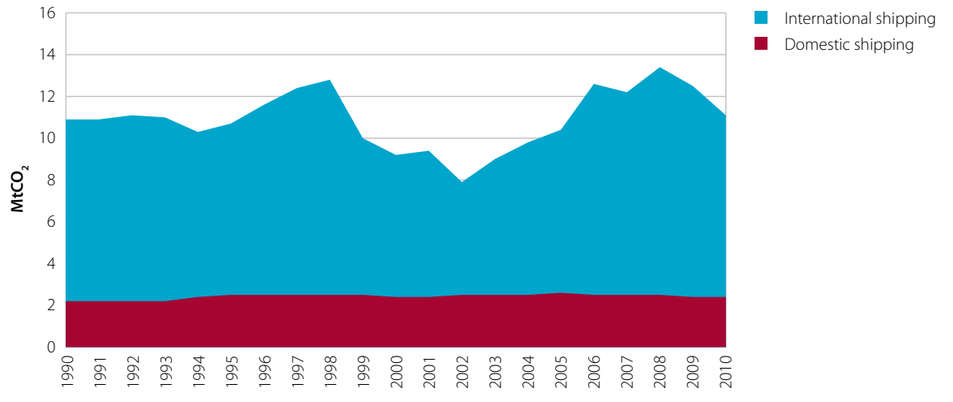
In 2010 UK cargo demand rose by 3%, implying that the fall in emissions was due to either reductions in the carbon intensity of shipping or changes in bunkering patterns.

Carbon intensity of shipping is likely to have fallen significantly in 2010, as speed reductions were widely implemented in order to match oversupply of ships with reduced demand during the recession (a 10% reduction in speed can reduce emissions by up to around 20%). Globally, average speeds in 2010 were around 9% lower than in 2009 and 20% lower than in 2008[1].

In November 2011 we published a review of UK shipping emissions. This highlighted scope to significantly reduce UK shipping emissions to 2050 (e.g. by up to around 65% below current levels), taking into account projections of future demand and abatement potential.

Currently agreed international policies (i.e. the IMO's EEDI – see Box 5.3) will not unlock the full range of abatement potential identified, and therefore more ambitious international policies should be implemented to realise potential for long-term emissions reduction.

Figure 5.7: UK shipping CO_2 emissions (1990-2010)



Source: NAEI (2012).

1 Sources: UNCTAD (2010), Review of Maritime Transport 2010, PWC (2011) A game changer for the shipping industry?

Box 5.3: Recent policy developments in aviation and shipping

At the **international level**, in July 2011 the International Maritime Organisation (IMO) agreed new regulations (the Energy Efficiency Design Index) setting minimum efficiency standards for new ships. The International Civil Aviation Organisation (ICAO) agreed to accelerate work on global market based measures for aviation, for consideration in 2013.

At the **EU level**, in January 2012 aviation entered into the EU ETS and the European Commission launched a consultation on EU policy approaches for reducing emissions from shipping.

At the **UK level**, in April 2012 the Committee advised that emissions from international aviation and shipping should now be included within the UK framework of carbon budgets (see Box 1.7, Chapter 1). Under the Climate Change Act the Government must make a decision on inclusion by the end of 2012; a new aviation strategy is expected to be published by the Government in Summer 2012.

2. Opportunities for reducing emissions – the indicator framework

We now recap our transport indicator framework before considering progress against indicators. The framework reflects measures that are either cost-effective now, or are required on the path to deeper decarbonisation in the 2020s:

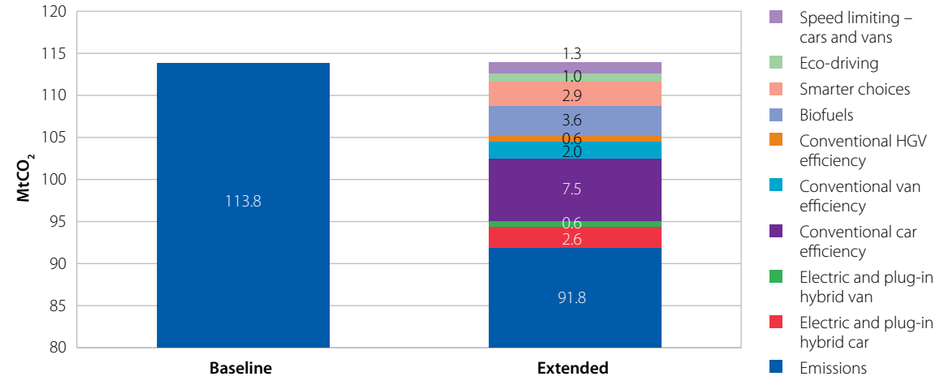
Surface transport emissions indicators

- In our indicator framework, car emissions fall to 51 $MtCO_2$ in 2020, and the CO_2 intensity of the car fleet falls to 121 gCO_2/km in 2020.
- Van emissions fall to 16 $MtCO_2$ in 2020, and the CO_2 intensity of the van fleet falls to 176 gCO_2/km in 2020.
- HGV emissions fall to 21 $MtCO_2$ in 2020, and the CO_2 intensity of the HGV fleet falls to 648 gCO_2/km in 2020.

Fuel/carbon efficiency of vehicles

- In our indicator framework, CO_2 intensity of new cars falls to an average of 95 gCO_2/km in 2020 in line with the EU new car CO_2 regulation target. We envisage that electric vehicles will contribute to meeting this target. Excluding electric vehicles, CO_2 intensity of conventional new cars falls to 110 gCO_2/km by 2020.
- The CO_2 intensity of new vans falls to an average of 147 gCO_2/km in 2020 in line with the EU new van CO_2 regulation target. Again we envisage that electric vehicles contribute to meeting this target. Excluding these, the CO_2 intensity of conventional new vans falls to 169 gCO_2/km by 2020.
- Battery electric and plug-in hybrid car penetration reaches 1.7 million vehicles in 2020 (5% of all cars and 16% of new cars).
- Battery electric and plug-in hybrid van penetration reaches 135,000 in 2020 (4% of all vans and 16% of new vans).
- The CO_2 intensity of new HGVs decreases by 6-9% between 2008 and 2020.
- Biofuels penetration increases to 8% (by energy) by 2020, in line with recommendations in the Gallagher Review.

Figure 5.8: Extended Ambition Surface Transport emissions reductions in 2020



Source: CCC modelling.

Behaviour change

- Implementation of Smarter Choices initiatives nationwide results in a 5% reduction in car travel by 2020.
- There is wide-scale uptake of eco-driving through training, with 10% of car and van drivers and 100% of HGV drivers trained by 2020.
- Speed limits are enforced at current levels. For example, if the existing 70 mph speed limit were strictly enforced, this could reduce emissions by 1.3 $MtCO_2$ in 2020.

If all indicators were to be achieved in practice, this would result in a 20% reduction in transport emissions from the 2020 baseline (Figure 5.8). Whether we are on track to deliver this emissions reduction depends on progress relative to indicators, which we now consider.

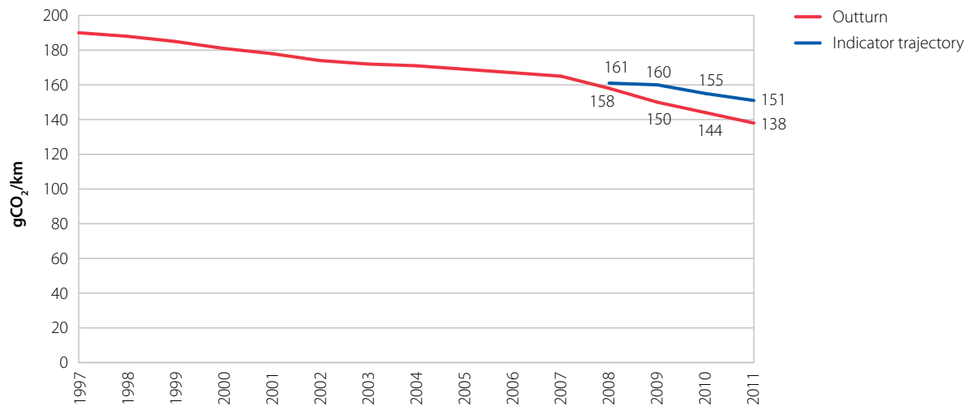
3. Progress in reducing car emissions

A reduction in car emissions is primarily achieved through renewal in the car fleet; our analysis suggests that replacement of old inefficient cars with increasingly efficient new cars offers scope for a 2.5% annual improvement in the CO_2 intensity of the car fleet between 2010 and 2020.

Strong progress in recent years on new car efficiency improvement continued in 2011 (Figure 5.9), although the impact of this on fleet efficiency was dampened due to low sales of new cars:

- CO_2 intensity of new cars fell from 149.5 gCO_2/km in 2009 to 144.2 gCO_2/km in 2010 (a 3.5% reduction), and to 138.1 gCO_2/km in 2011 (a further 4.2% reduction).
- Our indicator for 2011 – consistent with progress towards a 95 gCO_2/km target in 2020 – is 151.0 gCO_2/km.

Figure 5.9: New Car CO_2 – indicator trajectory and outturn (1997-2011)



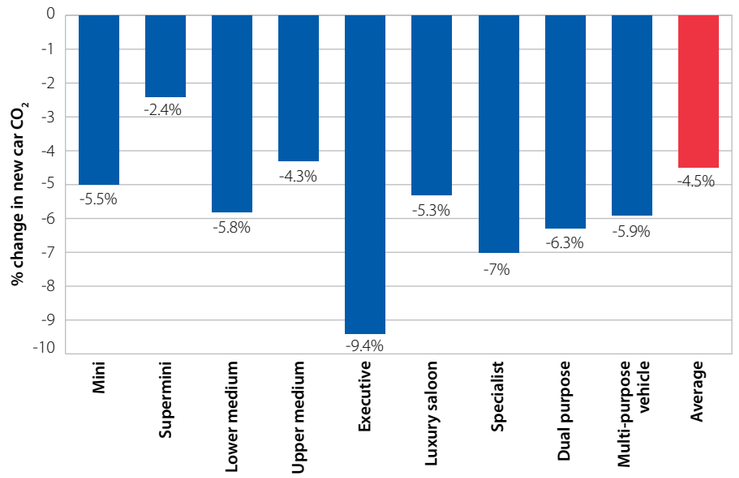
Source: SMMT, CCC modelling.

- Therefore CO_2 intensity of new cars is currently out-performing our indicator, by around 9% in 2011.
- However, one note of caution is that new car sales fell from 2.0 million units in 2010 to 1.9 million units in 2011, compared to average sales of 2.5 million units prior to the recession (2002-2007).

The reduction in CO_2 intensity of new cars across all car classes was partially offset by a shift towards purchase of larger, higher-emitting cars in 2011:

- CO_2 intensity of new cars fell across all car classes in 2011, with the reduction ranging from 2.4% for superminis to 9.4% for executive saloons (Figure 5.10). The significant improvement in CO_2 intensity of executive saloons was influenced by an increase in the share of diesel vehicles in this market segment.
- Reduction in average CO_2 intensity of new cars due to technological improvement occurs when newer, lower emitting car models are released on the market and older, higher emitting models reach the end of their product cycle and are retired from the market. There was a reduction in average CO_2 of new models in the majority of market segments in 2010, with an average reduction across all market segments of around 5%.

Figure 5.10: Change in gCO_2/km for each car segment (2011)



Source: SMMT.

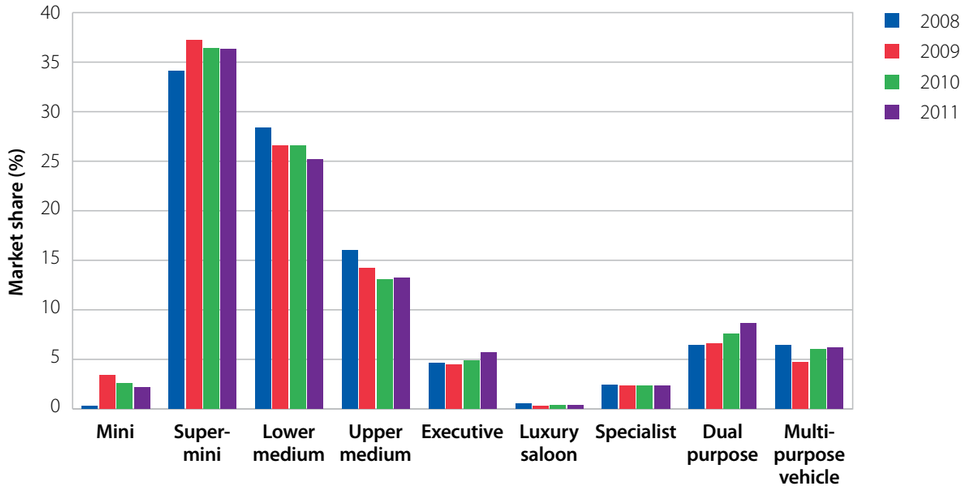
- There was a slightly higher share of larger, higher-emitting cars in the total in 2011, which offset some of the in-class efficiency improvement:
  - There was a small increase (around 2.1%) in the market share of cars in the higher-emitting upper medium and large segments, with a corresponding decrease (around 1.9%) in the share of cars in the lower-emitting mini, supermini and lower medium segments (Figure 5.11).
  - The net effect of this upsizing in 2011 is to reduce the improvement in CO_2 intensity of new cars by 0.3% (i.e. had the share of car sales in each class remained at their 2010 levels, the reduction in CO_2 intensity of new cars would have been around 4.6% in 2011, rather than the actual 4.2% reduction).

This continues a similar pattern in 2010, and represents a departure from 2009, when the reduction in CO_2 intensity of new cars was due both to efficiency improvements within class and switching between classes.

Going forward, there remains scope for CO_2 intensity of new cars to be reduced both due to within-class efficiency improvements and switching between classes. As the economy recovers, there is a risk that previous shifts in purchase behaviour could be reversed. Financial incentives, such as further differentiation in Vehicle Excise Duty (VED), increased VED and higher fuel duty may be required in future if progress in reducing car emissions is to be sustained.

We will continue to track the CO_2 intensity of new cars and highlight appropriate actions to support continued progress by encouraging demand for more efficient vehicles, thereby encouraging suppliers to bring more efficient models to market.

Figure 5.11: Market share of new car segments



Source: SMMT.

4. Progress in reducing van emissions

There is scope to reduce total van emissions in 2020 by around 2% from 2010 levels (in the context of an expected 28% increase in van km), mainly due to fleet efficiency improvement as old inefficient vans are replaced with increasingly efficient new vans. In particular, there is scope to increase new van efficiency through downsizing with turbo-charging and/or hybridisation.

The context for new van emissions reductions is the EU new van CO_2 target: in May 2011, the EU agreed a target to reduce the average CO_2 intensity of new vans to 175 gCO_2/km by 2014, and to 147 gCO_2/km by 2020.

The CO_2 intensity of new vans in the UK fell 0.5% from 196 gCO_2/km in 2010 to 195 gCO_2/km in 2011.

Although this reduction is small relative to that required to meet the 2020 target, it is not of immediate concern given that the target was only recently agreed, and that there is a lead time for industry and consumer responses. In addition, evidence suggests that it remains technically feasible to go well beyond the agreed target (e.g. to 125 gCO_2/km in 2020[2]).

However, acceleration in the pace of the reduction in the CO_2 intensity of new vans will be required, and we will monitor this closely. At this stage, the possibility that further levers may be required to encourage uptake of more efficient vans, and the emissions reductions that these offer, should not be ruled out.

2 AEA (2009), Assessment of options for CO_2 legislation for light commercial vehicles.

5. Progress in developing electric vehicle markets

In previous reports we have identified deployment of ultra-low emission vehicle (ULEV) technologies (battery electric, plug-in hybrid electric or hydrogen fuel cell vehicles) as key to achieving the deep emission cuts required to meet the 2050 emissions reduction target.

Most recently, analysis presented in support of our advice regarding inclusion of international aviation and shipping in carbon budgets suggested that it is technically feasible and economically desirable that all light duty vehicles should be ULEVs by 2050.

Based on this analysis, we recommended that this should be the current planning assumption, with the implication that 100% of new cars and vans purchased will need to be ULEVs by the mid 2030s, and requiring progress to be made now developing ULEV markets in order to prepare for this. The relative technical maturity of battery electric and plug-in hybrid electric vehicles implies that support for an early-stage electric vehicle market is now critical.

The Government has accepted this advice, and is supporting electric vehicle market development both through providing subsidy for purchase of electric vehicles, and through funding investment in battery-charging networks:

- **Price support.** The Government confirmed its support for the plug-in car grant in the 2010 Spending Review. This grant, which came into effect in January 2011, provides consumers and businesses with up to £5,000 towards the purchase of an eligible electric car. In 2011 892 claims were made through the scheme. In January 2012 this support was extended to vans, for which up to £8,000 will be provided for each eligible electric van.
- **Infrastructure investment.**
  - **Plugged-In Places.** As a first step towards developing a national system of recharging infrastructure, the Government is supporting the Plugged-In Places initiative to pay for battery-charging infrastructure. The Government is currently supporting eight Plugged-In Places programmes in the East of England, Greater Manchester, London, the Midlands, Milton Keynes, the North East, Northern Ireland and Scotland.
  - **Government charging strategy.** In June 2011 the Government published its strategy for the provision of recharging infrastructure. This sets out a vision in which the majority of recharging takes place at home (at night, after the peak in electricity demand), supported by workplace recharging for commuters and fleets, and additional charging provided by a limited public infrastructure deployed in areas of highest use. It also sets out actions the Government is taking towards delivering this vision, including removal of regulatory barriers to installation of charge points, rationalisation of incentives for chargepoint operators, improvement of the functionality of the early-stage charging infrastructure and market, and provision of data to consumers and chargepoint operators.

Sales of electric cars were around 1,100 vehicles in 2011, an increase over 2010 sales of around 170 vehicles. Although this is still very low relative to what is required over the next decade (e.g. a total of around 1.7 million electric vehicles by 2020), it can be explained by the initial high cost of the vehicles (only partly offset by the plug-in car grant), the limited range of models on the market in 2011 (Box 5.4), limited investment in public charging infrastructure, and initial consumer caution towards what may be perceived as a new and radically different technology.

There has been good progress both in development of public charging infrastructure, and in development of new electric vehicle models:

- Plugged-In Places delivered a total of around 2,000 chargepoints in the period to the end of March 2012. This period has also seen significant investment in privately delivered chargepoints, with a total of around 4,000 delivered to the end of March 2012. It is likely that the Plugged-In Places programme has facilitated investment in privately delivered chargepoints by providing the private sector with confidence in the existence of a market for electric vehicles and the viability of battery-charging business models.
- As of June 2012, there are 10 electric car models currently available on the UK market, and a considerable range of models is currently under development and due to come to market in the near future. In addition, a number of electric van models reached the UK market in 2012 (Box 5.4).

Box 5.4: Current and near-term electric vehicle releases

As of June 2012, the following electric car models are currently available on the UK market (Table B5.4.1):

Table B5.4.1: Electric car models currently available on the UK market

Brand	Model	Type	UK launch date
Citroen	CZero	BEV	2011
Mitsubishi	i-MiEV	BEV	2011
Nissan	Leaf	BEV	2011
Peugeot	iOn	BEV	2011
Smart	Electric Drive	BEV	2011
Renault	Fluence ZE	BEV	2012
Toyota	Prius (Plug-in)	PHEV	2012
Chevrolet	Volt	PHEV (RE)	2012
Vauxhall	Ampera	PHEV (RE)	2012
Fisker	Karma	PHEV (RE)	2012

Notes: BEV = Battery Electric Vehicle; PHEV = Plug-in Hybrid Electric Vehicle. RE refers to "Range Extended", a type of plug-in hybrid that is powered exclusively by the electric motor, with a petrol or diesel internal combustion engine and on-board generator to generate additional electricity when battery has been depleted. The Smart Electric Drive was available for leasing only in 2011 and for purchase in 2012.

In addition to these, options to purchase electric cars include a number of small cars formally classed as quadricycles, and third party electric conversions.

Box 5.4: Current and near-term electric vehicle releases

Furthermore, a considerable range of new electric car models are currently under development and due to come to market in the near future (Table B5.4.2):

Table B5.4.2: Electric car models currently under development

Brand	Model	Type	Expected UK launch date
Ford	Focus Electric	BEV	2012
Mercedes-Benz	E-Cell	BEV	2012
Renault	Zoe	BEV	2012
Tesla	Model S	BEV	2012
Volvo	V60 Hybrid (Plug-in)	PHEV	2012
Audi	E-Tron	BEV	2013
BMW	i3	BEV	2013
VW	Golf	BEV	2013
VW	e-Up	BEV	2013
Ford	Mondeo Energi	PHEV	2013
Ford	C-Max Energi	PHEV	2013
Hyundai	i30 plug in hybrid	PHEV	2013
VW	Golf	PHEV	2013
Fisker	Surf	PHEV (RE)	2013
Fisker	Atlantic	PHEV (RE)	2013
BMW	i8	PHEV	2013-14
Porsche	918 plug in hybrid	PHEV	2013-14
Jaguar	cx75	PHEV (RE)	2013-2015

Notes: BEV = Battery Electric Vehicle; PHEV = Plug-in Hybrid Electric Vehicle. RE refers to "Range Extended".

As of June 2012, there are a number of electric van models available on the UK market. DfT's list of vans eligible for the Plug-in Van Grant comprises the Azure Dynamics Transit Connect Electric, Daimler Mercedes-Benz Vito E-Cell, Faam ECOMILE, Faam JOLLY 2000, Mia U, Renault Kangoo and Smith Edison electric vans.

As with cars, options to purchase electric vans include a number of small electric vans formally classed as quadricycles, and third party electric conversions.

Source: Society of Motor Manufacturers and Traders (SMMT).

Budget 2012 announced that from 2015/16 zero and ultra-low emission cars will no longer be exempt from Company Car Tax, or from Business Cars First Year Allowance (for leasing firms). This could have a significant impact on purchases (e.g. removal of the company car tax exemption could increase the cost of electric vehicles by around £2,000 compared to conventional alternatives). Given the promise of this sector, the need for early take up of electric vehicles, and the very limited revenue generated by the Budget changes, we strongly recommend that the Government should reverse this decision. The Company Car Tax and Business Cars First Year Allowance exemption for electric vehicles should be extended to support the development of the electric vehicle market.

6. Progress on biofuels in surface transport

There is an important medium-term role for the use of sustainable biofuels in meeting carbon budgets. This is reflected in our indicator for road transport biofuels penetration of 8% by energy (10% by volume) in 2020.

Whilst in 2011 road transport biofuels penetration remained roughly constant at 2010 levels of around 3.5% (by volume), this is still broadly on track to meet our indicator for 2020.

The key issue on biofuels, and bioenergy more generally, is to ensure that this supply is sustainable. Our Bioenergy Review in 2011 considered sustainability in detail, and concluded that there is a near- to- medium-term risk that biofuels will result in limited lifecycle emissions reduction (or even increased emissions) because of indirect land use impacts. We recommended in the Review that sustainability criteria for biofuels are strengthened to ensure that indirect land use impacts are minimised. The Government reached a similar conclusion in its Bioenergy Strategy.

It is important now that the Government works with the EC to ensure that safeguards are introduced to complement the existing sustainability framework (which is focused on direct land use impacts), such that this also limits risks of indirect land use impacts.

The EC is due to review the minimum greenhouse gas emission saving thresholds to apply in the Renewable Energy Directive (RED) and assess the feasibility of reaching the RED target whilst ensuring the sustainability of biofuels production in the Community and in third countries by the end of 2014.

In the longer term, the analysis in our Bioenergy Review suggested a very limited role for use of biofuels in surface transport. Given scope for ultra-low emission vehicles, scarce bioenergy should be used in sectors where alternatives for decarbonisation are limited (e.g. industry, aviation) or in conjunction with CCS technology.

This analysis has been reinforced both by the Government's Bioenergy Strategy, which reached similar conclusions on availability of sustainable bioenergy, and by further analysis in our advice on inclusion of international aviation and shipping emissions in carbon budgets, which provided more confidence about the long-term viability of electric vehicles.

7. Progress in changing travel behaviour

(i) Smarter Choices

Smarter Choices refers to a range of measures that address psychological motivations for travel choice with the effect of reducing levels of car use (in contrast to alternative measures such as development of transport infrastructure or services, enforcement of travel behaviour or changes to economic incentives).

Smarter Choices measures include:

- Workplace and school travel plans
- Personalised travel planning
- Public transport information and marketing
- Travel awareness campaigns
- Car clubs
- Car sharing schemes
- Teleworking, teleconferencing, and home shopping
- Cycling and walking information, marketing, training and events.

Evidence from DfT's Sustainable Travel Towns project indicates that a sustained package of Smarter Choices measures could reduce total car travel by 5-7%[3]. This underpinned our recommendation that Smarter Choices initiatives should be rolled out across all urban areas in the UK by 2020. Accordingly, we factor a 5% reduction in car travel in our indicators for car km by this date.

In 2011 DfT announced the creation of the £560 million Local Sustainable Transport Fund (LSTF) with the twin objectives of supporting the local economy and facilitating economic development, and reducing carbon emissions.

This fund could support Smarter Choices projects, and a preliminary assessment of the first phase of funding, allocated in June 2011, suggests that this is the case.

However, the funding is only sufficient to roll out Smarter Choices to around 25% of the UK by 2015. This implies the need for further funding, if Smarter Choices is to be fully rolled out and potential emissions reductions of around 3 $MtCO_2$ in 2020 achieved.

3 Sloman et al. (2010), The Effects of Smarter Choice Programmes in the Sustainable Travel Towns: Research Report.

(ii) Eco-driving

Eco-driving (i.e. adoption of more efficient driving techniques such as smooth acceleration and braking, driving at optimal speeds, use of cruise control, engine braking) could make an important contribution to reducing the CO_2 intensity of vehicles.

In 2011, 7,892 drivers were trained under the Energy Saving Trust's Smarter Driving Programme, down from 9,704 in 2010. The pace of roll out is still very low relative to the 300,000 drivers to be trained annually if an emissions reduction of 1.2 $MtCO_2$ for eco-driving is to be achieved by 2020. Given this very limited progress, the Government should consider including this as a key element of the practical driving test, and consider options to increase eco-driving training and other opportunities to provide information on fuel consumption and other benefits of eco-driving.

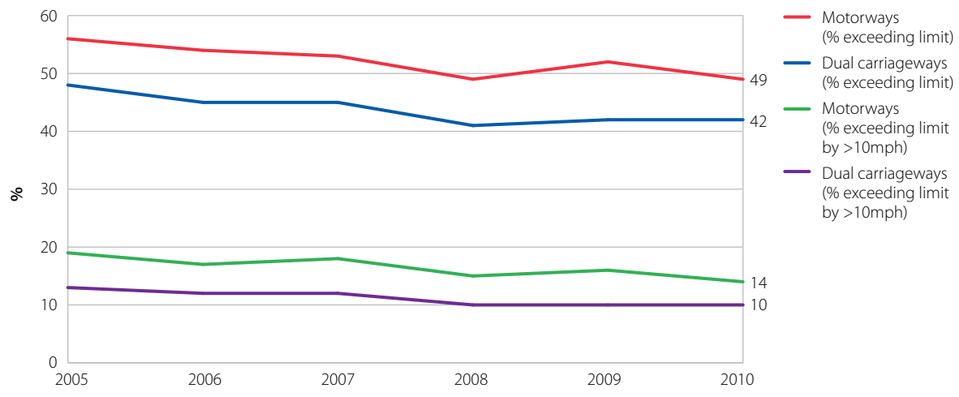
(iii) Speed limits and their enforcement

DfT statistics indicate that speed limits are exceeded by a high proportion of drivers on motorways (49%) and dual carriageways (42%) (Figure 5.12). This offers an opportunity for reducing emissions through enforcing the current speed limit, given the significant decline in fuel efficiency as car speed increases from 70 to 80 mph. Conversely, if the speed limit were to be increased, fuel efficiency would further decline, increasing emissions.

In October 2011 the Government announced their intention to consult on raising the national speed limit on motorways in England and Wales from 70 to 80 mph from 2013. The proposed change would apply to cars and motorcycles, and potentially to vans, could apply to other high-standard, near-motorway dual carriageways and would be initially trialled on sections of the motorway network with variable speed limits.

The rationale for the consultation is that raising the speed limit could result in economic benefits in terms of travel time savings, that current behaviour of a large part of the population would be legalised, and that the speed limit should reflect technological advances in the safety of cars since the current national speed limit was set in 1965.

Figure 5.12: Speeding on motorways and dual carriageways



Source: DfT (2011), Speeds Statistics 2010.

This would be problematic from a carbon budget perspective, given that it would result in significantly higher emissions than the alternative of enforcing the current speed limit (e.g. up to 3.5 $MtCO_2$ in 2020 compared to a situation where the speed limit is increased nationally, which is more than the emission savings from key policies such as the Energy Company Obligation, see Chapter 3), and would provide a negative signal about the Government's commitment to reducing emissions more generally.

Given the importance of reducing car and van emissions, and the opportunity that exists, we recommend that the Government should consult on enforcing the existing speed limit, and should provide a full analysis of the costs and benefits that this would entail.

(ii) Transport and land-use planning

We have previously identified a range of land-use factors associated with a reduction in car travel (Box 5.5), and have advised that the Government should develop an integrated planning and transport strategy to ensure that future development contributes as far as possible to delivering low levels of traffic and transport emissions.

Box 5.5: Land use factors associated with a reduction in car travel

Car travel originating from new housing development can be reduced by locating the development

- in settlements:
  - of sufficient size (with a minimum of 25,000 population and, if possible, larger than this);
  - that are self-contained having both a relatively high jobs/worker ratio and sufficient facilities;
  - in areas where the size and proximity (or more strictly accessibility) of other settlements is relatively low;
  - not served by the main inter-urban routes, or at least where the relative accessibility to other settlements by public versus private transport is high;
  - with relatively high house prices, to reduce 'enforced' inter-town commuting, (e.g. London workers 'displaced' to commute from somewhere like Reading, whereupon workers in Reading are further pushed out to places such as Swindon)
  - with high population density.
- in districts:
  - with sufficient proximity to frequent bus services;
  - within walking distance of amenities.

Car travel originating from new housing development can also be reduced by restricting parking spaces in new development to reduce the incentives for residents to own cars.

Car travel originating from new commercial development can be reduced by locating the development within town centres, rather than edge-of-centre or out-of-town locations.

Source: Commission for Integrated Transport (2009), Land use and Transport – Settlement Patterns and the Demand for Travel; Dargay (2009), Land Use and Mobility in Britain.

The new National Planning Policy Framework (NPPF) was published in March 2012. The NPPF sets out the Government's planning policies for England and how these are expected to be applied, and replaces all previous planning guidance.

The NPPF states that "a core land-use planning principle that should underpin both plan-making and decision-taking is that planning should actively manage patterns of growth to make the fullest possible use of public transport, walking and cycling, and focus significant development in locations which are or can be made sustainable." However, the NPPF does not provide specific guidance on how low levels of traffic and transport emissions can be delivered through the planning system.

Instead the NPPF aims to provide "a framework within which local people and their accountable councils can produce their own distinctive local and neighbourhood plans, which reflect the needs and priorities of their communities". Under such a framework, low levels of traffic and transport emissions would need to be delivered through local, rather than national, policies.

Although it is possible that the new framework will result in appropriate land-use planning decisions, it is not clear that this will be the case. In order to understand the extent of this risk, it will be important to closely monitor decisions on new developments and to assess associated impacts for transport emissions.

Key findings

- **Surface transport emissions were unchanged** in 2010, following two years of decline…
- … **further significant cuts are needed** to achieve future carbon budgets.
- **New car emissions outperformed** our indicator, falling to **138.1 gCO_2/km** in 2011.
- Conditions are in place to support development of the **electric vehicle market**.
- Government plans to **remove company car tax exemptions** for zero and ultra low-emission vehicles threaten progress and **should be reversed**.
- Progress on behaviour has been mixed: **progress on Smarter Choices** roll out but **slow progress on eco-driving** and risk of **higher emissions if motorway speed limits are raised**.

Table 5.1 The Committee's transport indicators

ROAD TRANSPORT		Budget 1	Budget 2	Budget 3	2011 trajectory	2011 outturn
Headline indicators						
Emissions (% change on 2007)	Road Transport	-10%	-18%	-27%	-7% (2010)	n/a (2010: -7%)
	Car	-13%	-23%	-35%	-10% (2010)	n/a (2010: -8%)
	Van	3%	4%	-2%	+3% (2010)	n/a (2010: -4%)
	HGV	-4%	-13%	-17%	-5% (2010)	n/a (2010: -7%)
gCO_2/km (carbon intensity of a vehicle kilometre)	Car	154	127	102	164 (2010)	n/a (2010: 167)
	Van	216	192	164	210 (2010)	n/a (2010: 219)
	HGV	761	678	619	756 (2010)	n/a (2010: 837)
Vehicle kilometres with impact of Smarter Choices (change on 2007, billion vehicle-km)	Car	420	450	478	409 (2010)	402 (2010)
Supporting indicators						
Vehicle technology						
New car gCO_2/km	Car	146	116	95 (by 2020)	151	138
New electric cars registered each year (at end of Budget period)		12,000	240,000	600,000	8,127	1,098
Stock of battery electric and plug-in hybrid cars in vehicle fleet		24,000	650,000 (240,000 delivered through pilot projects in 2015)	2.7 million	4,720 (2010)	n/a (2010: 289)
Biofuels						
Penetration of biofuels (by volume)		4.5%	7.7%	10.0%	4.0%	3.5%
Decision on whether RTFO target can be met sustainably		2011/12			n/a	n/a

Table 5.1 The Committee's transport indicators

ROAD TRANSPORT	Budget 1	Budget 2	Budget 3	2011 trajectory	2011 outturn
Demand side measures					
Proportion of drivers exceeding 70mph		0%*	0%*	n/a	n/a (2010: 48%)
Car drivers who have undergone eco driving training	1.2 million	2.8 million	4.5 million	884,500	23,055
Smarter Choices – demonstration in a city and development plan for roll out if successful, demonstration in rural areas and demonstration targeting longer journeys	2010			n/a	n/a
Smarter Choices – phased roll out to towns	2010		Complete	n/a	n/a
Development of integrated planning and transport strategy	2011			n/a	n/a
Other drivers					
Fuel pump prices, fuel duty, proportion of small/medium/large cars, Van and HGV kms (vehicle/tonne), Petrol/diesel consumption, surface transport modal split, average speed of car drivers exceeding 70mph.					
Agreement of modalities for reaching an EU target of 95 gCO_2/km target and strong enough penalties to deliver the target, new car CO_2 in EU, New Van and HGV gCO_2/km**, Number of EV car models on market, developments in battery and hydrogen fuel cell technology, battery costs.					
Successful conclusion of EU work on Indirect Land Use Change/development of accounting system for ILUC and sustainability.					
Number of households and Car ownership by household, cost of car travel vs cost of public transport, funding allocated to and percentage of population covered by Smarter Choices initiatives*, Proportion of new retail floorspace in town centre/edge of centre locations, proportion of new dwellings in settlements >100,000 (% within boundary, on edge), ratio of parking spaces to new dwellings on annual basis.					

Note: Numbers indicate amount in last year of budget period i.e. 2012, 2017, 2022.

* CCC recognise that in practice it is impossible to achieve zero speeding. However, as close to zero as practicable is required to achieve the greatest carbon savings.
** We aim to include new van and HGV gCO_2/km in our indicator set as the available monitoring data improves.

Key: Headline indicators | Implementation indicators | Milestones | Other drivers

Chapter 6: Progress reducing emissions from agriculture

Introduction and key messages

In this chapter we present latest evidence on emissions in agriculture, which accounted for almost 9% (50.7 $MtCO_2e$) of UK greenhouse gas emissions in 2010. We also consider the Land use, land use change and forestry (LULUCF) sector which is a net carbon sink, absorbing 3.8 $MtCO_2e$ in 2010.

The focus of the chapter is on trends and drivers of non-CO_2 emissions, progress in improving data and monitoring, and policy developments.

Our key messages are:

- Agricultural emissions increased by 0.9% in 2010, reversing the trend of falling emissions in recent years (e.g. emissions have fallen by 7.5% since 2003 and 19.7% since 1990).
- The key driver of this emissions increase was increased agricultural output[1] of 1.8%. Within this total, livestock output increased by 3.2% but crop output fell by 0.7%. Emissions intensity improved for livestock due to productivity gains in milk production and improved fertiliser efficiency on grassland. However, there was a worsening of emissions intensity of crops reflecting less efficient use of fertiliser. There is limited evidence of carbon efficiency improvements through implementation of measures that we have previously identified.
- The evidence base for assessing progress in reducing emissions remains incomplete. In order to address this, a framework of indicators and supporting data on farming practice should be established as a matter of urgency, and clear milestones set for the Government's project to develop a smart emissions inventory.
- The Government's policy review includes a number of useful elements, but should be broadened in scope to consider the full range of abatement options, and circumstances under which it would be appropriate to move from the current voluntary approach to one with stronger incentives for action (e.g. failing to deliver an improvement in carbon efficiency as set out in the Industry sector road maps over the next three years).

We set out the analysis that underpins these messages in four sections:

1. Agricultural emissions: trends and drivers
2. Progress against indicators
3. Incentives to reduce agricultural emissions – the policy framework
4. Land use, land use change and forestry

1 Volume based indicator

1. Agricultural emissions: trends and drivers

Emissions data in the agriculture sector lag that of other sectors by a year, due largely to the high proportion of non-CO_2 emissions in this sector, the data for which take longer to collate. This chapter therefore reports on trends and drivers to 2010.

The current evidence base does not support a full assessment of progress in reducing agricultural emissions given uncertainties over measuring emissions and current farming practice (discussed in detail in section 2). Within these constraints, it is important to assess high-level progress in reducing emissions, which is set out below.

Emission trends

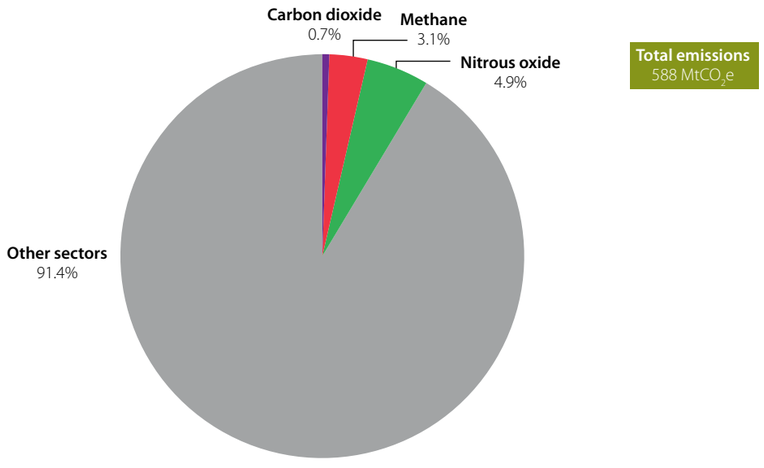
At 50.7 $MtCO_2e$ in 2010, agricultural emissions account for 8.6% of total greenhouse gases in the UK (Figure 6.1).

- Agricultural soil emissions make up the bulk of this sector (52%), followed by enteric emissions (30%). Stationary and mobile combustion and waste and manure management each account for 9% of emissions (Figure 6.2).
- Over half (56%) of agricultural emissions are due to emissions from nitrous oxide (N_2O), just over a third (36%) due to methane, with the remaining 8% due to carbon dioxide (CO_2).

Overall agricultural emissions increased by 0.9% in 2010 (Figure 6.3):

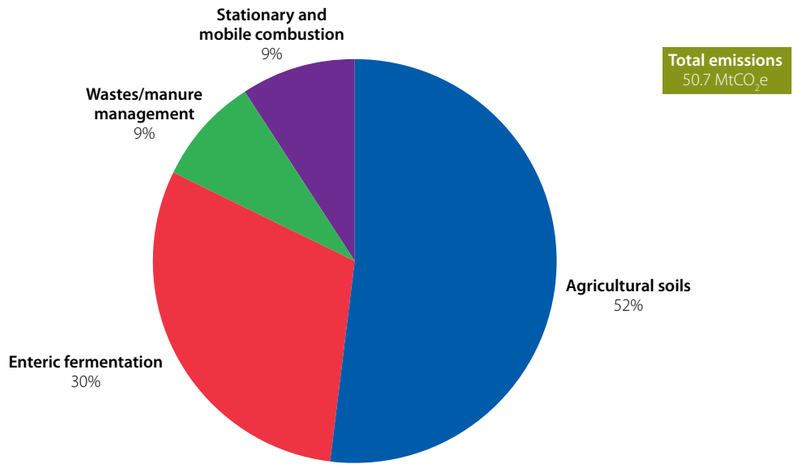
- The biggest absolute increase was in N_2O emissions from fertiliser use, which increased by 0.5 $MtCO_2e$.
- There were also increases across other sources: enteric emissions (0.4%); management of wastes and manures (0.2%); and stationary and mobile combustion (1.6%).

Figure 6.1: GHG emissions from agriculture in the context of total UK emissions (2010)



Source: NAEI (2012).
Notes: Emissions from other sectors excludes International aviation and shipping sectors.

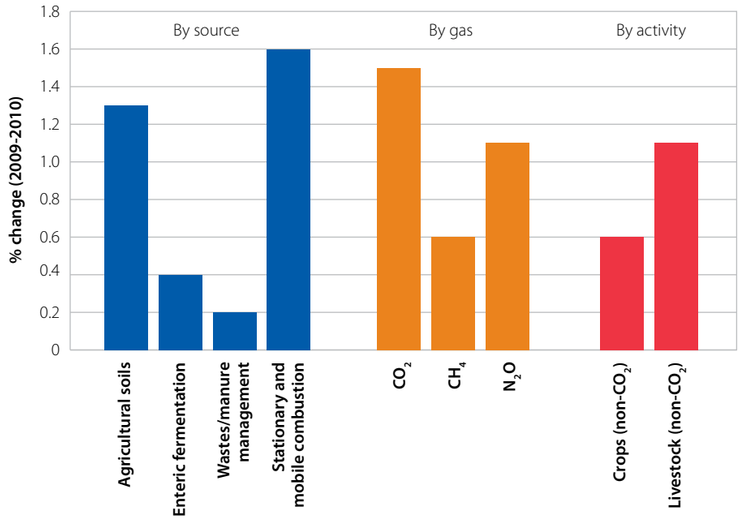
Figure 6.2: Agriculture emissions by source (2010)



Source: NAEI (2012).

- In terms of agricultural activity, non-CO_2 emissions from livestock increased by 1.1%, while crop related emissions increased by 0.6%[2].
- Emissions increased across the range of gases: CO_2 (1.5%), N_2O (1.1%) and methane (0.6%)

Figure 6.3: Percentage change in agricultural emissions by source, gas and activity (2009-2010)



Source: NAEI (2012).

2 This excludes the application of manures.

The emissions increase in 2010 reversed the falling trend in recent years (Figure 6.4):

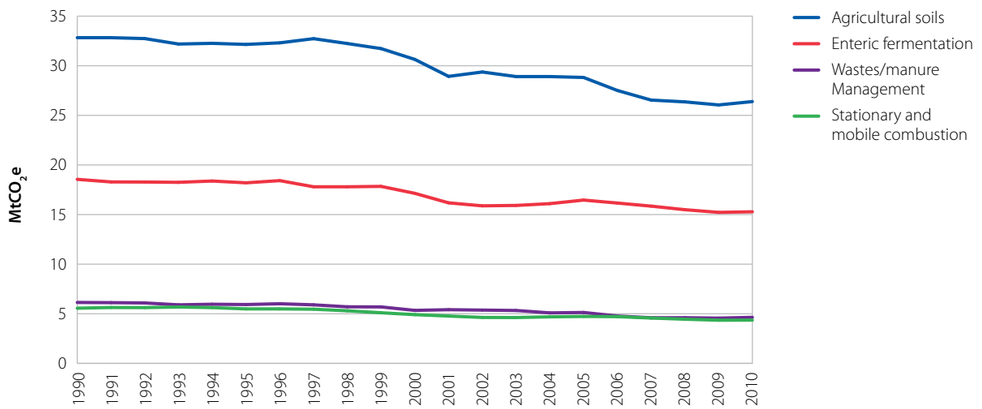
- In the last 20 years agricultural emissions have fallen by 20% from 63 $MtCO_2e$ in 1990 to 50.7 $MtCO_2e$ in 2010, with reductions across all sources: soils (-20%), enteric fermentation (-18%), wastes/manure management (-22%) and stationary/mobile combustion (-20%). Key drivers have been the fall in livestock numbers and changes in agricultural practices, notably a reduction in fertiliser application.
- Emissions have fallen by 7.5% since 2003, largely due to soil and combustion emissions reductions.

Given reductions in previous years, the levels of emissions in 2010 were in line with our emissions indicators:

- Non-CO_2 emissions were 1.9% lower than in 2007, consistent with the trajectory to a 3% reduction by 2012.
- Disaggregating emissions shows that all sources (enteric emissions, wastes/manure management and agricultural soils) and gases (N_2O and methane) were on track to meet our indicator trajectory.

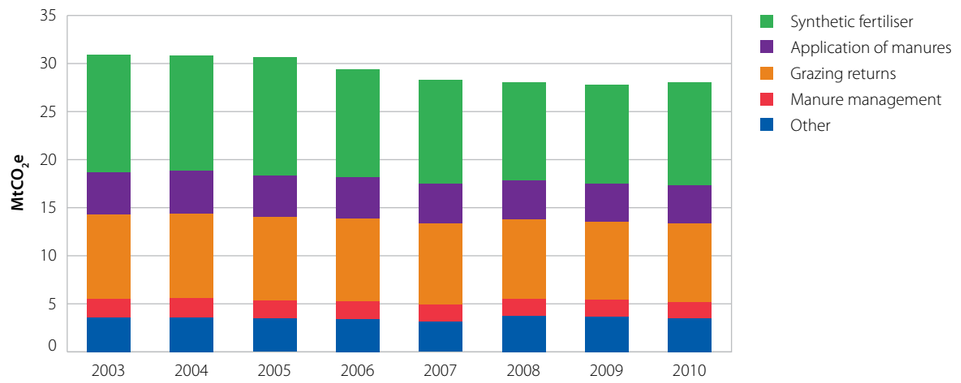
It is important, particularly in view of the overall increase in emissions in 2010, to assess emissions drivers, including the extent to which the changes in overall emissions are due to changes in carbon intensity of production compared to changes in demand or output.

Figure 6.4: Agricultural emissions by source (1990-2010)



Source: NAEI (2012)

Figure 6.5: Nitrous oxide emissions by source (2003-2010)



Source: NAEI (2012).

Emission drivers – nitrous oxide

Over 90% of N_2O emissions arise from agricultural soils, the remainder is due to manure management:

- Use of synthetic fertiliser is a key source, making up 38% (10.8 $MtCO_2e$) of N_2O emissions. Application of manures to land for crop and pasture comprise 14% (3.9 $MtCO_2e$).
- Grazing returns comprise 29% (8.2 $MtCO_2e$), whilst manure management and other sources related to livestock production are around 2 $MtCO_2e$.
- Crop residues and biological fixation by crops are the other key sources of N_2O emissions, which account for around 9% (2.6 $MtCO_2e$) (Figure 6.5).

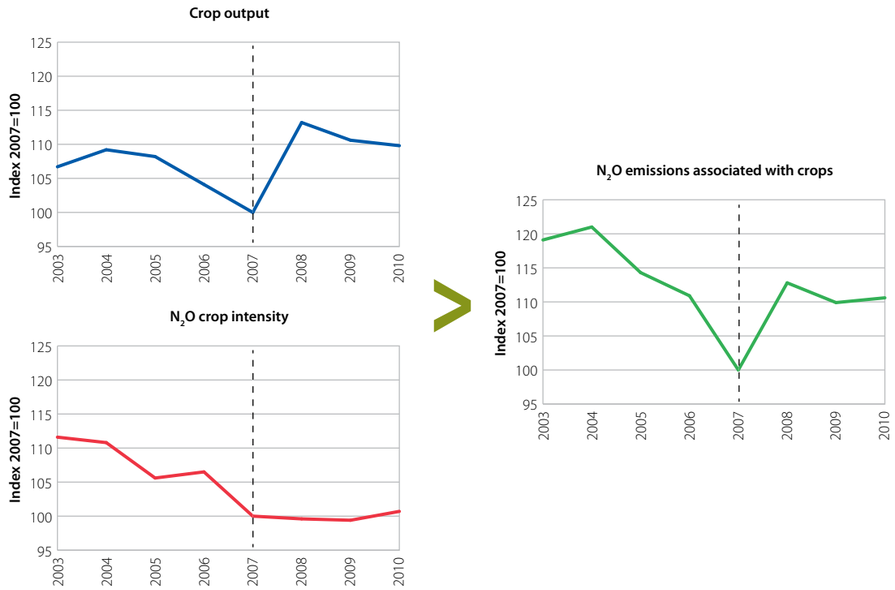
N_2O emissions increased by 1.1% in 2010. Strong growth in emissions from synthetic fertiliser (4.6%) was offset by falls from manure management (-1.2%) and other sources (-3.9%). Emissions arising from the use of manures on soils increased marginally (0.2%).

As overall agricultural output growth (up 1.8%) was faster than the growth of emissions (1.1%), overall N_2O intensity of output improved (-0.7%). However, since crop output declined while livestock output increased, it is important to look at these separately:

- N_2O emissions from synthetic fertiliser use on croplands increased by 3.2%. A fall in emissions from other crop-related sources resulted in a net increase in emissions from these sources of 0.6%. As crop output fell by 0.7%, this implies a 1.3% increase in crop N_2O intensity. Within this, there was a stronger rise in intensity of fertiliser use of 3.9%[3]. Adverse weather led to falling yields of many crops. Wheat and barley were affected by dry spells in April and May during crop establishment, which continued in the grain fill periods of June and July, while sugar beet was impacted by the cold winter (Figure 6.6).

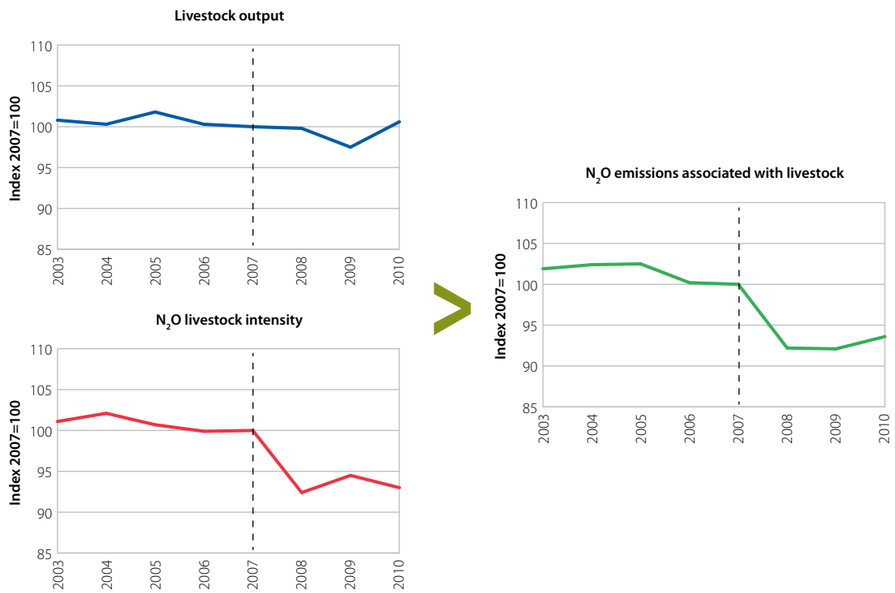
3 Excluding nitrous oxide emissions from the application of manures.

Figure 6.6: Crop output, N_2O emissions associated with crops and emissions intensity of crops (2003-2010)



Source: NAEI (2012), Agriculture in the UK (2010), CCC calculations.
Notes: Base Year (2007) = 100.

Figure 6.7: Livestock output, N_2O emissions associated with livestock and emissions intensity of livestock (2003-2010)



Source: NAEI (2012), Agriculture in the UK (2010), CCC calculations.
Notes: Base Year (2007) = 100.

- For livestock emissions, strong growth in emissions from inorganic fertiliser for pasture was partially counteracted by falls from manure management and grazing returns, so that livestock production emissions grew by 1.7%[3]. With livestock output increasing by 3.2%, this led to a 1.5% improvement in N_2O intensity of livestock (Figure 6.7).

Synthetic fertiliser application rates increased on both cropland and grasslands, notwithstanding a 5% increase in fertiliser prices in 2010. However, prices were still around 30% lower than their peak in 2008, when fertiliser application rates reached historic lows (Figure 6.8).

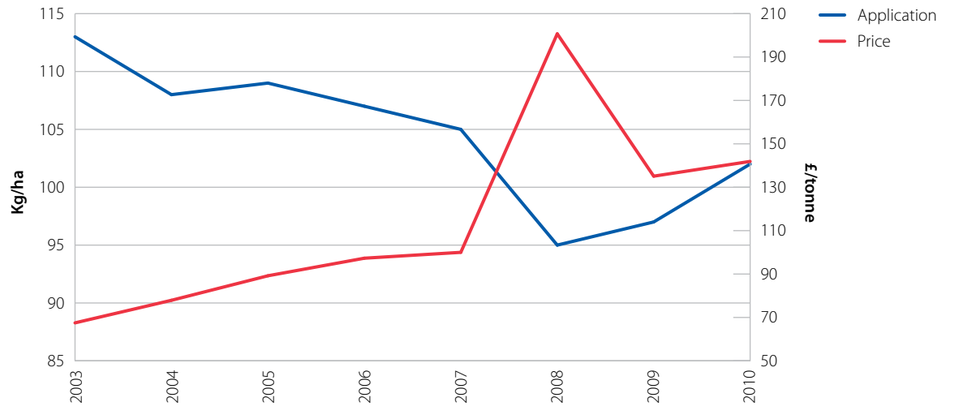
Emission drivers – methane

Methane emissions account for around 36% (18 $MtCO_2e$) of total agricultural emissions. In terms of source, the digestive process of livestock (e.g. cattle and sheep) accounts for approximately 85% of methane emissions, with the remainder due to waste and manure management.

In 2010, methane emissions increased by 0.6%, driven by higher output of meat and other livestock products, increased UK consumption and exports:

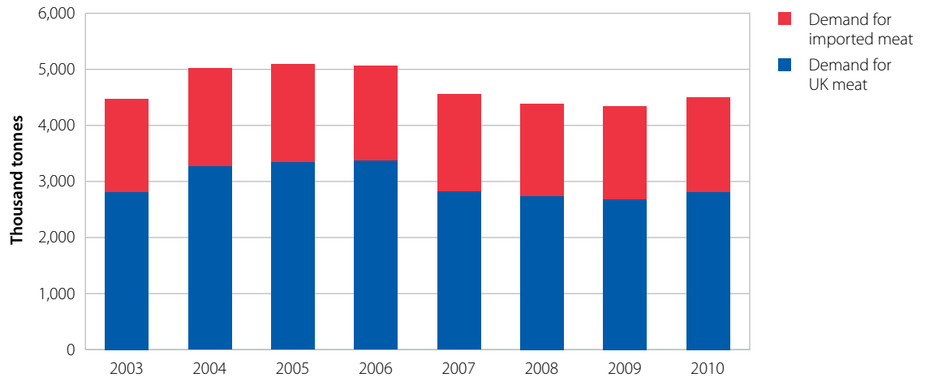
- Overall livestock output rose by 3.2% in 2010.
- There were particularly strong increases in output from cattle and calves (3.4%), poultry (9.5%) and eggs (12.2%).
- UK consumption of meat increased by 3.6% while exports rose by 12%. This reversed a two year decline in UK consumption despite meat prices continuing to increase in 2010, albeit at a slower rate than in the previous two years (Figure 6.9).

Figure 6.8: Fertiliser use and prices (2003-2010)



Source: British Survey of Fertiliser Practice; DairyCo.
Notes: Fertiliser price based on annual monthly average of ammonium nitrate.

Figure 6.9: UK meat consumption (2003-2010)



Source: Agriculture in the UK (2010).

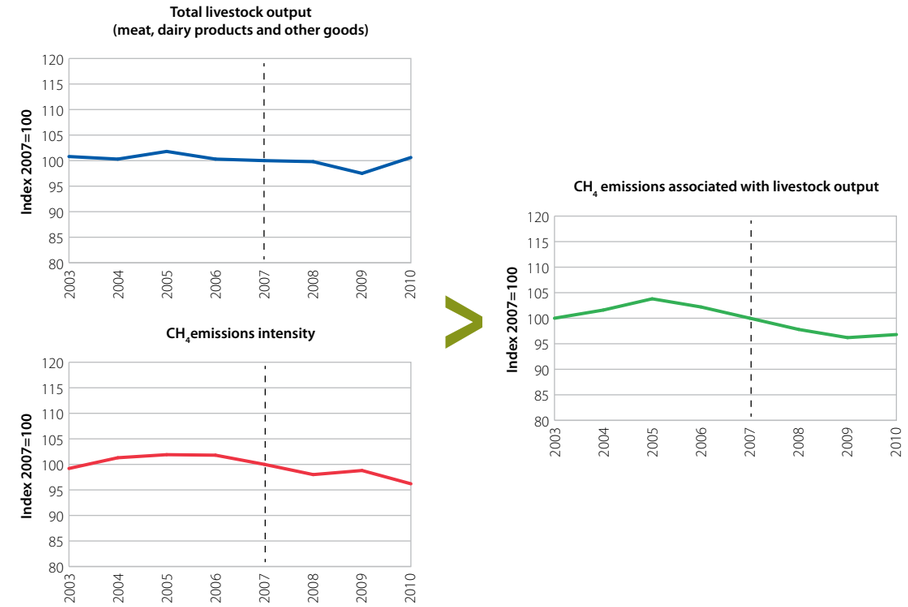
The fact that the increase in emissions was less than the increase in output can be explained by improved livestock productivity, particularly in the dairy sector:

- Despite a continued decline in the size of the dairy herd, average milk yields continued to increase and reached over 7,000 litres per dairy cow in 2010. This represents a 3.5% increase on the previous year.
- In 2010 average dressed carcase weights increased for poultry by 8%. Yields for other meat types also increased, albeit at a much lower rate (less than 1%).
- These improvements drove a reduction in the methane intensity of livestock output production of 2.6% in 2010 (Figure 6.10).

The increase in methane emissions in 2010 reverses the trend in recent years. Between 2003 and 2010 methane emissions fell by 3.2%. This has been driven by a reduction in livestock numbers reflecting a combination of changing patterns of UK consumption, particularly for dairy products, and improved productivity:

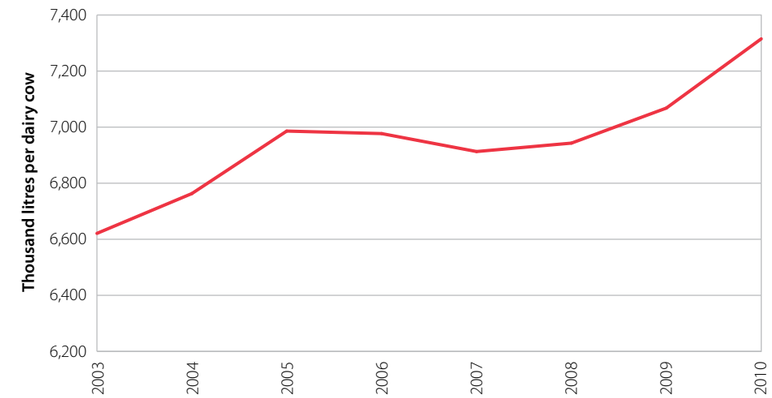
- UK milk consumption declined by 8% between 2003 and 2010 with milk production and imports declining by 8% and 16% respectively.
- The consumption of mutton and lamb declined by 13%, with domestic production and imports down by 7% and 6% respectively.
- Exports for meat output increased by 48% over the period, although this was in part driven by the rebound in beef exports following the BSE crisis. Exports of pig meat and lamb increased by 86% and 20% respectively
- The size of the dairy cattle herd has fallen by 16% since 2003 with improvements in production efficiency increasing average milk yields by 10.5% by 2010 (Figure 6.11).

Figure 6.10: Total livestock output, CH_4 emissions and CH_4 emissions intensity of output (2003-2010)



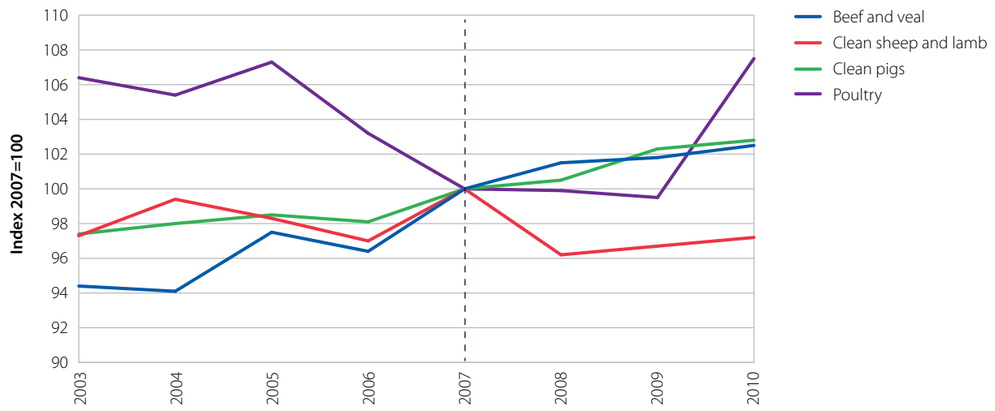
Source: NAEI (2012), Agriculture in the UK (2010).
Notes: Base Year (2007) = 100.

Figure 6.11: Milk output per dairy cow (2003-10)



Source: Agriculture in the UK (2010).

Figure 6.12: Index of average dressed carcase weight per animal (2003-2010)



Source: Agriculture in the UK (2010).
Notes: Base Year (2007) = 100.

- Average dressed carcase weights of beef and veal increased by 9%, while yields of clean pigs increased by 6% over the same period (Figure 6.12).

Despite the reduction in livestock numbers since 2003, UK consumption of meat has remained broadly unchanged with UK output continuing to meet just over 60% of demand in 2010. Within the meat types, demand met by UK output in 2010 was largest for poultry (73% share) and beef and veal (74%), while imports accounted for a larger share of the pig meat and lamb and mutton markets with 60% and 41% respectively. We will return to look at imports in our review on competitiveness and leakage next year, where we will consider emissions on a consumption (rather than production) basis.

Emission drivers – CO_2

Machinery used in agriculture (stationary and mobile combustion) is the biggest source of CO_2 in this sector, accounting for 8% of greenhouse gas emissions from agriculture. Within this, mobile machinery (e.g. tractors) makes up the bulk of emissions:

- Emissions increased by 1.5% in 2010, faster than other sources of gas in agriculture, although emissions are at 2007 levels.
- Since 2003 emissions from mobile and stationary machinery have fallen by around 13% from 5.3 $MtCO_2$ in 2003 to 4.6 $MtCO_2$ in 2010. Since agricultural output has declined by just over 1% in this period, the emissions intensity of output has improved.

Further savings can be achieved by reducing fossil fuel use by mobile machinery (e.g. use of efficient engine technology and alternative vehicle fuels).

2. Progress against indicators

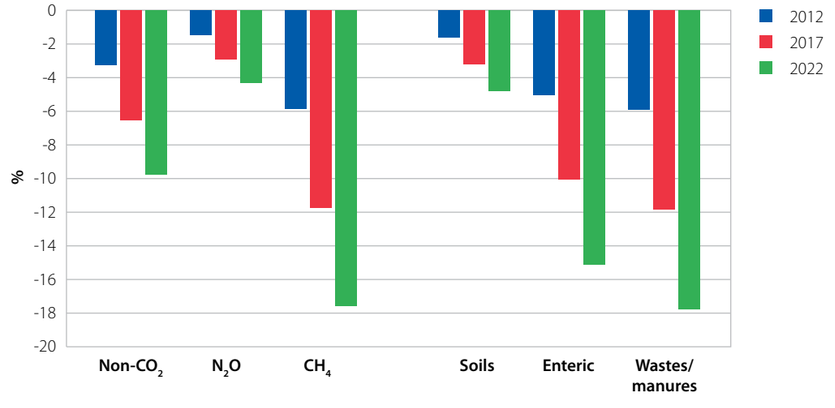
Progress reducing emissions, reducing carbon intensity and improving productivity

In our 2009 progress report we set out our preliminary set of indicators to track progress in the agriculture sector. These comprised a high level trajectory for CO_2e emissions, which were also disaggregated by gas and source, and trajectories for carbon intensity and productivity improvement. The emissions trajectories are consistent with ambition as set out in the Government's Low Carbon Transition Plan (3 $MtCO_2$e of abatement by 2020 for England, scaled to 4.5 $MtCO_2$e for the UK), the Industry Action Plan and supporting sector roadmaps (Figure 6.13).

- Average agricultural non-CO_2 emissions reductions of 10% by 2022 relative to 2007 levels. This is consistent with a 5% reduction in soil emissions, a 15% reduction in enteric emissions and a 20% reduction in emissions from wastes. Most of the expected reduction is in methane (18%), with N2O down by 4%.
- Average improvements in soil emissions intensity of 5% by 2022 relative to 2007 levels, through improvements in fertiliser efficiency on arable and pasture.
- Average improvement in livestock emissions intensity of 18% by 2022 relative to 2007 levels, through improvements in productivity (e.g. meat yields).

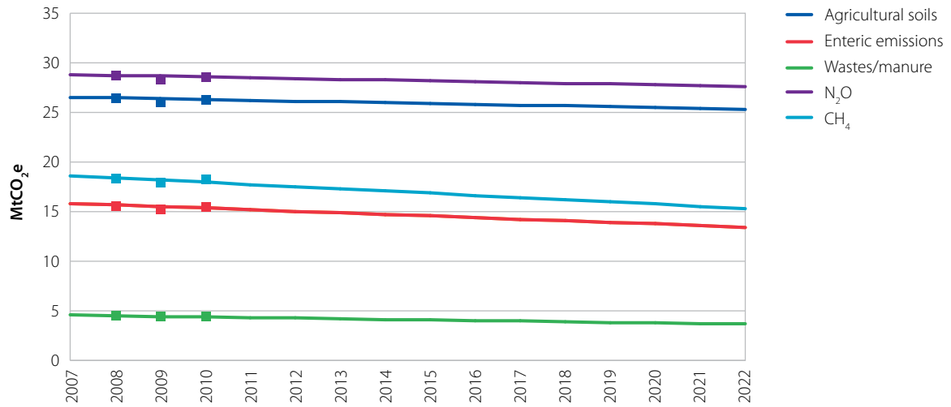
Despite the rise in emissions in 2010, the overall level of emissions is still consistent with our indicator trajectory, given emissions reductions in previous years (Figure 6.14).

Figure 6.13: Indicator projections for emission reduction by end of each budget



Source: CCC calculations based on LCTP ambition.
Notes: Indicative % change from 2007 reflecting LCTP ambition scaled to UK; N_2O and CH_4 reduction equates to a change in emissions intensity if output is unchanged.

Figure 6.14: Progress against indicators for agriculture to end of third budget period



Source: NAEI (2012); CCC calculations based on LCTP ambition.
Notes: Levels are fixed as carbon budgets are in levels terms therefore use this series, and percentage reductions will change.

Official projections indicate that by 2020, UK non-CO_2 emissions could be 1 $MtCO_2e$ below current levels without further action, and with savings envisaged under the Industry Action Plan could be below the level required under our indicator trajectory (Box 6.1).

Box 6.1: GHG emission projections for UK Agriculture

Defra central projections (August 2011) suggest that without action by 2020 UK CH_4 and N_2O emissions from agriculture could be around 1 $MtCO_2e$ below current levels, With abatement envisaged under the Industry Action Plan total N_2O and CH_4 emissions could be further reduced to below 40 $MtCO_2e$ by 2020.

In 2010 N_2O and CH_4 emissions were 44.8 $MtCO_2e$; by 2020 they could be 43.8 $MtCO_2e$. The reduction reflects continued improvement in fertiliser efficiency – though at lower rates than previously seen – and modest reductions in livestock numbers.

Delivery of the GHG Industry Action Plan is expected to deliver a further 3 $MtCO_2e$ of abatement by 2020 in England, which when grossed up to the UK could deliver 4.5 $MtCO_2e$.

The revised projections are based on the FAPRI-UK model of UK Agriculture which models livestock and crop activity in the UK. The new projection is around 8% lower than previously estimated by DECC for 2020. The key difference is that the new projections take account of recent trends, whereas the previous projections only used data up to 2004 to calibrate over the estimation period.

Whether these projections are realised will depend on underlying progress in reducing emissions through improving carbon efficiency. In this respect, there was an improvement in livestock carbon intensity in 2010, although there is limited evidence of carbon efficiency improvements through implementation of measures that we have previously identified. For crops, it is clearly a concern that the intensity of production increased. Therefore, there is a need for close monitoring in future to assess whether, for crop production in particular, this is indicative of more fundamental changes in the industry rather than due to one-off factors (e.g. weather).

The indicator trajectory we have developed assumes that output remains constant. There is a question over whether future changes in output imply the need for a different approach. It is clear that some of the indicators we have identified are appropriate irrespective of the level of output and should continue to be targeted. We will continue to monitor changes in output, including consideration of structural change, and will consider the specific issue of changes in imports in our review of carbon competitiveness and leakage.

Improving the evidence base for assessing progress reducing emissions

The current evidence base does not support full assessment of progress in reducing agricultural emissions given uncertainties over the measuring of emissions and current farming practice:

- **Uncertainty in measuring emissions.** The Tier 1 approach, which largely applies global emissions factors to fertiliser application and livestock numbers, is unlikely to reflect soil or climatic conditions in the UK (Box 6.2). A more disaggregated approach, with different factors for different regions and conditions, would improve the accuracy of emissions. Implementation of this approach would require resolution of current scientific uncertainty, for example, as regards emissions from soils under different circumstances.
- **Uncertainty in current farming practice.** The evidence base on current farming practice is incomplete, with a high degree of uncertainty over the extent to which best practice is currently deployed, how practice is changing over time and whether these changes have led to improvements in reducing emissions. This does not permit a full assessment of progress in reducing emissions or abatement potential that currently exists. For example, although it may be the case that soil carbon efficiency on grassland appears to have improved in 2010, we cannot be confident that this represents an actual improvement given the different conditions under which fertiliser has been applied, nor is it possible to explain why this might have happened given available data. In addition, some abatement measures would not result in reduced emissions under the current inventory approach which assumes standard practice (e.g. optimal timing of the application of fertiliser).

Defra estimates suggest that these uncertainties could result in emissions that are 61% lower or 152% higher than current estimates.

Box 6.2: Current method for calculating nitrous oxide and methane emissions

Nitrous oxide emissions (N_2O): Direct emissions from N_2O arise from: use of inorganic fertiliser, biological fixation of nitrogen by crops, ploughing in crop residues, cultivation of organic soils, spreading animal manures on land and manures dropped by grazing animals. In addition to these, the inventory contains N_2O estimates from indirect sources: atmospheric deposition of agricultural nitric oxide and ammonia and emission of N_2O from leaching of agricultural nitrate and run-off. Emissions from manure management systems are also included.

The main source of N_2O emissions is from the application of non-organic fertiliser, which accounts for over 80% of emissions. A number of factors influence the level of emissions resulting from fertiliser applications. These include:

- Land use
- Soil nitrogen content before application
- Organic carbon content of the soil
- Soil moisture content and the compaction of the soil.

The current NAEI methodology does not take these local factors into account when estimating N_2O emissions, but uses standard IPCC emission factors. Work on improving the GHG inventory is underway but is not due to be completed until 2015 (Box 6.3).

Therefore, whilst total N_2O emissions and intensity estimates are estimated, the broad brush methodology underpinning these means they cannot reflect the full range of relevant factors. Whilst these are still useful high level indicators, we cannot currently infer the impact of factors such as application time, location, weather conditions and soil type on emissions.

Methane emissions (CH_4): CH_4 emissions are produced in herbivores as a by-product of enteric fermentation, a digestive process by which carbohydrates are broken down by micro-organisms.

The current NAEI methodology estimates these by applying emission factors to the livestock population. These comprise a mixture of Tier 1, where IPCC default emission factors apply, and Tier 2 approaches which incorporate country-specific emissions factors. The Tier 1 factors do not change from year to year (for example with changes in diet or weight) while the Tier 2 factors do.

Dairy cattle use a Tier 2 approach that take account of weight of cows, improving milk yields over time and diet. Total emissions and emissions intensity for these herds therefore reflect specific changes in farming practices and productivity. This is also true of lamb and deer.

For other animals a Tier 1 approach is used. This means that emissions and intensity estimates do not reflect actual UK conditions for this group, and limits the ability of the current inventory to reflect emission intensity improvements and uncertainties in monitoring progress.

To reduce these uncertainties, the Government is undertaking work to better understand and measure how biological systems and different farming practices impact on emissions (Box 6.3). In order to provide confidence that the project will deliver, it is important now to set intermediate milestones for this project prior to its completion in 2015.

Government is also working to develop a monitoring framework based on survey and other data (see policy discussion in Section 3).

Box 6.3: Strands of the agricultural inventory research programme

Government is improving the agricultural GHG inventory through a five year research programme aimed at improving spatial and temporal resolution, as well as practice-specific emission factors which will improve forecasting and monitoring of performance practices.

The £12.6m project, reporting in 2015, has three key research strands:

- Measuring **nitrous oxide** emissions factors for direct and some indirect emissions from nitrogen fertilisers, manures and grazing returns of both dung and urine, from a range of soils, farming systems and climatic zones of the UK.
- Measuring **methane** emission factors for different livestock species (focusing on cattle and sheep) and breeds/genotypes, under a range of different farm systems and representative business structures.
- **Data synthesis, modelling and management.** This project will provide a synthesis of existing and new evidence on GHG emission factors and the effectiveness of mitigating measures, provided by literature review and the partner projects. This will be integrated with UK agricultural statistics and data on farm practices to define an improved Emissions Inventory structure for reporting and tracking change.

3. Incentives to reduce agricultural emissions – the policy framework

In order to meet the trajectories set out in the indicator framework, incentives to change farming practice will be required. The current approach to changing farming practice is industry led, based on the provision of information and voluntary action. Government is also undertaking a policy review which provides an opportunity to strengthen incentives as appropriate.

The Industry-led Approach

The industry-led approach to deliver the LCTP ambition to abate agricultural emissions in England by 3 $MtCO_2e$ by 2020 is based on the provision of information, advice and voluntary action.

The plan is to be delivered in three phases to 2020:

- Phase 1 (2010-2012) establishes the key activities required to deliver the planned 3 $MtCO_2e$ emissions reduction, including communications strategy, identifying key delivery routes and developing sector road maps.
- Phase 2 (2012-2015) will promote improvements in farming practices in target sectors (i.e. crop nutrition improvements, promoting low-emissions diets and improvements to animal health)
- Phase 3 (2015-2020), with the benefit of an improved inventory, will promote those measures where there is more cost-effective potential to reduce emissions.

Phase 1 has been successful in identifying priority areas for on-farm actions (e.g. crop nutrition management and livestock health) and establishing the pilot Farm Efficiency Hub, which is intended to be the main source of approved guidance and information for farmers and their advisors to access.

However, there is currently a lack of detail on Phase 2 delivery, which should be resolved to provide more confidence that objectives will be achieved. In particular, it is important that funding arrangements for the provision of information are clarified, and that a monitoring framework covering the set of measures to be implemented is put in place.

The 2012 Review of Progress towards reducing emissions from agriculture

The Government's current policy review is aimed at mapping current incentives to implementation of measures, establishing a monitoring framework, and reviewing progress against ambition:

- The review will map current policies and incentives against measures to reduce emissions, in order to assess whether the full range of measures is covered.
- It will develop a longer-term evaluation framework, including performance indicators. In order to be workable, the framework will focus on a small number of key indicators, which could cover a mixture of overarching and sector-specific metrics, with supporting information where this helps provide further evidence underpinning trends. It is planned that progress on uptake will be tracked and weighted to form an overarching view of the sector.
- It will review progress on the GHG Industry Action Plan and the sector roadmaps. Government will publish its assessment of the industry-led action plan to see if this approach is sufficient to deliver the required abatement.
- It will analyse new data from the Farm Practices Survey (FPS), British Survey of Fertiliser Practice and other climate and agriculture information (e.g. in 2011, a bespoke FPS largely focused its questions on practices that are relevant to emissions).
- It will review the findings of current research projects, including the inventory project work.

Government will shortly be publishing an interim report setting out initial findings, progress and broad direction of travel, with a final report due at the end of the year.

Although all of the above will be useful, the review does not propose to consider alternative approaches with stronger incentives. This is problematic given the risk that incentives under current approaches may be insufficient to drive required action.

We therefore recommend that the current scope of the review is broadened to include an assessment of the full range of policy options (e.g. carbon pricing, cap and trade, and regulation), and a set of triggers for the introduction of new policies depending on performance under the current approach (e.g. failing to deliver an improvement in carbon efficiency as set out in the Industry road maps over the next three years).

Furthermore, with regard to the Farm Practice Survey and other such surveys, we recommend that questions on practices that can support emissions reductions are retained in future surveys, with scope to incorporate other relevant information (e.g. data needed to monitor the measures being proposed for the indicator framework, when these are finalised)

Other Policy Developments

In last year's report we suggested that specific UK and EU polices under review could strengthen incentives for reducing agricultural emissions:

- Tighter ammonia limits under the Gothenburg Protocol, and
- Widening the coverage of Nitrate Vulnerable Zones (NVZs) to all of England.

Since then, a new target to constrain ammonia emissions by 8% by 2020 against 2005 levels has been agreed, while a decision by Government to widen NVZ coverage is due end 2012. From a carbon perspective, the decision should clearly be to extend NVZ coverage to all of England, which would also have wider benefits (e.g. water quality).

4. Land use, land use change and forestry

Emission trends

The Land use, land use change and forestry (LULUCF) sector was a net carbon sink in 2010, absorbing 3.8 $MtCO_2e$. The biggest source of emissions are croplands, particularly from conversions, and settlements, which together accounted for 19.9 $MtCO_2$ emitted in this sector in 2010. Emissions are largely offset by carbon sequestered from forestry and grassland, which in 2010 absorbed 23.7 $MtCO_2$ (Figure 6.15). Net emissions rose slightly in 2010, which reversed the long-term trend for declining net emissions since 1990 (Figure 6.16).

Projections from DECC and the Centre for Ecology and Hydrology suggest that this sector will turn from being a net carbon sink to a carbon source from around 2012. This is largely a result of the sharp decline in tree planting rates from the late 1980s onwards following large-scale afforestation schemes in the previous three decades, which is reducing the strength of the forest carbon sink. Grassland is projected to become a bigger carbon sink than forests by 2020.

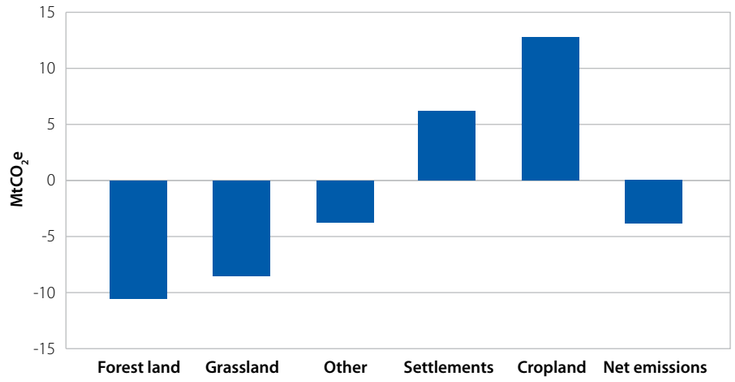
Opportunities to reduce land use emissions

There are a range of options that can be used to increase carbon sequestration and reduce the release of emissions in the LULUCF sector:

- **Forestry** can reduce emissions by sequestering carbon:
  - Only 13% of the UK is covered by woodland compared to an average of 44% in Europe. In our fourth budget[4] advice we identified an opportunity to reduce emissions from the LULUCF sector through afforestation of an additional 10,000 hectares a year over a 15-year period. We assumed in a central scenario that this could deliver savings of at least 1 $MtCO_2e$ by 2030. This would require a step change given that current UK planting rates are below these levels at 8,200 ha per year.
  - Increasing planting rates would require overcoming a set of barriers, which include:
    - The limited amount of land (approximately 50,000 ha) that comes up for sale each year.
    - Since woodland creation represents a permanent land-use change it offers less flexibility for a landowner to switch land use in response to changes in commodity markets (e.g. increase in cereal prices)
    - Switching from growing arable crops to trees incurs a loss of annual income due to the much longer growing period of a tree.

4 CCC (2010), *'The Fourth Carbon Budget: reducing emissions throughout the 2020s'.*

Figure 6.15: LULUCF emissions/removals by category (2009-2010)



Source: NAEI (2012).

– Work is ongoing which could support the development and creation of a woodland programme by 2014, in line with our indicator:

  • An Independent Panel on Forestry has been set up by Defra to look at the future direction of forestry and woodland policy in England, including advice on an appropriate level of ambition for woodland creation. A progress report published end 2011 supported the aspiration for increased woodland. Recommendations due this summer will cover planting rates, types of trees to be planted and use of instruments such as carbon markets to support increased planting.

  • The Forestry Commission, in conjunction with Natural England and the Environment Agency, is undertaking work to determine the potential for long-term woodland creation in England, which will help inform the Government's response to the Panel's recommendations.

- **Reducing horticultural use of peat.** Horticultural use is the single largest cause of peat extraction in the UK, and accounted for around 0.4 $MtCO_2$ in 2010. We recommended in our 2011 progress report that the use of peat for all horticultural purposes should be banned by 2030:

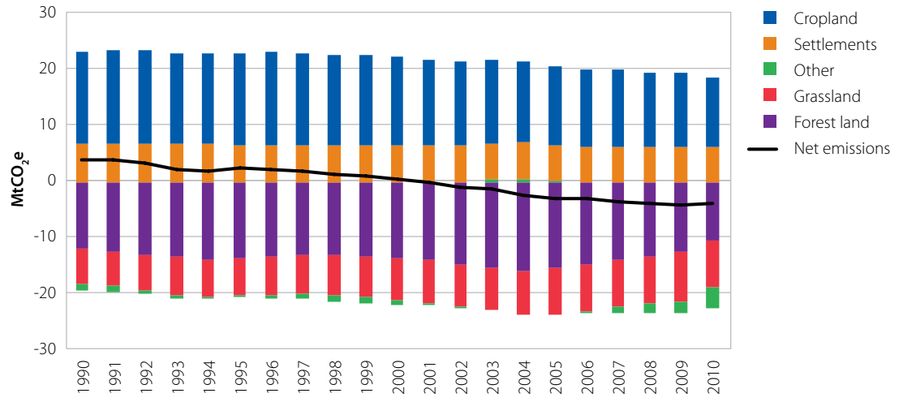
  – The Government has since announced its commitment to a voluntary phase out (by 2020 for the amateur market and 2030 for specialist/professional use) for horticultural applications in England. This voluntary approach may need strengthening if outcomes fall short of ambition. This requires Government to periodically review progress.

  – The biggest barrier to achieving the target is the price of domestic sourced peat, which is currently cheaper than alternative mediums. However, the availability of less expensive alternatives over time should support their uptake.

- **Upland and lowland peat restoration.** There are gaps in the current inventory with regards to emissions from peat lands, though work to improve understanding is ongoing:

  – The current inventory does not account for emissions arising from upland peat use:

Figure 6.16: LULUCF emissions/removals (1990-2010)



Source: NAEI (2012).

  • Emissions are mainly due to historic practices of drainage rather than current land uses. Drainage involved digging 5-6 metre wide channels every 2 metres, resulting in on-going peat decomposition and the release of carbon.

  • Although this is not an issue for England as most upland peat is inaccessible, it is a problem in Scotland, where most of the UK's upland peat is located.

  – Carbon sequestration and restoration of peat (e.g. re-wetting of peat land) is not captured. Work is underway both in the UK and internationally, which should improve our understanding of emissions from peat and the savings potential from the restoration of degraded peat land:

    • The IPCC is developing a methodology for capturing changes in emissions from restoration for 2013, although an issue remains on how to capture restoration since 1990 baseline.

    • A Defra project[5] is looking at how best to restore drained upland peat land to achieve the biggest emissions impact by maximising CO_2 sequestration and reducing methane loss. Fields trials are to be conducted to identify the best restoration methods by examining the impact on emissions over a three year period. The project is due to complete in 2015.

    • Work is underway to quantify the emissions from lowland peat systems in England and Wales under different management and land uses (e.g. pristine bogs and lands that have been impacted by extraction, grazing and arable production). Results will feed into development of emissions factors for each peat type for inclusion in the inventory.

There are several areas where LULUCF emissions could be reduced. We will monitor closely the findings of the Independent Panel on Forestry and government's response, and the on-going efforts to address gaps in measurement of emissions from peat. We will return to these in next year's assessment of progress.

5 'Investigation of peatland restoration (grip blocking) techniques to achieve best outcomes for methane and greenhouse gas emissions/balance', SP1202.

Key findings

- Agricultural emissions **increased by 0.9%** in 2010, but given emissions reductions in previous years, agriculture remains **on track** to broadly meet the first carbon budget.
- Emissions increased due to higher agricultural output in 2010, but while the **emissions intensity** of livestock production improved it **worsened for** crop production.
- The **evidence base** for assessing progress in reducing emissions remains **incomplete**.

We recommend that:

- As part of its **policy review**, the Government consider a full range of policy options, and performance triggers for the introduction of new policies.
- Government should establish as a matter of urgency a **framework of indicators** and supporting data on farm practice, and establish **clear intermediate milestones** for delivery of the smart inventory.
- There is a lack of detail on **Phase 2** of the **Industry Action Plan** which should be resolved to provide more confidence emissions savings will be achieved.

Table 6.1 The Committee's agriculture indicators

AGRICULTURE		Budget 1	Budget 2	Budget 3	2010 trajectory	2010 outturn
Headline indicators						
Emissions (indicative % change from 2007 reflecting LCTP ambition scaled to UK)						
CO_2e emissions		-3%	-6%	-9%	-1.9%	-1.9%
GHG emissions (% change in tCO_2e against 2007)	N_2O	-1%	-3%	-4%	-0.8%	-0.9%
	CH4	-6%	-12%	-18%	-3.5%	-3.4%
	CO_2*	n/a	n/a	n/a	n/a	n/a
	Soils	-2%	-3%	-5%	-0.9%	-1.2%
Source emissions (% change in tCO_2e against 2007)	Enteric fermentation	-5%	-10%	-15%	-3.0%	-4.0%
	Animal waste	-7%	-13%	-20%	-3.9%	-5.3%
	Machinery/fuels*	n/a	n/a	n/a	n/a	n/a
Drivers**						
tN_2O emissions per thousand hectares of arable and managed pasture		2007 = 2.18	2.15	2.08	2.16	2.17
tCH4 emissions per tonne of cattle and calf meat, dressed carcase weight		2007 = 9.10	8.63	7.68	8.82	9.01
tCH4 emissions per thousand litres of milk		2007 = 0.42	0.40	0.36	0.41	0.42
tCH4 emissions per tonne of sheep and lamb meat, dressed carcase weight		2007 = 10.67	10.05	8.81	10.30	9.78
tCH4 emissions per tonne of pig meat, dressed carcase weight		2007 = 1.12	1.06	0.94	1.08	0.93
tCH4 emissions per tonne of poultry, dressed carcase weight		2007 = 0.18	0.17	0.15	0.18	0.18

Table 6.1 The Committee's agriculture indicators

AGRICULTURE		Budget 1	Budget 2	Budget 3	2010 trajectory	2010 outturn
Supporting indicators						
Farming Practice						
Measures where greater confidence exists (e.g. proven technology, considered best practice, consistent abatement results) but uncertainty about baseline use.						
Nutrient management – including improved mineral and organic N timing, separating slurry and mineral N, using composts, and making full allowance for manure N	% of hectares where measures are in place	Better evidence about current farming practice is required to develop full trajectories.				
Livestock management – including breeding for fertility and productivity	% of livestock of different production/fertility efficiency	Better evidence about current farming practice is required to develop full trajectories.				
Manure management	% of manure/slurry stored in covered tanks or lagoons	Better evidence about current farming practice is required to develop full trajectories.				
Anaerobic Digestion	Installed AD capacity using manures (MW)***	31	68	102	Less than 1% of holdings have AD (2011)	
Measures that require further evidence to establish appropriateness and effectiveness in UK and in regional contexts						
Soil management (reduced tillage/drainage), nitrification inhibitors, and using more N-efficient plants (species introduction and improved N-use plants)	% of hectares where measures are in place	Not suitable for all hectares. Requires development of evidence base to resolve possible conflicts with other goals and to determine applicability, GHG benefits and costs under different conditions.				
Livestock management (including maize silage and dietary additives in form of propionate precursors or ionophores)	% of livestock consuming different diets and feed additives	Not suitable for all animals/farms. We will monitor the development of the evidence base around these measures, including applicability, net GHG benefits and resolution of possible conflicts with other sector goals.				
Policy Milestones						
Phase 1 of Industry Action Plan completed		April 2012				April 2012
Phase 2 delivery: • Roll-out of Industry information hub • Establish baseline farming practice and framework to monitor progress			2013			Pilot information hub completed 2012
Government policy review on voluntary approach: • Development of policy options for intervention • Set triggers for intervention		End 2012 End 2012				Report due end 2012
On-going monitoring of voluntary approach: • Evaluate triggers • Decide if new policies are required			2013-2014 2014-2015			

Table 6.1 The Committee's agriculture indicators

Development of smart inventory		Set milestones for delivery	2014 (1st phase)			Projects underway
Other drivers						
Crops/soils: Crop yields (e.g. cereals), cropping areas, N_2O emissions per hectare of cultivated land, N_2O emissions per unit of fertiliser use, output of product per unit of fertiliser use.						
Livestock: tCH_4/tonne dressed carcase weight (cattle & calves), weight of carcase produced per day of age, calves produced per cow per year.						
General: We will monitor development of the evidence base and R&D support for the various mitigation measures. We will also track upcoming CAP reform negotiations (to be complete by 2014) and implications for farming practice and emissions.						
LAND USE, LAND USE CHANGE AND FORESTRY					**By 2030**	
Headline indicator						
Emissions (annual savings from carbon sequestration by 2030)						
CO_2 sequestered					1 $MtCO_2e$	
Supporting indicators						
UK woodland planting					At least 21,000 hectares/year from 2015	
Policy Milestones						
Development and implementation of a woodland creation programme					By 2014	

* CO_2 abatement potential not factored into first three budget periods.
** Broadly consistent with LCTP ambition and industry roadmaps. UK Inventory at present will not fully capture reductions in emissions as a result of uptake of particular measures. Intensity indicators for budget periods assume constant output. Should output exceed assumed levels then lower intensities would be needed to deliver absolute emissions reduction.
*** Handling beef, dairy and pig manures and slurries.
**** 2007 baseline = 10.7 thousand hectares. Source: Forestry statistics 2010, figure 1.4.

Note: Numbers indicate amount in last year of budget period i.e. 2012, 2017, 2022.

Key: Headline indicators | Implementation indicators | Milestones | Other drivers

Introduction and key messages

1. Waste emissions: trends and drivers
2. Waste emissions: projections and abatement potential
3. Incentives for reducing emissions from waste
4. Waste as bioenergy resource and recycling emissions
5. Indicators of progress reducing waste emissions

Image courtesy of the London Borough of Islington.

Chapter 7: Progress reducing emissions from waste

Introduction and key messages

Waste emissions account for around 3% of total UK greenhouse gas emissions. They are predominantly methane emissions which arise due to the decomposition of biodegradable waste in landfill sites in the absence of oxygen (around 90% of waste emissions). They also arise due to wastewater treatment and incineration of wastes.

Although we have previously set out high-level assessments of waste emissions (e.g. in our advice on the 2050 target, and on the fourth carbon budget), this is the first time that we have included an analysis in our progress reports to Parliament.

Therefore, whereas other chapters consider progress against already established indicator frameworks, this chapter considers latest emissions data and sets out indicators against which future progress can be monitored, including policy milestones to drive progress.

Our key messages are:

- Waste emissions fell by 3% in 2010, continuing a longer-term trend where emissions fell by 64% over the period since 1990, largely due to reduced methane emissions arising from landfill sites.
- The Government has ambition to further reduce emissions by 22% in 2020 (72% relative to 1990). This reflects a 25% reduction in the amount of biodegradable waste landfilled in 2020 relative to 2010, which is required to meet UK targets under the EU Landfill Directive. Our analysis suggests that there is potential to go beyond this given further opportunities for waste prevention and recycling and other disposal methods such as anaerobic digestion and composting. Increased ambition for the next decade may be appropriate, particularly given the long-term legacy emissions from waste sent to landfill over the next decade, and should be considered by the Government.
- The key driver of future waste emissions reductions will be the landfill tax, which provides a financial incentive for reducing the amount of biodegradable waste sent to landfill. In addition to the landfill tax, the Government is considering new approaches to addressing barriers to the reduction of biodegradable waste sent to landfill, with a focus on voluntary agreements and the role of information provision/public engagement. Stronger levers may need to be introduced if full potential for reducing waste emissions is to be addressed; this should be kept under review.
- Food and paper/card are the two largest sources of waste emissions and offer the largest potential to reduce emissions. We therefore recommend that the Government should develop specific strategies for reducing the amount of these waste streams sent to landfill. These should cover the full range of levers across the waste chain (i.e. from producers and retailers through to disposal) and for waste generated by households and the commercial and industrial sectors.

We set out the analysis that underpins these messages in five sections:

1. Waste emissions: trends and drivers
2. Waste emissions: projections and abatement potential
3. Incentives for reducing emissions from waste
4. Waste as bioenergy resource and recycling emissions
5. Indicators of progress reducing waste emissions

1. Waste emissions: trends and drivers

Emission trends – methane, nitrous oxide, and CO_2

Waste emissions in the UK inventory comprise emissions arising from the disposal and treatment of biodegradable wastes produced by UK households and the commercial and industrial sectors. These waste streams include food, paper and card, green (e.g. garden waste), wood, and textiles, as well as wastewater. Emissions arising from agricultural wastes (i.e. manures) are captured in the agriculture rather than the waste inventory (see Chapter 6). Emissions from incineration of waste without energy recovery are included in the waste inventory, but those from incineration of waste with energy recovery are accounted for under energy supply emissions.

Emissions from waste (CO_2 and non-CO_2) represent around 3% of all UK greenhouse gas (GHG) emissions (Figure 7.1). They relate primarily to methane arising at landfill sites, which accounted for 89% of total waste emissions in 2010, and 36% of all UK methane emissions.

The remaining waste emissions relate to nitrous oxide (N_2O) arising from wastewater treatment (9%) and CO_2 from the incineration of wastes without energy recovery (2%)[1].

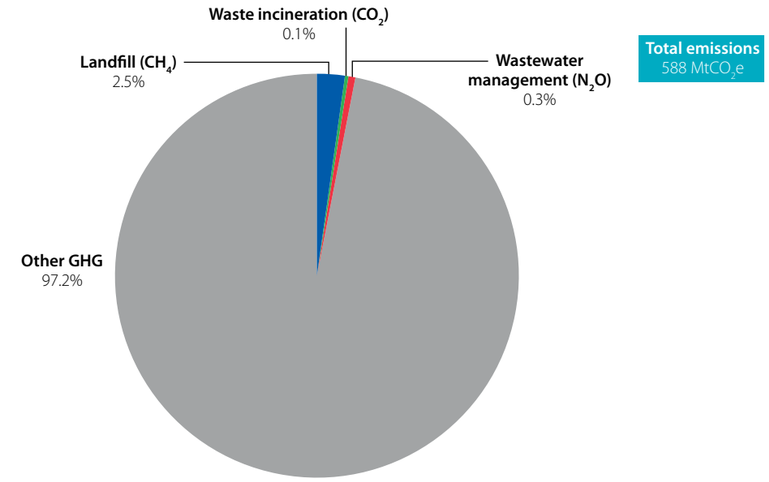
Overall waste emissions (methane, N_2O and CO_2) have declined 64% over the period 1990-2010 from 46 $MtCO_2e$ to 17 $MtCO_2e$ (Figure 7.2):

- Methane emissions fell 66%, from 43 $MtCO_2e$ to 15 $MtCO_2e$.
- N_2O emissions from sewage sludge decomposition have risen slightly (+3%) to 1.5 $MtCO_2e$.
- CO_2 emissions from incineration of wastes (without energy recovery) have decreased from 1.4 to 0.3 $MtCO_2e$ (77%); CO_2 emissions arising from incineration that are accounted for in the energy supply sector increased from 0.2 to 1.3 $MtCO_2$.

Historical waste methane emissions are not directly measured. Rather they are calculated using national data on the quantity and composition of waste sent to landfill sites, assumptions on the properties of various waste streams (e.g. how much and over how many years methane is emitted from different fractions of wastes) as well as the properties of landfill sites (e.g. how much methane is captured).

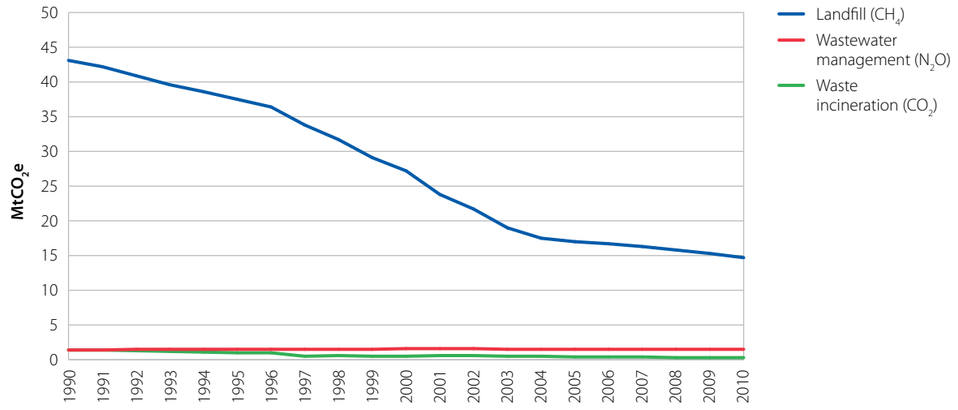
1 Emissions arising from the incineration of wastes with energy recovery are captured in the energy supply sector.

Figure 7.1: Waste emissions as a share of all UK greenhouse gas emissions (2010)



Source: NAEI (2012).

Figure 7.2: Waste emissions by source and greenhouse gas (1990-2010)



Source: NAEI (2012).

During 2010, Defra carried out a review of the data and assumptions used to calculate and project methane emissions from landfill. The results of this review suggest landfill methane emissions in 1990 were lower than previously modelled (43 $MtCO_2e$ rather than 51 $MtCO_2e$), have since fallen more quickly (to 15 $MtCO_2e$ in 2009 rather than 21 $MtCO_2e$), and will continue to decrease faster than previously expected[2]. The new estimates reflect a more thorough modelling approach, including better data on the quantity of biodegradable wastes landfilled over time and improved emissions factors for methane arising from different waste types over time. The UK GHG inventory for waste emissions was revised to reflect these new estimates, which we have incorporated into our assessment in this chapter.

Even taking account of this latest work to advance the evidence base, considerable scientific and analytical uncertainty regarding the modelling of methane emissions from waste remains:

- **Waste arisings.** Emissions are in part determined by waste that was landfilled many years ago, for which good data do not exist (data are based on past surveys of varying quality and cannot be gathered retrospectively). Even for current waste arisings, data are survey based, with limited confidence particularly for the commercial, industrial, construction and demolition sectors.
- **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, with field and experimental observations exhibiting wide variation (e.g. reflecting differences in how materials are mixed together, which affects moisture content, and access of waste streams to oxygen)[3]. The yield and decay rate are also affected by real landfill conditions, which will 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 54% greater or lower than currently recorded in the inventory[4].
- **Methane capture rate.** Data on which to base assumptions on the level of methane that is captured at landfill sites is very limited. The quantity of gas captured will be landfill site specific and depend on various factors, such as the capture technology implemented, the point at which the technology becomes active and its day-to-day operation. For example, if a site is not properly capped during its operational phase, methane will start to be emitted and, for some fast decaying materials like food, a significant proportion will be released before the cap is in place.

While these uncertainties mean that the precise level of emissions from waste is uncertain, it is clear that a reduction in biodegradable waste sent to landfill will reduce emissions.

There may be opportunities to develop the evidence base further and therefore to improve the accuracy of estimates of waste emissions, for example through working with the waste management industry to improve estimates of construction and industrial waste arisings. Defra and the Environment Agency are currently working jointly to improve estimates of methane captured at UK landfill sites through on-site testing. We will reflect any improvement in the evidence base in our future reports.

2 DECC (2011) Projections of non-CO_2 greenhouse gas emissions
3 IPCC (2006) Guidelines for National Greenhouse Gas Inventories, Chapter 3
4 AEA & DECC (2012). *Waste GHG Inventory summary factsheet*

Emissions drivers – methane

Methane arising from landfill sites as food, paper and other biodegradable rubbish decomposes without oxygen accounts for 98% of methane from the waste sector. The remaining 2% comes primarily from wastewater treatment, as methane is produced from anaerobic decomposition of organic matter by bacteria in sewage facilities.

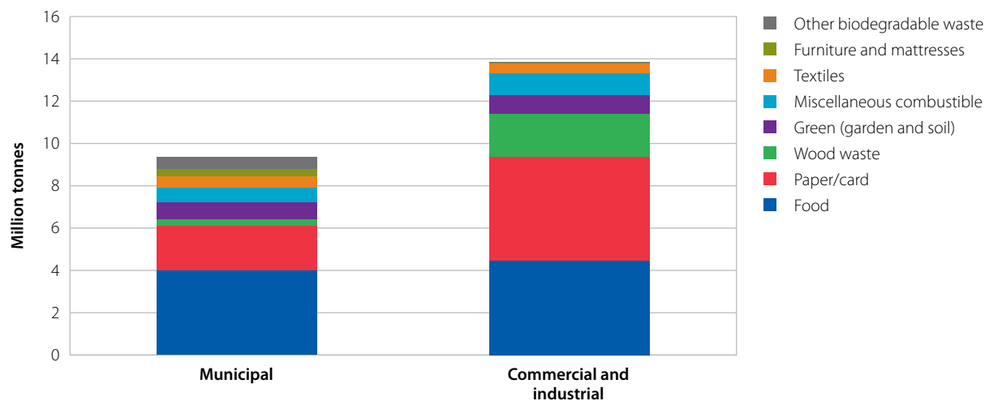
Degradation of waste varies according to the type of waste, and some types of waste are more 'highly gassing' than others, meaning they will emit a greater quantity of methane per tonne of waste landfilled over time (Box. 7.1). Degradation also takes place over many years, so that even if there was a significant decline in the volume of waste being sent to landfill, emissions would not immediately fall by as much, as the waste already in the ground would continue to emit.

Biodegradable waste is estimated to comprise 40% of total waste sent to landfill (by weight). Of that landfilled biodegradable waste, 60% is from the commercial and industrial sectors, with the remaining 40% arising from municipal sources (i.e. mainly households). Food (36%), paper/card (30%), wood (10%) and green (7%) waste are the largest components of the biodegradable waste stream sent to landfill (Figure 7.3). These waste streams (i.e. food, paper/card, wood and green waste) also emit a greater amount of methane per tonne of waste landfilled relative to other biodegradable sources and are therefore the largest contributors to waste emissions (Figure 7.4).

The three key drivers of methane emissions arising from landfill sites are:

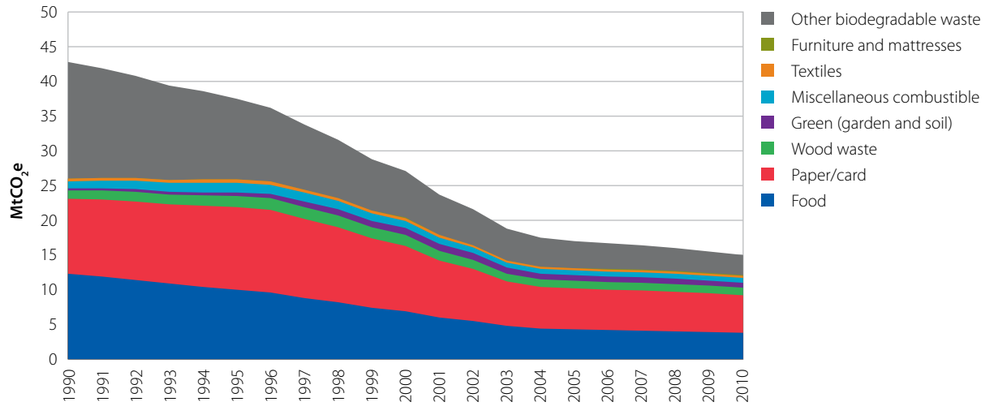
- The total amount of biodegradable waste arising,
- The proportion of biodegradable waste sent to landfill,
- The proportion of methane emitted by landfill sites that is captured or flared.

Figure 7.3: Biodegradable waste sent to landfill (2010)



Source: Defra (2012), MELMod (UK landfill methane emissions) model.

Figure 7.4: Contribution of different waste streams to historical landfill methane emissions (1990-2010)



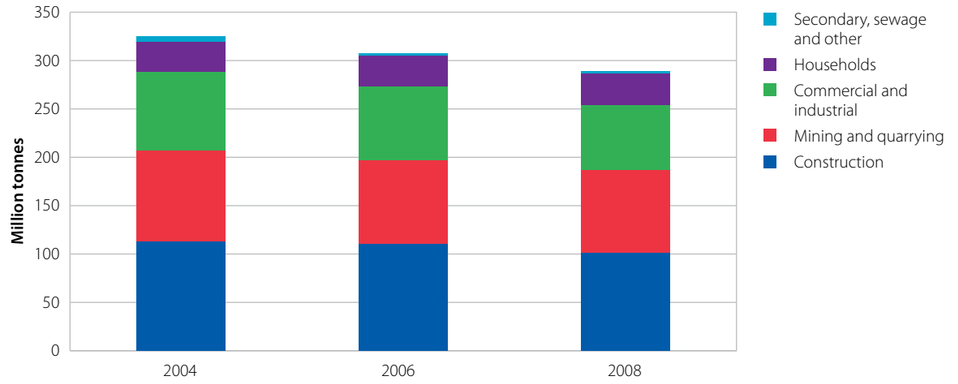
Source: Defra (2012) UK MELMod model.

A range of EU and UK policies have led to significant progress across all three emissions drivers since 1990:

- **Waste arisings.** The limited data available on total UK waste arisings suggest a reduction in the overall level, with particular reductions in the commercial and industrial sectors as well as household food waste.
  - In the UK, in 2008 (the latest year for which survey data are available), total waste generation was estimated at 289 million tonnes (Mt)[5], a decrease of 11% since 2004; within this 187 Mt was from the construction, mining and quarrying sectors (i.e. inert waste such as minerals) and around 100 Mt was from the household and commercial/industrial sectors (i.e. largely non-inert waste with potential to release methane if landfilled). Commercial and industrial waste fell by 17% while household waste increased by 2% (Figure 7.5).
  - Data on trends in biodegradable waste arisings are limited but suggests a 6% increase in total arisings between 2004 and 2008, with food waste increasing by 22% but with decreases in paper/card (-2%), wood (-8%), and textile (-29%) waste[6]. However, more recent evidence from the Waste Reduction Action Programme (WRAP) suggests overall UK household food and drink waste decreased by 13% between 2007 and 2010.
- **Waste sent to landfill.** The amount of household and commercial/industrial waste landfilled is estimated to have decreased by 34% relative to 1990 levels from 93 to 62 Mt (i.e. around 60% of waste arisings). Within this, biodegradable waste sent to landfill fell by 56% to 23 Mt[7].

5 Defra UK waste statistics (August 2011), Total UK Waste Generation by Sector
6 Defra UK waste statistics (August 2011), Total UK Waste Generation by Waste Type; this does not reflect potential reductions in biodegradable waste mixed with household and other mixed/undifferentiated wastes.
7 Based on data in the latest version of Defra's MELMod model (2012), used to calculate UK landfill methane emissions.

Figure 7.5: Total UK waste arisings by sector (2004, 2006 and 2008)



Source: Defra (2011) *Total UK Waste Generation by Sector.*
Notes: Other includes healthcare wastes, batteries & accumulators, and wastes containing PCB.

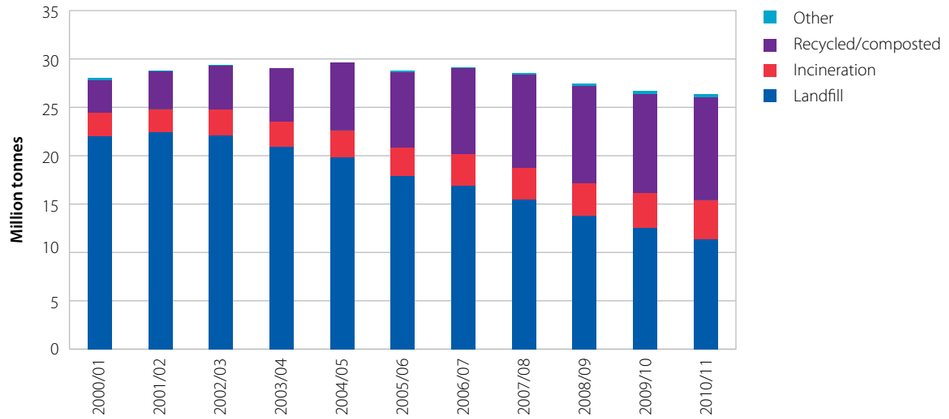
  - Municipal waste (i.e. mostly household waste collected by local authorities) sent to landfill increased from 18 Mt in 1990 to reach 28 Mt in 2000, but has since fallen to 13 Mt in 2010. Within this, biodegradable waste also fell by 26% from 1990, to 9 Mt in 2011.
  - Commercial and industrial waste sent to landfill has decreased 35% from 75 to 48 Mt. Within this, biodegradable waste fell more quickly, by 65% to 14 Mt.
  - These reductions were achieved by increasing the use of alternative disposal methods. For example, the overall household recycling rate (including composting) in England has increased from 12% to 40% between 2001 and 2011 and the proportion of total municipal waste treated via recycling, reuse, composting or for energy production has increased from 21% in 2001 to 55% in 2011 (Figure 7.6).
- **Methane capture rate at landfill sites.** Average lifetime capture rates at operational landfills with gas utilisation have increased from 15% in 1990 to an assumed average rate of 75% from 2007.

As a result, methane emissions decreased by 66% between 1990 and 2010 (Figure 7.7).

Key to this reduction is the EU Landfill Directive, which requires that biodegradable municipal waste landfilled in the UK had to be reduced to 75% of that produced in 1995 by 2010, and has to be further reduced to 50% by 2013 and to 35% by 2020. Data for 2010 suggest that the target is currently being outperformed, with reductions already at the level required by 2013[8]. The Directive also requires landfill operators to collect and treat gases arising from sites (e.g. for energy production or through flaring).

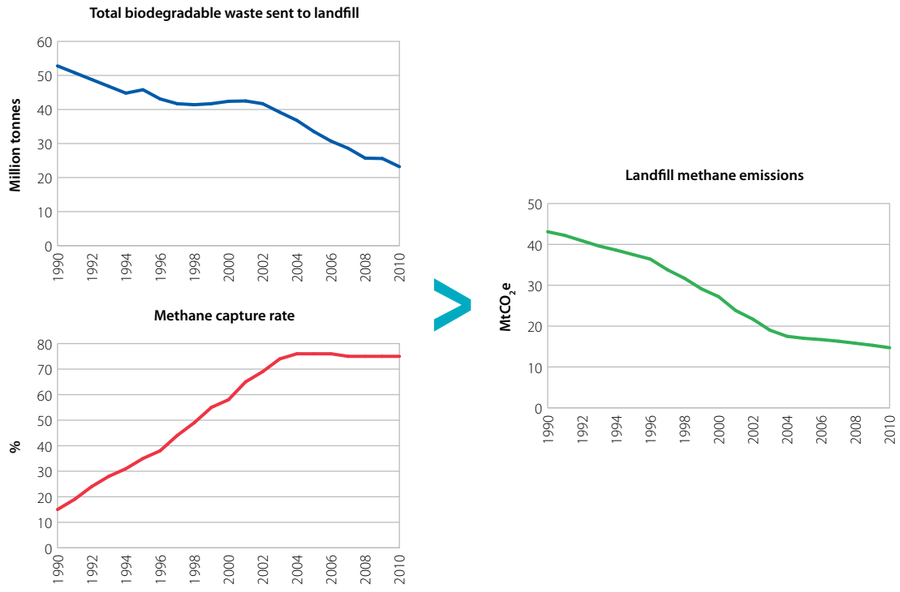
8 Based on data in Defra's MELMod model (2012).

Figure 7.6: Local authority collected waste management in England (2001-2011)



Source: Defra (2011) *Local Authority Collected Waste Statistics*.
Notes: 'Other includes material sent for Mechanical Biological Treatment (MBT), mixed municipal waste sent for Anaerobic Digestion (AD) and that disposed through other treatment processes.

Figure 7.7: Total biodegradable waste sent to landfill, proportion of methane captured at landfill sites and methane emissions ($MtCO_2e$) from landfill (1990-2010)



Source: Defra (2012), MELMod model.
Notes: These charts provide a high-level overview of the key drivers accounting for reductions in landfill methane, which arises as various biodegradable waste streams decompose in the absence of oxygen. Emissions are a function of 1 minus the methane capture rate, and depend on the precise composition and historical timing of landfilled materials (e.g. each waste stream decays at a different rate and emits different levels of methane over time).

In order to achieve targets under the Directive the UK Landfill Tax and the Landfill Allowance Trading Scheme were introduced.

- The **UK Landfill Tax**, introduced in 1996, has been the main driver of reduced emissions from landfill. The tax is paid by landfill operators, who pass on the costs as gate fees to Local Authorities and businesses, creating an incentive for them to seek means to reduce the waste they send to landfill. The standard rate has been increased from its initial rate of £7 per tonne to a current level of £64 per tonne, and will rise to £80 per tonne by 2014/15.
- The **Landfill Allowance Trading Scheme** was also introduced in 2005, with landfill allowances allocated to local authorities to meet UK targets under the Landfill Directive. The value of these allowances has tended to be far lower than the landfill tax (e.g. £5 per tonne in 2009/10). The scheme will be abolished after 2012/13 as the landfill tax has been determined to be a more effective driver for landfill diversion.

There have also been a number of complementary approaches to encourage waste reduction, increased recycling rates and diversion of waste from landfill:

- **Waste reduction.** WRAP's Love Food Hate Waste Programme encourages voluntary reductions in food waste. It was introduced in 2007 and has had some success, with food waste generated by English households falling by over 1 million tonnes between 2007 and 2010. The Courtauld Commitment, a responsibility deal aimed at improving resource efficiency in the grocery retail sector, prevented 0.7 Mt of food waste between 2005 and 2009 and aims to further reduce household food and drink waste by 4% between 2009 and 2012.
- **Diversion of waste towards recycling and other treatments.** Partly incentivised by the landfill tax, local authorities have supported the sorting of waste through providing for recycling (and in some cases for separate food waste) collection, encouraged composting, and invested in waste treatment facilities.
- **Methane capture and anaerobic digestion.** A combination of permit conditions and financial incentives for capturing methane from landfill and anaerobic digestion (under the Renewables Obligation, Feed-in Tariffs, Renewable Heat Incentive and Renewable Transport Fuel Obligation) has driven investment to significantly increase capture of methane at landfill sites.

Success in reducing landfill emissions since 1990 therefore reflects a combination of financial incentives introduced through the landfill tax, information and voluntary programmes for waste reduction, local authority and commercial/industrial sector actions in response to the landfill tax, and regulations requiring improved practices.

Box 7.1: Rates of decay and lifetime methane emissions for different waste streams

Different types of biodegradable waste decay at different rates in landfill and therefore emit methane at different rates. For example, a tonne of paper waste will emit half its eventual total methane emissions between 12 to 17 years, approximately twice as quickly as a tonne of wood waste. Some types of biodegradable waste also emit a greater quantity of methane per tonne of waste landfilled over time (e.g. food will emit 0.38 tCO_2e per tonne of food waste landfilled over 100 years) (Table B7.1).

Table B7.1: IPCC default half-life values (boreal and temperate climate zones) and lifetime methane emissions for waste streams landfilled in the UK

Type of waste		Dry materials (years)	Wet materials (years)	Lifetime methane emissions (tCO_2e/t waste landfilled)
Slowly degrading	Paper/Textiles	17	12	0.42
	Wood/Straw	35	23	0.28
Moderately degrading	Other (non-food)/ Garden and park waste	14	7	0.44
Rapidly degrading	Food/sewage sludge	12	4	0.38
Bulk waste		14	7	0.21

Source: IPCC (2006) *Guidelines for National Greenhouse Gas Inventories*; UK GHG Inventory for Waste Tier 2 emissions factors; Eunomia (2008), *Development of Marginal Abatement Cost Curves for the Waste Sector* model.
Note: Material half-life refers to the number of years for it to release half of its remaining emissions potential. Lifetime methane emissions indicate the amount of methane (CO_2e) a tonne of waste will emit over 100 years.

Emissions drivers – nitrous oxide and CO_2

Nitrous oxide (N_2O) emissions in the waste management sector primarily come from wastewater treatment[9]. The main drivers of N_2O emissions are the quantity of sewage sludge disposed, population levels, and protein consumption. In 2010, N_2O emissions from wastewater treatment and sewage sludge disposal accounted for around 4% of all UK N_2O emissions[10]. Waste N_2O emissions have increased by 3% since 1990 due to an increase in the total volume of sludge disposed, reflecting an increase in the UK population and average protein consumption per capita.

CO_2 emissions from incineration of wastes without any recovery of energy are included in the waste sector inventory emissions. Emissions from incineration of waste *with* energy recovery are captured in the energy supply sector. Since the late 1990s most incineration has included energy recovery and therefore most waste incineration emissions are accounted for in the energy supply sector. In total, CO_2 emissions from incineration of wastes (both with and without energy recovery) have increased by 3% between 1990 and 2010:

- Emissions from incineration of waste *without* energy recovery arise from the incineration of clinical waste and sewage sludge rather than local authority collected waste. These emissions have decreased from 1.4 $MtCO_2$ to 0.3 $MtCO_2$ between 1990 and 2010.
- Emissions arising from the incineration of waste with energy recovery have increased from 0.2 to 1.3 $MtCO_2$ between 1990 and 2010. These emissions are related to the burning of wastes with fossil fuel content (e.g. plastics). CO_2 emissions released from incineration of organic waste are considered to be carbon neutral as, by nature, they are offset by an equivalent amount of CO_2 absorbed from the atmosphere via photosynthesis during growth.

Given the small magnitude of these emissions, our focus in considering abatement potential and in setting out indicators is on methane from landfill.

9 There is also a very small amount of N_2O emitted from incineration.
10 DECC (2011) *UK Greenhouse Gas Inventory: National Statistics User Guide.*

2. Waste emissions: projections and abatement potential

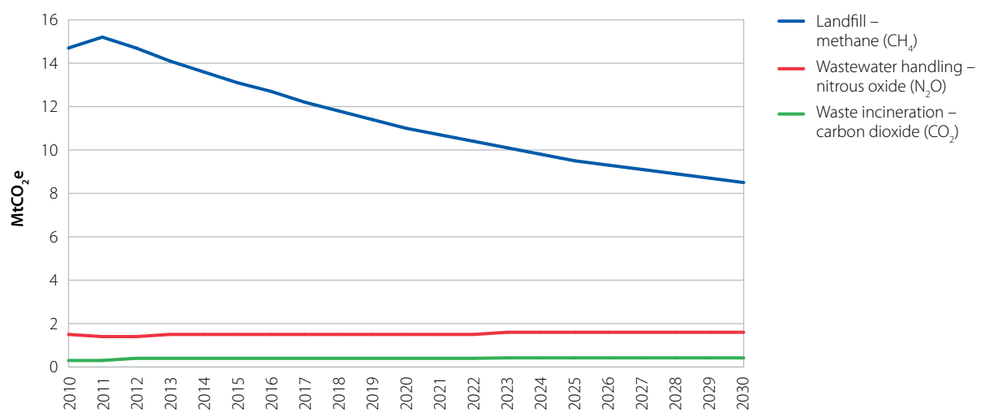
Emission projections – methane

Latest Government projections assume a continuing reduction in waste methane emissions, to reach 11 $MtCO_2e$ by 2020 and 8.5 $MtCO_2e$ by 2030 (compared to 15 $MtCO_2e$ in 2010) as Landfill Directive targets are met (Figure 7.8).

- Food and paper/card waste are estimated to contribute 65% of 2020 emissions (Figure 7.9).
- The amount of biodegradable waste sent to landfill is assumed to decline by 25% in 2020 relative to 2010 levels (food by 22%, paper/card by 33% and all other biodegradable waste by 21%).
- The methane capture rate at landfill sites is assumed to continue at 75%.

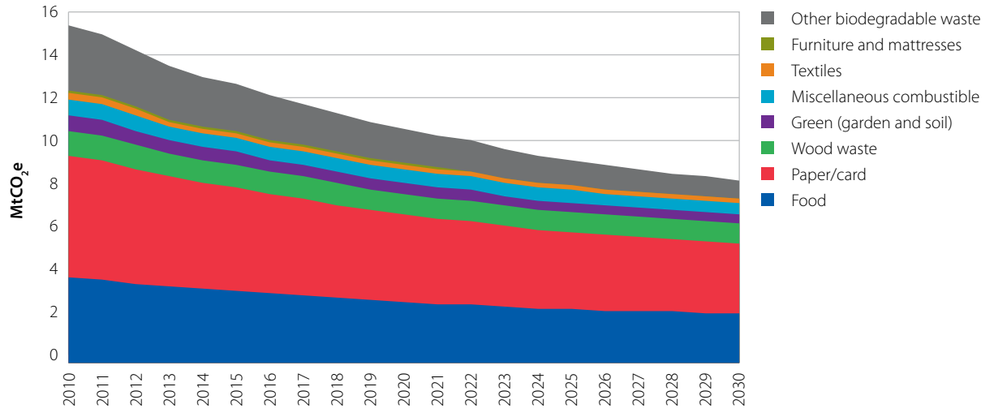
The key driver in the Government's projections is therefore reduced waste sent to landfill, rather than an increase in the amount of methane captured at landfill sites.

Figure 7.8: Waste emissions projections (2010-2030)



Source: DECC (2012), 2011 Energy and emissions projections

Figure 7.9: Landfill methane emissions projections by waste stream (2010-2030)



Source: Defra (2012), MELMod (UK landfill methane emissions model).
Notes: Tonnage sent to landfill remains flat post-2020.

Emission projections – N_2O & CO_2

Reflecting population projections, the general upward trend in N_2O emissions observed over the past two decades is expected to continue, with emissions increasing 3% from 2010 levels to 1.5 $MtCO_2e$ in 2020.

CO_2 emissions projections for the incineration of waste without energy recovery are projected to remain roughly constant at current levels (0.3 $MtCO_2e$ in 2010 to 0.4 $MtCO_2e$ in 2020). Our analysis suggests that CO_2 emissions from incineration with energy recovery (which are in the energy supply sector) should remain broadly flat in the future as other waste management options are likely to be more cost-effective than incineration.

Scope for further reductions in waste emissions

Diversion of biodegradable waste from landfill

For our December 2008 report we commissioned analysis from Eunomia on scope for reducing waste emissions[11]. This analysis focused on opportunities for diverting biodegradable waste away from landfill and towards recycling, composting, anaerobic digestion (AD), mechanical biological treatment (MBT), and incineration with energy recovery (Box 7.2).

The analysis assumed that under the influence of the landfill tax and other existing policies, the amount of biodegradable waste sent to landfill could be reduced by 30% in 2022 relative to 2008 levels. This is similar to the reduction underpinning the Government's new projections for waste emissions (a 32% reduction in landfilled biodegradable waste in 2022 relative to 2008).

11 Eunomia (2008), *Development of Marginal Abatement Cost Curves for the Waste Sector.*

The Eunomia analysis also identified scope to go significantly further than the Government's current ambition (and EU Landfill Directive requirements) across all waste streams and sectors:

- There is cost-effective potential (i.e. available at a cost below the Government's carbon price underpin of £30/tCO_2e in 2020) to divert an additional 7% of biodegradable waste (mainly sorted food and paper/card waste) towards recycling, composting and AD by 2022 relative to 2008 levels (for a total reduction in biodegradable waste in 2022 of 37% relative to 2008 levels). This opportunity is from commercial/industrial waste, which is assumed to be easier to sort and collect separately than municipal waste.
- There is technical potential at a higher cost (£35-150/tCO_2e) to divert nearly all biodegradable waste from landfill by 2022. This would require further sorting and separate collection of waste streams for recycling, composting or AD, with the remainder treated by MBT. These deeper reductions may be worth pursuing today given rising carbon prices over the period of legacy emissions from waste landfilled in the next decade (e.g. the Government's carbon values reach £70/tCO_2e in 2030, rising to £200/tCO_2e in 2050) as well as general uncertainties over costs and potential for co-benefits associated with avoiding landfill (e.g. contribution to renewable targets from AD, avoided local disamenity associated with landfill sites).

This analysis raises questions as to whether the current ambition is appropriate or whether increased ambition would be desirable; this should be considered by Government.

The European Commission in its recent *Roadmap to a Resource Efficient Europe* (2011) has similarly suggested that landfilling could be "virtually eliminated" by 2020 through a combination of waste prevention and increased reuse, recycling and recovery of wastes.

Waste prevention

Waste emissions can also be further reduced through waste prevention, which offers substantial upstream environmental and economic gains associated with resource efficiency beyond the benefits of reducing methane from landfill. Evidence from WRAP and comparisons with other European countries suggest significant potential may be available:

- UK households threw away 7.2 Mt of food in 2010, of which 4.4 million tonnes (valued at £12 billion) was identified by WRAP as avoidable (i.e. preventable through simple measures including information provision, engagement of retailers, brands, local authorities and householders, better planning).
- The amount of household food waste generated in the UK is currently higher than other European countries (e.g. 137kg/capita in the UK compared to 100kg/capita in France, 93kg/capita in Germany and 46kg/capita in Italy)[12].
- Opportunities may also exist in other sectors (e.g. hospitality and food service), but are less well researched.

12 European Commission (2010) *Preparatory Study on Food Waste across EU 27.*

These opportunities for waste prevention strengthen our previous conclusion that greater reductions in waste sent to landfill than those targeted by the Government are feasible and may be desirable.

Landfill methane capture

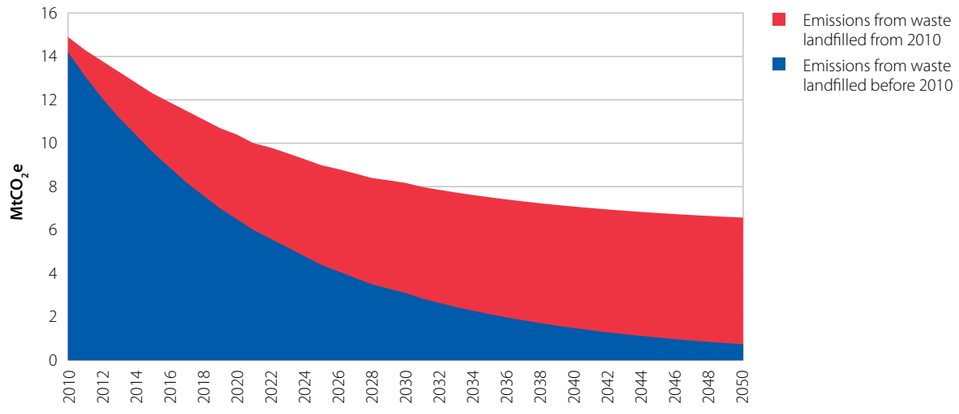
Even if biodegradable waste sent to landfill could be eliminated overnight, there would still be significant legacy emissions from waste (Figure 7.10). This highlights the importance of methane capture from landfill sites.

Evidence on methane capture is limited, but there may be scope to achieve higher rates:

- The assumed average capture rate for UK landfill sites is 75%, however this assumption is currently being investigated and the rate of methane capture is likely to be considerably lower at older sites.
- Methane capture at modern landfill sites is over 80% and can reach as high as 90%, with these sites set to play a bigger role as legacy emissions from older (and less efficient) landfill sites decline[13].

The Government (Defra and the Environment Agency) is currently commissioning research to improve confidence in the levels of methane capture at UK landfill sites and is engaged in projects to promote new technologies and share best practice between landfill sites.

Figure 7.10: Impact of legacy waste on future landfill methane emissions



Source: Defra (2012), MELMod model.
Notes: Tonnage sent to landfill remains flat post-2020.

13 UK Environmental Services Association

CO_2 emissions from incineration of wastes

CO_2 emissions are currently a very low proportion of emissions from waste management. However, as less waste is sent to landfill in order to meet landfill targets, more could be sent to incineration with energy recovery, reducing methane emissions but increasing CO_2 emissions (e.g. plastics combusted in an incinerator emit CO_2). Depending on the evolution of waste management (e.g. effectiveness of waste minimisation measures, increases in recycling), it is also possible that a major part of future waste sector GHG emissions could be the thermal treatment of waste with a fossil carbon content. It is therefore important that steps are taken to avoid increases in these emissions (Box 7.3).

Box 7.2: Treatment options for biodegradable waste diverted from landfill

In our December 2008 report and our Fourth Carbon Budget report (December 2010), we published analysis of potential emission reductions in the waste sector. This focused on treatment options for biodegradable waste diverted from landfill:

- **Recycling.** The processing of various waste streams (e.g. plastics, glass and paper/card) into new products can reduce the use of raw materials and energy use from manufacturing, as well as reduce environmental impacts from waste processing (e.g. incineration). In particular, the recycling of biodegradable waste streams such as paper/card and wood will avoid landfill methane emissions.
- **Composting.** Composting can be used to treat food and green waste. If properly managed, organic waste in a compost pile will decompose in the presence of oxygen (i.e. aerobically rather than anaerobically) and will produce (biogenic) CO_2 instead of methane. The compost can be applied to land, reducing the need for fertiliser and the associated emissions. Composting requires that food and green wastes are collected separately from other wastes.
- **Anaerobic Digestion (AD).** AD can be used to treat sorted food and green waste. The biogas produced can be used, for example, for generating heat and/or power or as a vehicle fuel (if it is cleaned of impurities). The digestate that remains after biogas has been generated can be applied to land, displacing the need for fertiliser.
- **Mechanical Biological Treatment (MBT).** MBT involves breaking mixed waste down (e.g. by shredding) and removing any recyclable material. The waste is then either composted or digested, producing biogas. There are two possible outputs: a low-quality soil or a solid recovered fuel (SRF) for burning in a dedicated combustion facility. The emissions impact of MBT with SRF varies according to the type of thermal process. For example, if it is used to offset coal use in cement kilns, the emissions savings are favourable but if used for mass-burn incineration the savings are less favourable relative to landfilling.
- I**ncineration with energy recovery.** Waste collected can either be fed directly into a furnace or boiler without any prior separation or sorting, or it can be passed through an MBT process first and the refuse-derived fuel fed into the incinerator.

Box 7.2: Treatment options for biodegradable waste diverted from landfill

Many of the above treatment options were estimated to be available at negative or low cost. The costlier options generally involve MBT. Full technical potential was identified at a cost of up to £150/tCO_2e to divert close to all biodegradable waste (95%) from landfill by 2022.

Since the Eunomia analysis was published, the waste emissions inventory has been revised and the landfill tax has increased, both of which may affect the costs and abatement potentials identified. However, they are not likely to affect the conclusion that close to full diversion of biodegradable waste from landfill is feasible.

For example, a recent WRAP study (2010) suggests that landfill bans, particularly for biodegradable wastes, have potential to yield climate change benefits and resource efficiency gains, if coupled with policies to support waste sorting and increased recycling levels. This is subject to a number of factors including costs, environmental performance, and availability of sufficient treatment capacity for processing residual waste streams.

The costs of the key treatment options and implications for the quantities of biodegradable waste diverted from landfill are summarised in Table B7.2, taking into account all relevant emissions (e.g. including CO_2 emissions displaced by any generated biogas).

Table B7.2: Costs and potential from key landfill diversion measures (2022)

Treatment alternative to landfill	Waste stream	Sector	Cost (£/tCO_2e)	Biodegradable waste diverted from landfill (% from 2008)
Recycling	Paper/card	Industrial & Commercial	-£108 to -£67	1.1%
Composting	Food/green	Commercial	-£4	0.8%
AD (compressed biogas used in vehicles)	Food	Commercial & Industrial	£5-16	4.8%
MBT (SRF to power station or cement kiln)	Residual (unsorted)	All sectors	£34-37	16.4%
Composting, recycling and AD	Paper/card, food, green	Commercial and municipal	£69-108	3.3%
MBT (SRF to land recovery)	Other residual (unsorted)	All sectors	£147	38.8%
Total additional biodegradable waste diverted from landfill				65.2%
Total biodegradable waste diverted from landfill (including baseline reductions)				95.2%[14]

Source: Eunomia (2008); Eunomia (2010), *Landfill Bans: Feasibility Research*

14 The Eunomia analysis assumed that the amount of biodegradable waste sent to landfill could be reduced by 30% in 2022 relative to 2008 levels under baseline conditions (e.g. the influence of the landfill tax and other existing policies).

Box 7.3: Avoiding increases in CO_2 emissions from incineration of residual waste streams

Current options for avoiding CO_2 emissions arising from incineration of waste streams with fossil carbon content include:

- **Increased recycling.** If more plastics could be recycled or reused, the fossil carbon content of the residual waste stream sent for incineration would be reduced.
- **Landfilling.** As fossil plastics do not biodegrade, landfilling of plastics (with or without MBT) rather than incineration could be considered. Analysis by WRAP[15] suggests that while landfilling plastics generally results in a better climate change outcome than incineration, it could involve trade-offs with other environmental objectives (e.g. local disamenity impacts associated with landfill sites).

Longer-term solutions to reducing CO_2 emissions from incineration of waste also include:

- **Use of biodegradable plastics derived from renewable biomass sources**, which could then be treated in the same way as other biodegradable waste streams (e.g. via anaerobic digestion). It would be important to keep biodegradable plastics out of landfill, where they would generate methane emissions.
- Use of **carbon capture and storage (CCS) technologies** in incineration plants to capture CO_2 emissions.
- **Novel treatments.** In the longer term there may be means of thermally treating residual waste which does not lead to the combustion of fossil carbon (e.g. approaches to chemical synthesis or feedstock recycling).[16]

Given these options, it is feasible to reduce the total amount of waste sent to landfill without a significant increase in CO_2 emissions from waste.

Source: see Footnotes 15 and 16 below

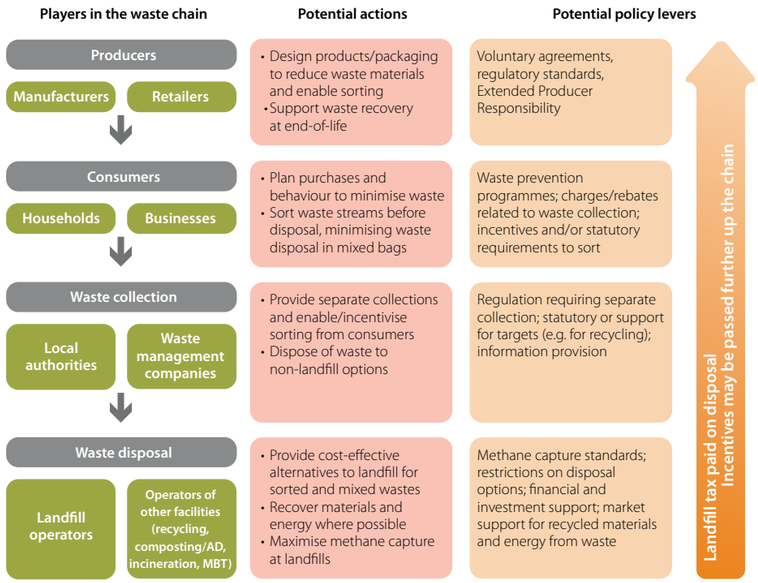
3. Incentives for reducing emissions from waste

The key driver for reducing future waste emissions will be the financial incentive provided by the landfill tax to avoid disposing of biodegradable waste in landfill. In theory this could drive the actions required by agents across the waste chain (i.e. not just from waste management companies who pay the landfill tax) – from packaging firms and retailers to households and businesses, local authorities and investors/operators of waste disposal facilities (Figure 7.11). However, some parts of the waste chain may require direct regulations or incentives:

- **Waste reduction.** Most households and businesses are able to reduce the amount of waste they produce. While businesses with large waste streams may seek to do this to reduce their waste management costs, incentives are limited for households and smaller businesses that do not face the full cost of waste disposal. Securing effective responses from households, small businesses, and from further up the product chain (e.g. by packaging firms and retailers) may therefore require levers beyond the landfill tax.
- **Waste sorting.** Sorted (rather than mixed bag) waste has more disposal options and is likely to be lower cost to divert from landfill (e.g. paper/card can be recycled, food and green waste can be sent to composting or anaerobic digestion). Again, the landfill tax may incentivise large firms to sort their waste in order to reduce their waste management costs, but households and small firms may not be rewarded for sorting waste.

15 WRAP (2010), *Environmental benefits of recycling*
16 Eunomia (2008), *Development of Marginal Abatement Cost Curves for the Waste Sector*

Figure 7.11: The waste chain – key players, potential actions and policy levers



Source: CCC.
Notes: Potential actions and policy levers are not exhaustive of all options.

- **Separate collections.** In order to effectively dispose of sorted waste it must be collected separately. The landfill tax provides an incentive for waste management firms and local authorities to provide separate collections in order to reduce their own disposal costs. However, separate collection will only be worthwhile where wastes are sorted and there may be other barriers to provision of separate waste collection (e.g. added 'hassle' of having to sort items, having an extra bin, and needing to wash bins more often; information for local authorities on designing efficient collection systems). Currently approximately 25% of English local authorities provide for separate collection of food waste, with a further 25% collecting food mixed in with garden waste.
- **Appropriate disposal.** The landfill tax will most directly affect incentives for disposal. However even here there may be barriers (e.g. financing) related to development/deployment of technologies (such as MBT and AD) and some alternatives may not capture the full value they offer (e.g. the upstream carbon benefits associated with recycling).
- **Methane capture.** The landfill tax is the same regardless of the performance of a given landfill site. Incentivising increases in methane capture at landfill sites is therefore likely to require regulation (e.g. through standards and permit conditions) and sharing of best practice.

In June 2011 Government published a review of its waste policy (this covered England only), aiming to put the UK on a path towards a 'zero waste' economy. The landfill tax remains the key lever for reducing waste sent to landfill, with announced rises to increase the rate by 25% on 2012 levels to £80/tonne in 2015/16.

The Waste Review also included an Action Plan that set out further waste policy measures Government will commit to or consider in order to drive waste further up the "waste hierarchy"[17]. Measures most likely to reduce waste emissions include ambition for a comprehensive waste prevention programme, voluntary responsibility deals with key sectors to reduce material use and promote recovery (e.g. with the waste management, paper, packaging, and hospitality industries), encouraging better management of food waste (e.g. through promoting separate collection for composting or AD), and exploring opportunities to capture more methane from landfill sites and for material-specific landfill bans (e.g. for wood waste and textiles) – see Box 7.4. The Government has also committed to promoting increased energy from waste from AD through reducing key barriers (e.g. informational barriers, a lack of sufficient markets for end products, and access to up-front capital).

The Government's approach is in line with our assessment in that it considers the possibility of going beyond the UK's obligations in the EU Landfill Directive, is centred around economic incentives provided by the landfill tax and includes measures to encourage actions earlier in the waste chain and to address methane capture at landfill sites. While the proposed approach covers various stages in the waste chain and commits to considering the potential role of incentives and landfill restrictions, it focuses more immediately on voluntary measures and information provision, rather than regulatory measures. This approach therefore carries a risk that there will not be effective action throughout the waste chain to reduce emissions.

We therefore recommend that the effectiveness of waste policy should be carefully monitored throughout the waste chain, with stronger levers introduced as needed. Levers that should remain as options for if voluntary approaches are not successful include: statutory recycling targets, mandatory sorting requirements, support for separate collection systems, incentives (or penalties) to encourage households and businesses to recycle, extended producer responsibility schemes, and minimum standards for methane capture at landfill sites.

In particular, the Government should develop specific strategies for reducing food and paper/card waste sent to landfill as these waste streams are identified as the two largest contributors to future waste emissions and the two largest sources of low-cost abatement potential (see Section 2). Strategies should set out an approach to monitoring progress and policy options to address any slow progress across the key sectors and the full waste chain (i.e. the residential, commercial and industrial sectors, from production and retail through to final disposal). Strategies should build on work underway as part of the Waste Review and be developed by the end of 2013.

As waste policy in the UK is devolved, Scotland, Wales and Northern Ireland have their own strategies for reducing waste emissions (see Chapter 8). The devolved administrations should also consider the full range of levers available for reducing waste emissions across the waste chain.

17 Defined in the European Commission Waste Framework Directive, with a priority on prevention, followed by re-use/recycling/energy recovery, and last of all disposal.

Box 7.4: The Government's Review of Waste Policy in England (2011)

The Waste Review targets actions across the waste chain. Measures that focus on voluntary commitments, sharing of best practices, the role of information provision/public engagement, and reducing barriers (e.g. up-front capital for investing in energy from waste) include:

- **Waste reduction.** Develop a national waste prevention programme including:
  - Building upon the success of the Courtauld Commitment, explore new responsibility deals covering paper, packaging, textiles and the hospitality and food service sector to reduce overall waste and improve waste management (i.e. increasing the amount of recycled products used in the sector and making products more recyclable).
  - To further encourage households and businesses to reduce and manage food waste; to work with industry sector bodies on food labelling, providing information and access to skills; to provide funding to local authorities, community groups and small businesses to develop waste prevention programmes.
- **Waste sorting/separate collection**
  - Work with local authorities to increase recycling from households (e.g. through improved design and increased frequency of collection schemes).
  - Work with local authorities and waste management companies to help small businesses recycle (e.g. through creating a partnership of recycling commitments and offering collective contracting).
  - Provide technical support and advice to local authorities on collection systems and appropriate treatment options.
- **Appropriate disposal**
  - Publish an AD strategy (June 2011) to address key barriers to uptake of AD facilities. This included a new £10 million loan fund to help stimulate investment in additional AD infrastructure.
  - Publish guidance on energy from waste (July 2012) to advise on hierarchy for energy recovery (and therefore reduce potential CO_2 emissions associated with energy from waste).
  - In addition to measures announced in the Waste Review, the waste management sector has been identified as one of the three priority sectors that will receive financing from the Green Investment Bank to support recycling and reprocessing facilities, pre-treatment projects and energy-from-waste projects.
- **Methane capture**
  - Explore opportunities for capturing more methane from landfill, including promoting new technology and practices and removing barriers.
  - Continue to improve understanding around methane generation, oxidation and emissions from landfills.

The Government has also recognised the potential risk of these approaches (e.g. some waste that would be better disposed of elsewhere may still end up in landfill) and has committed to further examining the role of stronger levers, including:

- Exploring the role of incentives for reducing and ensuring household waste is managed sustainably.
- Considering restricting the landfilling of certain materials. A consultation on whether to introduce a restriction on the landfilling of wood waste has been launched and a review of the case for restrictions on sending other materials to landfill (e.g. textiles and other biodegradable wastes) will be conducted.

These options may be required if the current approach is unsuccessful, or if higher ambition is to be achieved.

Source: Defra (2011) *Government Review of Waste Policy in England 2011;* Defra (2012) *Progress with delivery of commitments from the Government's Review of Waste Policy in England (2011)*

4. Waste as bioenergy resource and recycling emissions

In addition to waste management strategies to reduce methane emissions, there are also opportunities for waste as a bioenergy resource to offset emissions arising from the combustion of fossil fuels in electricity and heat generation. Moreover increased recycling of wastes (particularly of non-biodegradable wastes such as plastics, glass and metals) can reduce upstream production emissions.

Waste as bioenergy resource

In our 2011 Bioenergy Review, we presented evidence suggesting that UK waste arisings could supply around 60 TWh of primary energy supply in 2020:

- 22 TWh from waste wood (combusted in boilers).
- 10 TWh from food and other wastes treated via AD.
- 7 TWh from residual waste going into energy recovery.
- 18 TWh in landfill gas.

Over the longer term, waste arisings are forecast to fall and could contribute 50 TWh in primary energy supply by 2030 (and a similar level in 2050). In the context of scarce sustainable bioenergy resource, this would make a useful contribution towards UK carbon targets.

Government should address remaining barriers to its delivery (e.g. separate collection of waste streams for AD, location of feedstocks relative to demand, investment in combustion and AD plants), and we will monitor progress in securing this resource.

Upstream emissions savings from recycling

Increased recycling of non-food waste streams (e.g. paper, glass, metal and plastics) can reduce upstream production emissions. The Government's Waste Strategy for England (2007) estimated that UK recycling of paper, glass, plastics, aluminium and steel saved 18 $MtCO_2$ through avoided primary material production (although these emissions may not originate wholly in the UK). These savings should be recognised in evaluating the costs and carbon performance of recycling as a landfill diversion option.

Whilst there are emissions associated with recycling facilities, these emissions are likely to be more than offset by potential upstream savings (current recycling processing emissions are 2 $MtCO_2$) and moreover potential abatement options are well-characterised in our scenarios for reducing industry emissions (Chapter 4).

5. Indicators of progress reducing waste emissions

Our indicator framework for each emitting sector comprises an emissions trajectory, trajectories for key drivers of emissions, and policy milestones to strengthen incentives for implementation of measures to reduce emissions.

Our waste emissions indicators include trajectories for emissions, biodegradable waste sent to landfill, the amount of methane captured at landfill sites, and policies to drive progress. Recognising opportunities to go further than the Government's ambition, we present our indicators as a range, reflecting scenarios where biodegradable waste sent to landfill is reduced at least in line with the Government's projections and potentially reduced close to zero by 2022 (Table 7.1).

- Landfill methane emissions fall by 30-50% from 2007 (the last year before the first carbon budget) to reach 8-11 $MtCO_2e$ in 2020.
- The amount of biodegradable waste sent to landfill falls by 40-94% from 2007 levels to reach no more than 17 Mt in 2020. Within this, food waste falls at least 35%, paper/card waste falls at least 46%, green waste falls at least 44% and wood waste falls at least 31%.
- At least 75% of methane is captured on average across UK landfill sites.

We will monitor other drivers including total waste arisings by sector and type and the amount of renewable energy derived from waste, the proportion of the waste stream treated through alternatives to landfill (e.g. recycling and AD), and the number of local authorities providing separate collections (e.g. for food waste). We will also monitor work to improve emissions data estimates and costs/environmental benefits from various landfill diversion treatment options.

Our policy milestone indicators cover actions identified in the Government's Waste Review and our recommendations for further actions:

- Develop National Waste Prevention Programme.
- Agree responsibility deals with sectors specified in Waste Review.
- Launch consultation on wood landfill restriction and review case for other material-specific landfill restrictions (e.g. on textiles, green, or paper/card waste).
- Improve estimates of methane captured.
- Explore scope to strengthen incentives through the waste chain using the full range of levers (i.e. beyond the current voluntary approach to supporting the landfill tax), for example by requiring separate collection of food waste.
- Develop specific food and paper/card waste strategy.

With progress across these areas there is scope for the waste sector to make a significant contribution to the overall emissions reductions required to meet UK carbon budgets and the 2050 target.

Key findings

- Waste emissions fell by **3% in 2010**, and are now 64% below 1990 levels. This is largely due to reduced methane emissions from landfill, driven by reductions in the amount of biodegradable waste sent to landfill and an improved rate of methane capture at landfill sites.
- The **Government** has **ambition** to further reduce emissions by **22% (4 $MtCO_2e$) by 2020**, in line with further reduction in waste sent to landfill required under the EU Landfill Directive.
- There is potential to go beyond these reductions**,** given further opportunities for waste prevention, recycling, and treatment through other methods such as anaerobic digestion. This **increased ambition should be considered**.
- If full **technical potential** to divert waste from landfill could be delivered, 2020 emissions would be further reduced by around **3 $MtCO_2e$**.
- The current policy approach should be closely monitored, with **stronger incentives** for waste reduction and diversion from landfill introduced as required.
- Specific strategies should be developed to increase diversion of **food, paper and card waste** from landfill.

Table 7.1 The Committee's waste indicators

WASTE		Budget 1	Budget 2	Budget 3	2010 trajectory	2010 Outturn
Headline indicators						
Emissions (indicative % change from 2007)*						
CO_2e emissions		-9%	-22% to -33%	-32% to -50%	n/a	-9%
GHG and source emissions (% change in $MtCO_2e$ against 2007)	Landfill – CH_4*	-10% to -15%	-25% to -37%	-36% to -56%	n/a	-10%
	Wastewater treatment – N_2O*	-5%	-2%	+2%	n/a	-2%
	Incineration – total CO_2*	No more than 25%			n/a	+18%
Drivers (indicative % change from 2007 levels)**						
Biodegradable waste sent to landfill	2007 = 29 Million tonnes (Mt)	-30% (20 Mt)	-38% to -84% (18 Mt to 4.5 Mt)	-39% to -97% (17 Mt to 1 Mt)	n/a	-19% (23 Mt)
Percentage of methane captured at landfill sites	2007 = 75%**	75%	75%	75%	75%	n/a
Policy Milestones						
Develop National Waste Prevention Programme			End 2013			Evidence to support waste prevention measures currently being developed
Agree responsibility deals with sectors specified in Waste Review (waste management, paper, packaging, hospitality, textiles, Courtauld 2 successor)		Different timetables for various sectors; ongoing work to 2015				Ongoing discussions with various sectors
Explore scope to strengthen incentives through the waste chain			Publish findings during Budget 2			Initial exploration underway including funding for reward and recognition trial schemes by local authorities
Launch consultation on wood landfill restriction		Autumn 2012				
Review case for material-specific landfill restrictions (e.g. on textiles or paper/card)		2012/2013 Parliament session				

Table 7.1 The Committee's waste indicators

WASTE	Budget 1	Budget 2	Budget 3	2010 trajectory	2010 Outturn
Policy Milestones (continued)					
Improve estimates of methane captured and explore opportunities for capturing more methane from landfill	Ongoing				Pilot landfill study completed March 2012; scoping of wider survey underway
Develop specific food and paper/card waste strategy		End 2013			
Other drivers					
Total waste arisings: total waste generated (Mt) broken down by source (municipal and commercial/industrial sectors) and type.					
Waste management: amount, proportion and type of waste (Mt) sent to landfill and to alternative treatments (e.g. recycling/composting, energy from waste, MBT); municipal recycling rates.					
Separate collection: number/percentage of local authorities providing for separate collection of food waste; percentage of food waste sent to treatment via AD.					
General: We will monitor work to improve emissions data (e.g. estimates of activity data, methane yields and decay rates) as well as costs and environmental benefits from various landfill diversion treatment options.					

* Methane emissions trajectories reflect a range of emissions reductions from the Government's projections to close to full diversion of biodegradable waste from landfill. Other greenhouse gas trajectories are based on Government projections.

** An average methane capture rate of 75% is assumed across UK landfill sites.

Note: Numbers indicate amount in last year of budget period (i.e. 2012, 2017, 2022).

Key: Headline indicators Implementation indicators Milestones Other drivers

Chapter 8: Devolved administrations

Introduction and key messages

Emissions in the devolved administrations account for 20% of the UK's greenhouse gas emissions (9%, 8% and 3% in Scotland, Wales and Northern Ireland respectively). In our June 2011 progress report we noted that emissions fell in Scotland and Northern Ireland in 2008, and increased in Wales (due mainly to a large coal-fired power station coming back on the system). Data for 2009 on the economy, energy consumption and production and the EU ETS suggested a significant drop in emissions across each devolved administration.

In this chapter we assess progress made across the devolved administrations based on new emissions data, which confirm large reductions in emissions in 2009. We also consider more recent information on temperature, the economy, the EU ETS, policy development and implementation. Based on this information we assess likely progress in 2010 and 2011, as well as prospects of meeting future targets.

The key messages resulting from this are:

- Emissions in 2009 fell by 7%, 14% and 8% in Scotland, Wales and Northern Ireland respectively. This is primarily due to the drop in economic activity and energy demand as a result of the recession.
- Emissions are likely to have risen in 2010, primarily due to increased energy demand resulting from the particularly cold temperatures at the start and end of 2010.
- Although some economic data show increases in output in 2011, overall, it is likely that emissions fell in 2011 due to milder temperatures and significant emissions reductions in the energy intensive sectors.
- The devolved administrations have continued to develop their climate change strategies in the last year (Box 8.1). Scotland legislated annual emission reduction targets to 2027, the Welsh Government has published its report on progress and refreshed its climate change strategy, while in Northern Ireland, the emission reduction target for 2025 was strengthened and plans for a climate change act are being taken forward.
- Our assessment of progress so far in implementing these programmes is that there are a number of positive areas. These include for example, progress increasing renewable capacity, implementing energy efficiency and fuel poverty programmes, developing firm policies on waste reduction, and in the case of Scotland, improving afforestation rates. However major challenges remain in meeting the significant increase in effort across all sectors that will be needed to meet future emission reduction targets. Therefore continued action to develop and implement new policies across the key emitting sectors will be vital.

We set out the analysis that underpins these points in 6 sections:

1. Emission trends
2. Power sector
3. Buildings and industry
4. Transport
5. Agriculture and land use
6. Waste
7. Conclusions and future work of the Committee with the devolved administrations

1. Emission trends

Whereas the latest UK emission data considered elsewhere in this report are for 2011, the latest devolved administration data are currently for 2009. In last year's report we presented temperature, macroeconomic and EU ETS data for 2010, which we now update and supplement with power generation and energy demand information. For 2011 we consider new data from the EU ETS, on temperature, and economic output and also draw inferences from the UK emission data.

New emissions data for 2009

Greenhouse gas (GHG) data (Figure 8.1) for the devolved administrations show that in 2009[1]:

- In **Scotland**, 2009 total emissions were 48.1 $MtCO_2e$, 9% of the UK total and 30% lower than 1990 levels. Emissions fell 7% in 2009, with the largest falls from non-residential buildings (12%), industry (11%) and the power sector (7%). This was as expected given the sharp falls in output in the commercial and industrial sectors (Figure 8.2)

  Although generation in the power sector increased slightly (3%), there were large falls in oil and gas-fired generation which were more than offset by increases in nuclear and renewable generation. This reduced the carbon intensity of generation by 7% (from 318 gCO_2e/kWh in 2008 to 295 gCO_2e/kWh in 2009), which will have helped to reduce overall emissions.

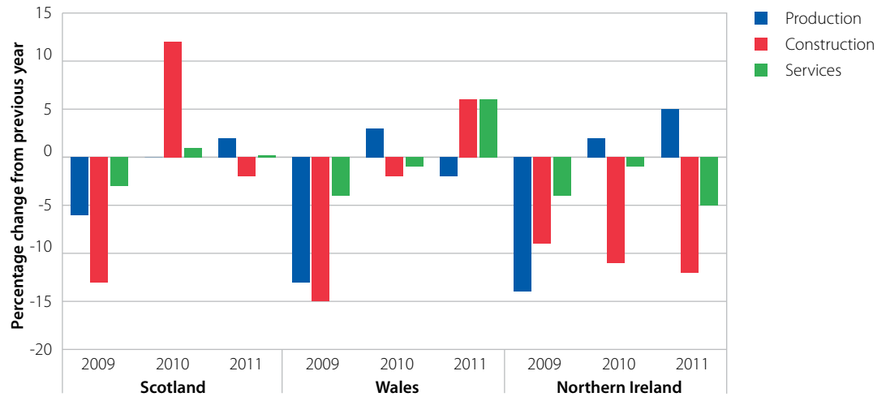
- In **Wales**, emissions were 42.6 $MtCO_2e$ in 2009, 8% of the UK total and 23% lower than in 1990. Emissions fell 14% in 2009, with significant reductions in the power sector (23%), industry (16%) and non-residential buildings (12%). Again this is likely to reflect the impact of the recession (Figure 8.2). As well as a large drop in overall power generation in Wales in 2009, there was a fall in the share of coal in the electricity generation mix. This contributed to the reduction in overall emissions as well as the carbon intensity of generation, from 401 gCO_2e/kWh to 368 gCO_2e/kWh.

1 Emission data here are presented on a 'gross' basis – i.e. before trading in the EU ETS is accounted for. Emission totals do not include emissions from international aviation and shipping as these are currently not included in UK carbon budgets.

Figure 8.1: Greenhouse gas emissions in devolved administrations by sector (1990 and 2009)

Source: NAEI (2011).
Note: Emissions are presented here before accounting for trading in the EU ETS, and do not include emissions from international aviation and shipping.

Figure 8.2: Output trends in Scotland, Wales and Northern Ireland (2009-2011)



Source: Scottish Government, Welsh Government, Northern Ireland Executive.

- In **Northern Ireland**, emissions were 19.5 $MtCO_2e$, 3% of the UK total and 20% lower than in 1990. Emissions fell 8% overall in 2009. The largest reductions at the sector level were in power (24%) and industry (21%), as output fell sharply during the recession (Figure 8.2). Overall generation in the power sector fell 17%, while the carbon intensity of generation fell 8% (from 525 gCO_2e/kWh to 481 gCO_2e/kWh) due to a switch from fossil fuels to renewable generation.

Inferences about 2010 emissions

In 2010, at the UK level, emissions increased by 3%, primarily due to increased energy consumption in buildings during the cold winter months of 2010. We showed in last year's progress report that it is likely we will see a similar increase in the devolved administrations, given that they also experienced temperatures significantly below the long-run average. We also reported macroeconomic and EU ETS data; these showed a return to growth in output and suggested a corresponding increase in energy demand.

The return to growth and corresponding increase in energy demand is borne out in commercial and industrial gas consumption data for 2010 in Scotland, but the picture is mixed in Wales:

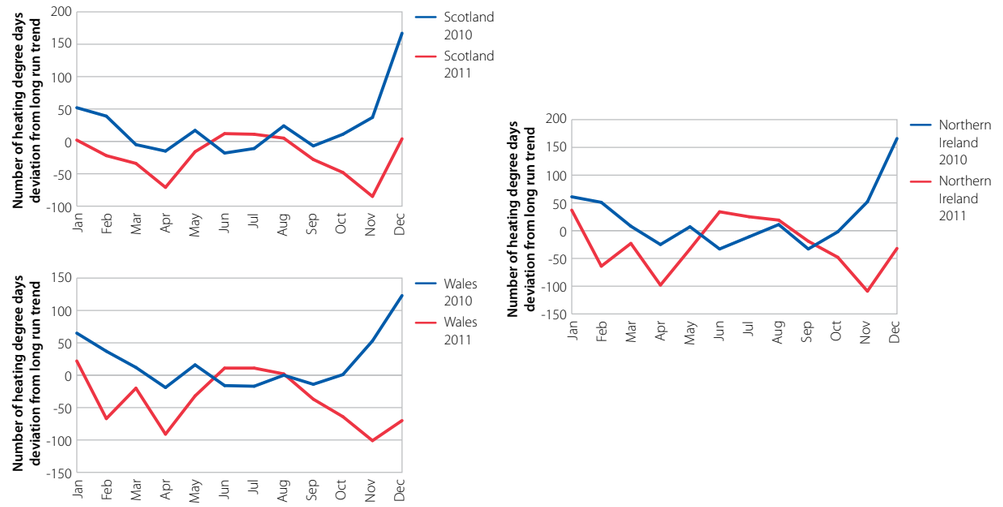
- In **Scotland,** gas demand across commercial and industrial users increased 12% from 2009 levels (temperature corrected), while electricity demand increased 2%.
- In **Wales**, gas demand from industrial and commercial users fell by 1% from 2009 levels, although this was a much lower drop than in the previous year (9%). Electricity demand increased 1% in 2010.
- Equivalent gas and electricity consumption data is not currently available for Northern Ireland.

New data on power generation for 2010 also suggest a mixed picture across the devolved administrations, with Scottish emissions likely to have increased but emissions in Wales and Northern Ireland likely to have remained broadly flat:

- In **Scotland**, overall generation fell by 3% in 2010 relative to 2009. However, coal generation increased by 23%, to make up for reduced nuclear generation due to outages, and reduced renewables generation mainly due to low rainfall resulting in low hydropower production. Therefore it is likely that the carbon intensity of generation, as well as overall emissions, will have increased.
- In **Wales,** generation fell by 1%. It is likely that emissions will have remained broadly level or have fallen slightly, as reductions in coal-fired generation were offset by increases in oil- and gas-fired generation.
- In **Northern Ireland** it is likely that emissions will have remained broadly level in 2010. There was an overall reduction in electricity generation of 5%, with reductions in renewable, gas- and oil-fired generation partially compensated by an increase in coal-fired generation.

Overall, the conclusion reached last year remains the same, that following significant reductions in 2009 in each devolved administration, emissions are likely to have risen in 2010. This will be due to cold temperatures across the devolved administrations, together with increased output and increased carbon intensity of power generation in the case of Scotland.

Figure 8.3: Heating degree days 2011 – deviation from long run trend



Source: Vesma.com (2012).
Note: Heating degree days (HDDs) are calculated relative to a baseline temperature, typically 15.5°C, which is the outside temperature above which a building needs no heating. One HDD is the number of degrees centigrade deviation from the base temperature of the actual temperature on a given day (e.g. if the temperature was 5.5°C for one day the number of HDD would be 10).The long run trend is 1971-2000.

Preliminary assessment of 2011 emissions

In 2011, emissions in the UK fell by 7%, in the context of warmer temperatures, falling household real income, slightly rising GDP, and rising energy and fuel prices.

Temperature data for the devolved administrations also show that 2011 was overall a milder year than 2010, and milder than the long run average (Figure 8.3).

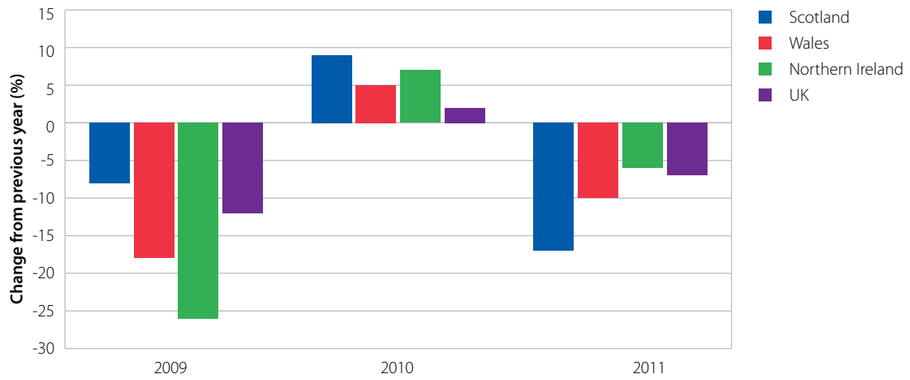
The economic data show that (Figure 8.2):

- In Scotland, overall GDP increased by 0.4% in 2011, slowing from an increase of 1.3% in 2010. Within that, production output increased 2%, construction fell by 2% and service sector output remained broadly flat.
- In Wales, (total GDP not available for 2011) production output fell 2% in 2011, but construction and the service sector both increased output, by 6% each.
- In Northern Ireland, positive growth continued in the production sector, with output increasing 5% in 2011. However construction output fell 12% and the service sector contracted by 5%.

Preliminary EU ETS data show (Figure 8.4):

- In Scotland, EU ETS emissions fell 17% in 2011, following an increase of 9% in 2010.
- In Wales, EU ETS emissions fell 10% in 2011, following a 5% increase in 2010.
- In Northern Ireland, EU ETS emissions fell 6% in 2011, following a 7% increase in 2010.

Figure 8.4: Percentage change in emissions – EU ETS (2009-2011)



Source: European Commission (2012).

Given limited changes in output in 2011, these significant emission reductions are likely to be due to reduced carbon intensity of production (e.g. through switching from coal and oil to gas, improved energy efficiency, and low carbon power generation); we will return to this when data on power generation and fuel consumption by energy intensive industry in 2011 become available.

Taken together, these factors suggest that emissions are likely to have fallen in 2011.

Box 8.1: Progress in devolved administration climate change policy and CCC advice

Since our progress report last year, there have been a range of developments in the devolved administrations, and the Committee has continued to work with each of the devolved administrations in the development of their climate change policies.

Scotland: The Scottish Parliament agreed secondary legislation in October 2011 to set statutory emission reduction targets for 2023-2027. These reflect the advice of the Committee and represent a halving of emissions, relative to 1990 levels, by 2025. The Scottish Government is due to publish its 'Report on Proposals and Policies' setting out how these targets will be met later this year. In January 2012, the Committee published its first report on Scotland's progress reducing emissions.

Wales: In October 2011, the Committee published its first report assessing Wales' progress reducing emissions and preparing for climate change. Subsequently the Welsh Government published its first progress report and climate change strategy refresh in March 2012.

Northern Ireland: The Committee was asked to provide advice to Northern Ireland's Environment Minister on the appropriateness of climate change legislation in Northern Ireland, with the Minister now taking forward proposals to introduce legally binding emission targets. The Executive has increased Northern Ireland's emission reduction target from a 25% reduction on 1990 levels by 2025, to a 35% reduction by 2025. The first progress report of a cross-departmental group on climate change was published in May 2012.

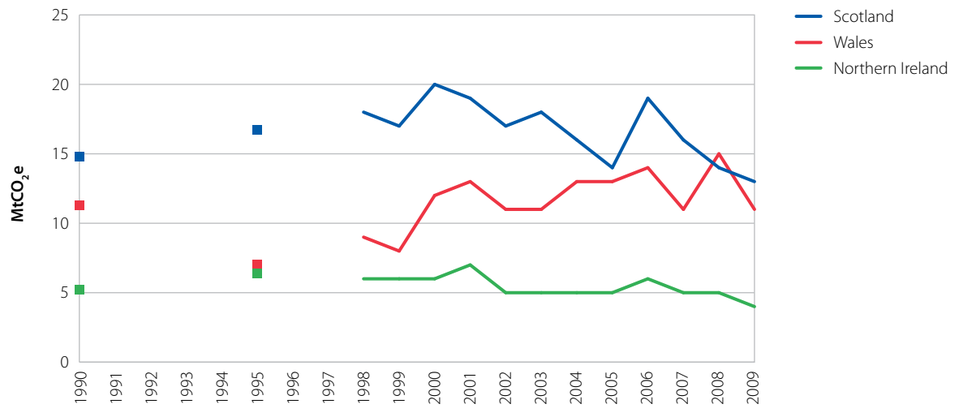
2. Power sector

Emission trends

Power sector emissions fell across the devolved administrations in 2009, due to a changing generation mix, as well as significant reductions in generation in the case of Wales and Northern Ireland (Figure 8.5 and 8.6):

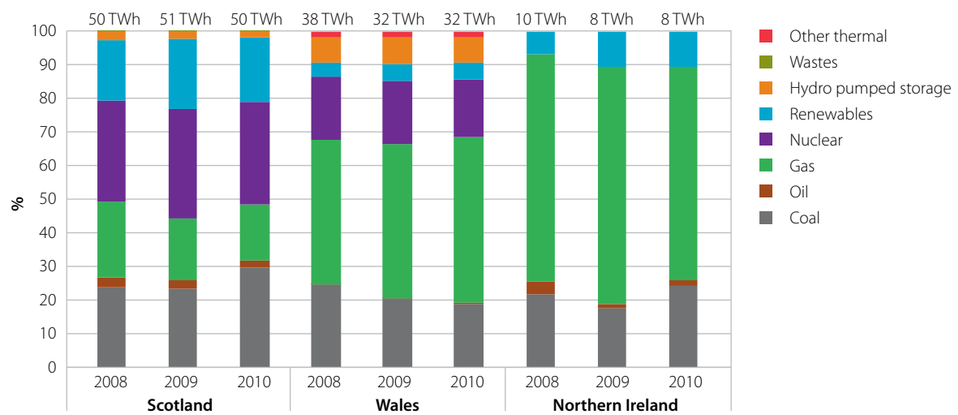
- In **Scotland**, power sector emissions were 13.4 $MtCO_2e$ in 2009, accounting for 28% of Scotland's total GHG emissions. Emissions fell 7% in 2009, reflecting that although overall generation increased by 3%, nuclear and renewable generation increased as gas and oil generation fell. Overall, 2009 emissions were 9% lower than in 1990.

Figure 8.5: Power sector emissions in Scotland, Wales and Northern Ireland (1990-2009)



Source: NAEI (2011).
Note: . No inventory data are available for devolved administrations for 1991-1994 or 1996-1997.

Figure 8.6: Proportion of generation by fuel type in Scotland, Wales and Northern Ireland (2009 and 2010)



Source: DECC (2012).

- In **Wales**, power sector emissions were 11.3 $MtCO_2e$ in 2009, 26% of Welsh total emissions. Emissions fell 23% in 2009, reflecting a fall of 16% in overall generation, including a 30% drop in coal-fired generation and a 10% drop in gas-fired generation. Although emissions have fluctuated over the last two decades, 2009 emissions are at the same level as in 1990.
- In **Northern Ireland**, 2009 power sector emissions were 3.7 $MtCO_2e$, a 20% share of total GHG emissions. Emissions fell 24% in 2009. In 2009 overall generation fell by 17%, with large falls in coal-, gas- and oil-fired generation. Renewable generation increased by over a third. Overall emissions are 31% lower than 1990 levels.

This pattern of generation across the devolved administrations in 2009 is a reflection of a fall in electricity demand across the UK and use of different power stations across the country according to relative fuel prices, carbon prices and availability.

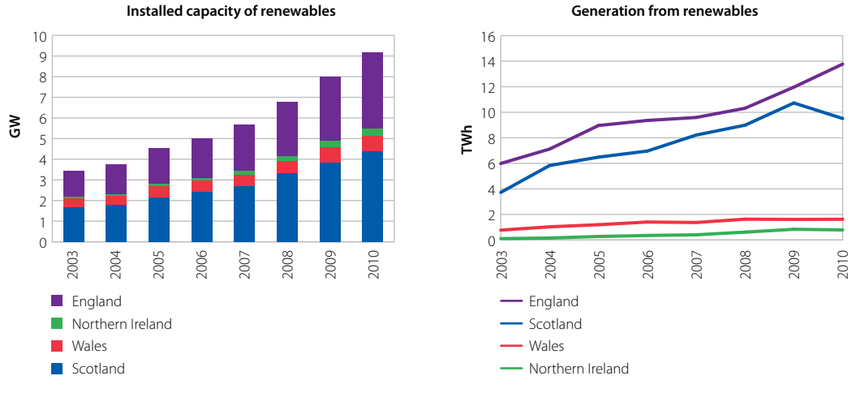
In 2009, Scotland's generation increased 3% as more nuclear and renewable generation was available. Exports from Scotland to the rest of the UK increased by 35% overall in 2009, including an almost four-fold increase in exports to Northern Ireland. At the same time, reductions in coal and gas generation drove the overall reduction in output in Northern Ireland and Wales and a reduction in exports from Wales to England of 35%.

As noted in Section 1 above, 2010 data suggests slightly increasing (Scotland) or broadly level (Wales and Northern Ireland) emissions relative to 2009, with increased carbon intensity due to changes in the generation mix (Figure 8.6)

Progress and policy on renewables

Progress deploying renewables continued through 2010 (Figure 8.7), including a 25% increase in wind capacity in Scotland. However, low wind speeds and low rainfall during 2010 saw reductions in generation for Northern Ireland and Scotland, for which wind and hydro respectively form a major component of renewable capacity.

Figure 8.7: Renewable deployment and generation in the UK (2003-2010)



Source: DECC (2012).

- In **Scotland**, renewable installed capacity increased to 4.4 GW, 14% above 2009 levels, and 160% up on 2003. 48% of all renewable capacity in the UK is located in Scotland, including 49% of wind capacity, compared to Scotland's 10% share of total UK power demand[2]. In 2010, renewables accounted for 19% of power generated in Scotland and the equivalent of 24% of electricity consumption.
- In **Wales**, installed capacity increased 1% to 0.76 GW, a 78 % overall increase from 2003. Wales accounts for 8% of the UK's total renewable installed capacity, including 10% of wind capacity, compared to 6% of UK electricity demand. In 2010, renewables accounted for 5% of generation in Wales and the equivalent of 7% of power consumption.
- In **Northern Ireland**, installed capacity increased 5% to 0.35 GW in 2010, an increase of 621% since 2003. Northern Ireland accounts for 4% of the UK's total installed capacity, including 6% of wind capacity, compared to its 3% share of UK electricity demand. In 2010, renewables accounted for 10% of generation in Northern Ireland and the equivalent of 8% of consumption.

At the UK level, the Government has envisaged (in its Renewable Energy Roadmap) a capacity mix including between 10 and 13 GW of onshore wind, 11-18 GW of offshore wind, and between 0.2 and 0.3 GW of wave and tidal stream by 2020.

Additionally, each of the devolved administrations has developed renewable targets:

- **Scotland** has a target to generate the equivalent of 100% of electricity demand from renewables by 2020. Scottish Government analysis suggests this is likely to require capacity to increase from 4.4 GW today to between 14-16 GW by 2020.
- The **Welsh Government** has previously identified potential for 48 TWh /year renewable generation by 2025 (twice Wales's current demand) from potential installed capacity of 22.5 GW.
- **Northern Ireland** has a target for 40% of electricity demand to be met from renewables by 2020, up from approximately 9% in 2010.

This highlights the need to accelerate deployment in order to meet these stretching targets:

- In **Scotland**, around an additional 10 GW of installed capacity is required between now and 2020 – more than double the capacity built to date. However the pipeline of potential capacity is substantial – with 12 GW in various stages of project planning, development and deployment, including 3 GW of mainly onshore wind projects consented or in build. A further 17 GW of offshore technologies are currently in the scoping stages.
- In **Wales**, generation from renewables stood at 1.6 TWh in 2010, 3% of the 48 TWh identified for 2025. An average of 1.45 GW would need to be added each year to 2025, relative to an average of 48 MW over 2003 – 2010. Earlier this year the Welsh Government commissioned a review of the planning process for renewable energy schemes, with the aims of identifying any factors that might be delaying consents and improving the approval process.

2 As measured by total generation less exports plus imports.

- In **Northern Ireland**, installed capacity of renewables would need to increase approximately 5-fold in order to meet 40% of electricity consumption within Northern Ireland (assuming no change in current demand levels). This would require average annual installed capacity to treble over the next ten years (140 MW per year from 2010 – 2020, relative to an average 43 MW since 2003). The most capacity added in one year so far was in 2009, when 103 MW installed capacity (mainly wind) was added. In December 2011, the Crown Estate announced a competitive call for an offshore leasing round in Northern Ireland waters, for 600 MW offshore wind and 300 MW tidal energy by 2020,

If this capacity is delivered to meet devolved targets it would make a significant contribution to the required capacity needed at the UK level by 2020.

Currently the main policy to drive investment is the Renewables Obligation. This will be superseded by the Electricity Market Reform (EMR), which subject to the resolution of detailed design questions, will provide stable revenues for investors in the range of low carbon technologies (see Chapter 2).

As outlined in the Draft Energy Bill, all provisions of the Bill extend to Wales and Scotland given that electricity market organisation is a reserved matter. However, the implementation of an Emissions Performance Standard (EPS) comes under Scottish responsibilities, with the Scottish Government recently consulting on whether a separate EPS should apply in Scotland, and if so how it should be designed.

Although energy market policy is devolved to Northern Ireland, the Northern Ireland Executive has announced a series of measures to support UK-wide implementation of EMR. Subject to Northern Ireland Assembly consent, the Feed in Tariff with Contracts for Difference, and Emissions Performance Standard will extend to Northern Ireland also.

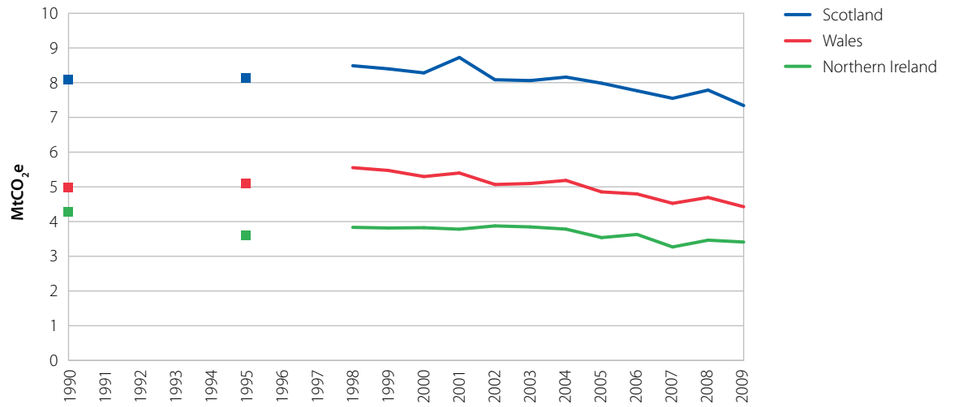
3. Buildings and industry

Emissions from residential buildings

There were reductions in direct residential emissions in all the devolved administrations in 2009, in the context of a relatively mild year, and rising domestic fuel prices (Figure 8.8):

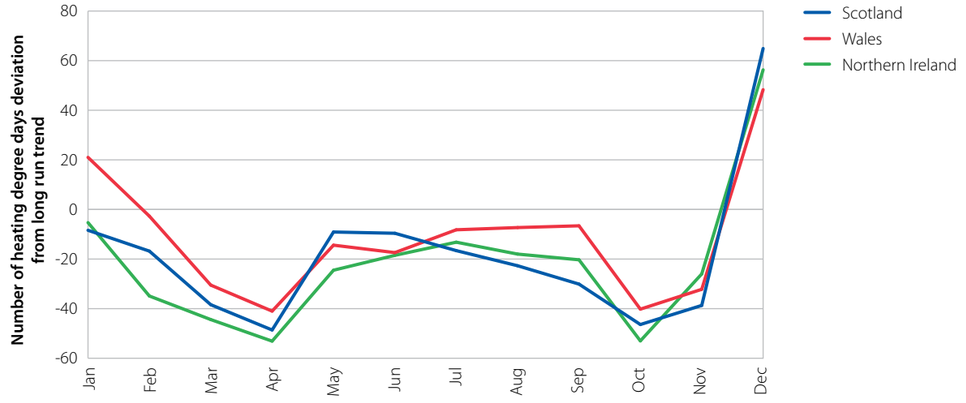
- In **Scotland**, emissions from residential buildings were 7.3 $MtCO_2e$ in 2009, 15% of Scotland's total GHG emissions. Emissions fell 6% in 2009 and 10% between 1990 and 2009. Despite a particularly cold December, overall the year was milder than 2008 and the long-run average (Figure 8.9), while domestic gas prices rose 13% from 2008 (real terms).
- In **Wales**, residential emissions were 4.4 $MtCO_2e$ in 2009, accounting for 10% of Wales' GHG emissions. Emissions fell 6% in 2009 and overall 2009 emissions are 11% lower than in 1990. 2009 was a relatively mild year compared to the long-run average, and milder than 2008. Residential gas prices are published in combination with England, and show up to 14% increases in 2009.

Figure 8.8: Residential emissions in Scotland, Wales and Northern Ireland (1990-2009)



Source: NAEI (2011).
Note: Inventory GHG data are not available for the devolved administrations in 1991-1994 or 1996-1997.

Figure 8.9: Heating degree days in 2009 – deviation from long-run trend



Source: Vesma.com (2012).
Note: Heating degree days (HDDs) are calculated relative to a baseline temperature, typically 15.5°C, which is the outside temperature above which a building needs no heating. One HDD is the number of degrees centigrade deviation from the base temperature of the actual temperature on a given day (e.g. if the temperature was 5.5°C for one day the number of HDD would be 10).The long-run trend is 1971-2000.

- In **Northern Ireland**, residential emissions were 3.4 $MtCO_2e$, 17% of total GHG emissions. Emissions fell 2% in 2009 and overall 2009 emissions are 22% lower than in 1990. 2009 was milder than 2008 and the long-run average. Although comparable gas price data are not currently available for Northern Ireland, 70% of homes are heated with oil in Northern Ireland, for which prices increased 5% in 2009.

On underlying progress through the implementation of measures, the key policy to achieve this is in Scotland and Wales is CERT (see chapter 3), which requires energy companies to deliver energy efficiency measures such as loft and cavity wall insulation. Implementation of measures under this policy in Scotland and Wales has been broadly in line with their share of the GB housing stock (Table 8.1).

Table 8.1: CERT insulation measures in Scotland and Wales from beginning of CERT (1 April 2008 – end Nov 2011)

Percentage of GB measures shown in brackets	Cavity wall insulations	Loft insulations	Homes treated
Scotland (9% GB housing stock)	142,890 (9%)	184,575 (9%)	283,940 (9%)
Wales (5% GB housing stock)	94,122 (6%)	150,046 (7%)	206,421 (9%)

Source: Energy Saving Trust HEED database.
Note: There is lag between data records being submitted to Ofgem (who operate the scheme) and the submission of data to HEED. This results in a data gap of around 12% (at the GB level) for the first 14 quarters shown above.

CESP is an additional obligation on energy companies which requires them to deliver energy efficiency measures in low-income areas. It appears that as at end 2011 Scotland and Wales had been particularly successful in accessing CESP funding and implementing measures, as shown in the relatively high share of implementation compared to share in housing stock (though Scotland in particular has a high share of eligible areas in the scheme total). However, as discussed in Chapter 3, overall delivery under CESP has been slow, with only 15% of the target achieved by the end of 2011.

- In Scotland 3,947 dwellings (13% scheme total), benefitted from a total of 8,511 measures (14% scheme total)
- In Wales 3,213 dwellings (11% scheme total) were treated with a total of 5,135 measures (9% scheme total).

Scotland and Wales each also run their own insulation schemes, with funding from national budgets in addition to drawing in CERT and CESP:

- In **Scotland** – the Universal Home Insulation Scheme (UHIS – replaced the Home Insulation Scheme) was launched in 2010/11. As well as drawing in funding from CERT, £12.9 million was provided by the Scottish Government to local authorities who submitted bids for funding, while a further £16 million is available for 2012/13. It is anticipated that a new programme will be developed and in place for April 2013, operating to help deliver the Green Deal and Energy Company Obligation (which will replace CERT towards the end of 2012) in Scotland.

  The Scottish Government has estimated that implementation of UK and Scottish programmes could result in savings of up to 1 $MtCO_2$ by 2020, which is broadly in line with the cost-effective abatement potential we have identified in Scotland by 2020.

- In **Wales**, arbed is an area based energy performance investment programme. Welsh Government funding of £30 million plus £30 million leveraged from energy companies and social housing providers, provided for: 2,900 solid wall insulations (the equivalent of 20% of the total solid wall insulations in the UK in that year), solar hot water to 1,000 households and 121 heat pump installations. Phase 2 is expected to improve just under 5,000 homes.

  The Welsh Government has estimated that UK and Welsh policies could deliver savings of 1.7 $MtCO_2e$ in the residential sector by 2020, which is slightly above the cost-effective abatement potential we have estimated in Wales by 2020

- In **Northern Ireland**, where CERT and CESP do not apply, a voluntary supplier scheme funded through a levy on all electricity customers operates. Funding amounts to almost £8 million each year over 2011/12 and 2012/13, with 80% of this ring-fenced for measures for priority vulnerable households. In addition the Executive has committed to spend £4m over the next three years to replace up to 16,000 older, less efficient boilers with more energy efficient ones.

Continuation of these programmes and the additional fuel poverty schemes in devolved administrations (Box 8.2), will be key in helping to bring the energy efficiency of the housing stock up to required levels. There is still a need to increase the pace of implementation of measures, in particular, for more difficult measures such as solid wall insulation. As set out in the Buildings chapter (Chapter 3) there is concern that the proposals for the Green Deal and Energy Company Obligation indicate that the insulation measures required to meet the Committee's insulation trajectories will not be achieved.

Box 8.2: Fuel poverty

The latest figures on fuel poverty (see also Chapter 3) find that across the UK as a whole in 2010, 4.75 million households, or 19% of all households, spend more than 10% of their income on energy, putting them in fuel poverty as per the current definition. This is a fall of around 750,000 households from 2009, largely attributed to increases in incomes and energy efficiency outweighing the effects of energy price rises in 2009.

In Scotland 28% of households were estimated to be in fuel poverty in 2010 (700,000 households). The **Scottish Government** has a statutory duty to eradicate fuel poverty in Scotland by November 2016 under the Housing (Scotland) Act 2001. The Scottish Government announced a fuel poverty strategy in 2002 and has produced updates on progress on this strategy in 2006 and 2010. The strategy is currently being reviewed by the Scottish Fuel Poverty Forum, which will report to the Cabinet Secretary for Infrastructure and Capital Investment.

The **Welsh Government** has estimated that in 2010, 332,000 households, or 26%, are in fuel poverty. The Welsh Government has committed to undertaking analysis to estimate the number and distribution of households that would be in fuel poverty under the new definition proposed by the Hills Review team. This will help inform its considerations of the final recommendations of the review.

The main policy on fuel poverty in Wales is NEST, which was launched on 1 April 2011 for a five year period. The programme is expected to deliver energy efficiency improvement packages to nearly 4,000 householders in its first year as well as providing energy savings advice to 11,000 householders**.**

Northern Ireland has the highest rate of fuel poverty across the UK, at 44% (2009 figure). Northern Ireland recently refreshed its fuel poverty strategy which outlined the Executive's intention to continue funding its main fuel poverty scheme 'Warm Homes', to tackle 9,000 of the most vulnerable homes each year. In August 2010 the Executive commissioned a review in to the definition of fuel poverty. An interim report found that the current 10% definition remains strong but that a local threshold, severity index and affordability index, reflecting circumstances in Northern Ireland should be developed to run parallel to the UK definition.

A comparison of spending on fuel poverty programmes shows that spending per fuel poor household is set to increase in the devolved administrations, compared to England where there is no specific tax-payer funded fuel poverty programme following the closure of Warm Front (see Chapter 3).

No. of households in fuel poverty (latest available year)		Spend per fuel poor household				
		2010/11	2011/12	2012/13	2013/14	2014/15
England	3,500,000	£99	£31	£29	–	–
Scotland	658,000	£108	£83	£104	£111	£129
Wales	332,000	see note below				
Northern Ireland	302,310		£103	£104	£106	£108

Note: Figures are in current prices and refer to spending on government-funded fuel poverty programmes – these figures do not include any anticipated funding through supplier obligations. Figures to estimate spend per fuel poor household not available at present but will include spending from the 4-year NEST programme and arbed (which is designed to assist some of the lowest income households).

Emissions from non-residential buildings and industry

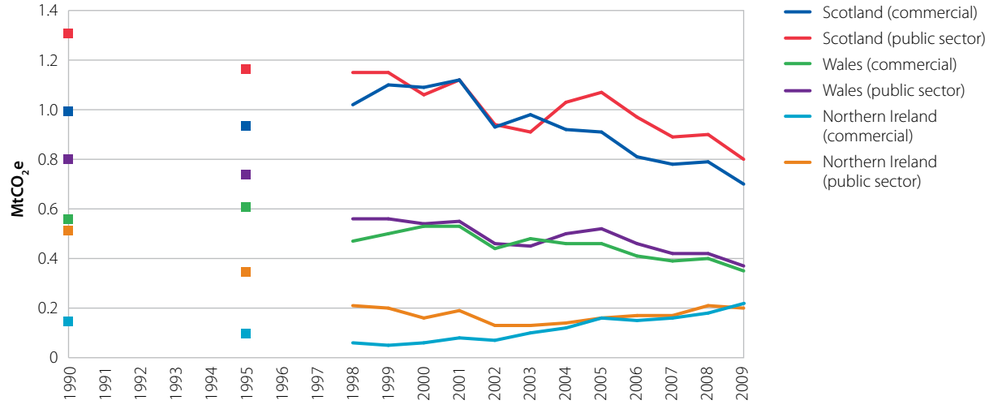
Non-residential buildings

Direct emissions from non-residential buildings in 2009 fell in Scotland and Wales and increased in Northern Ireland (Figure 8.10).

- In **Scotland**, emissions from non-residential buildings were 1.5 $MtCO_2e$ in 2009 (0.7 $MtCO_2e$ from commercial buildings and 0.8 $MtCO_2e$ from public sector buildings), 3% of Scotland's total GHG emissions. Emissions fell 12% in 2009 and overall are 37% lower than in 1990.
- In **Wales**, emissions from non-residential buildings were 0.7 $MtCO_2e$ in 2009 (split almost 50/50 between commercial and public buildings), 2% of Wales' total. Emissions fell 12% in 2009 and overall were 48% of 1990 levels.
- In **Northern Ireland**, emissions from non-residential buildings were 0.4 $MtCO_2e$ in 2009 (0.2 $MtCO_2e$ each from commercial and public buildings), 2% of total GHGs. Emissions increased 13% in 2009 but overall were 37% lower than in 1990. The increase has been driven by emissions from commercial buildings (up 32% in 2009, and 314% since 1998. Emissions from public sector buildings fell 6% in 2009, and overall have been broadly level since 1998.

The main policies to drive emission reductions in non-residential buildings are the UK-wide CRC Energy Efficiency Scheme, and renewable heat incentives operating in Great Britain and Northern Ireland (see renewable heat section below). As outlined in the Buildings chapter (chapter 3) the UK Government has proposed further simplification of the CRC and if administrative efficiency savings cannot be realised, the scheme will abolished. We have concluded abolition would be premature, given that the CRC has resulted in a greater focus on measuring energy consumption, and given a lack of alternative policies to encourage energy efficiency improvement in the non-residential sector.

Figure 8.10: Emissions from non-residential buildings in Scotland, Wales and Northern Ireland (1990-2009)



Source: NAEI (2011).
Note: Inventory GHG data are not available for the devolved administrations for 1991-1994 or 1996-1997.

The Scottish Government had estimated that the CRC could save up to 150 $ktCO_2$ in the non-energy intensive business and public sector by 2020, which forms a substantial saving relative to projected emissions in this sector.

In relation to **public sector** emissions, Scotland has now enacted a statutory public bodies climate change duty which places a statutory obligation on any public body to *"exercise its functions in the way best calculated to contribute to delivery of the Act's emission reduction targets"*. It does not require public bodies to set targets but they are 'expected' to identify their own ambitious targets that should echo the national targets.

The Committee's recent report on how local authorities[3] (in England) can reduce emissions recommended that the UK Government should consider a statutory duty for local authorities to develop and implement low-carbon plans. We considered the evidence on whether Scotland's statutory duty is effective, and found that:

- All 32 local authorities in Scotland for the first time in 2010/11 submitted an annual report under Scotland's Climate Change Declaration including reporting their corporate carbon baseline. Additionally, 130 public bodies (of a total of 154 in Scotland) including all 32 local authorities now have Carbon Management Programmes as certified by the Carbon Trust
- The duty has also been helpful in encouraging action in wider public bodies. For example, South Ayrshire Council has successfully signed all 12 partners in its Community Planning Partnerships to the Climate Change Declaration, with commitments to prepare and publish low-carbon plans that set out targets, timescales and measures for reducing emissions, and work with local communities to take action to adapt to the impact of climate change.

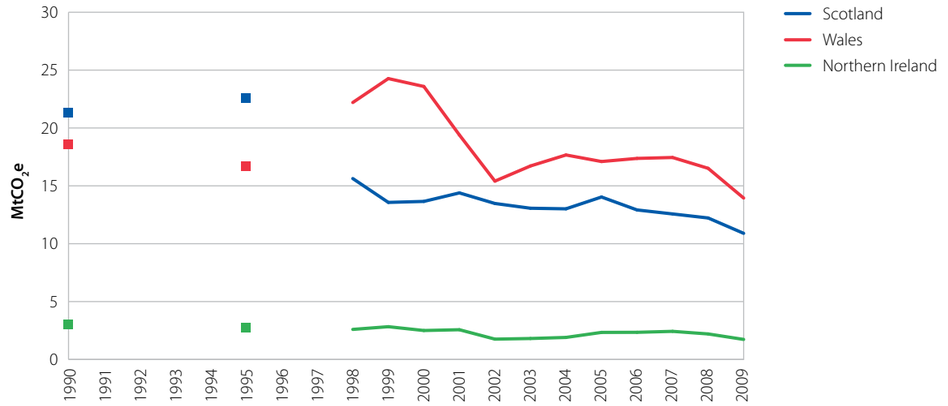
Industry emissions

Across all devolved administrations, industry emissions fell significantly in 2009, reflecting the declines in output during the recession (Figure 8.11). The longer term trend is also one of falling emissions, reflecting a general shift away from heavy industry, including the closure of some industrial plant (steel in Scotland for example), and fuel switching to less carbon-intensive fuels.

- In **Scotland**, industry emissions were 10.9 $MtCO_2e$ in 2009, 23% of Scotland's total emissions. Emissions fell 11% in 2009, and overall were 42% lower than in 1990. In 2009 manufacturing output fell by 8%, including a 12% fall in refineries output
- In **Wales**, industry emissions were 13.9 $MtCO_2e$ in 2009, 33% of Wales' total GHG emissions. Emissions fell 16% in 2009, and overall were 36% lower than in 1990. This large fall in 2009 is unsurprising, given that manufacturing output fell 14% during 2009. Iron and steel output, a significant industry in Wales, fell 24% and 18% respectively in Wales in 2009.
- Industry emissions in **Northern Ireland** were 1.7 $MtCO_2e$ in 2009, 9% of the total. Emissions fell 21% in 2009 alone, and overall were 43% lower than in 1990. Again this reflects a significant reduction in output, with the manufacturing sector in Northern Ireland losing 18% of its output in 2009.

3 Committee on Climate Change (2012) *'How local authorities can reduce emissions and manage climate risks'*. http://www.theccc.org.uk/reports/local-authorities

Figure 8.11: Industry emissions in Scotland, Wales and Northern Ireland (1990-2009)



Source: NAEI (2011).
Note: Inventory GHG data are not available for the devolved administrations for 1991-1994 or 1996-1997.

The importance of energy intensive industry in the overall emission mix varies across the devolved administrations, with Wales featuring a much higher proportion of energy intensive industry than Northern Ireland:

- In 2009, EU ETS emissions accounted for half of the UK's CO_2 emissions.
- The proportion is higher in Scotland (60%) and Wales (63%) but lower in Northern Ireland (32%).

As outlined in the industry chapter (Chapter 4) there are a range of opportunities for reducing emissions from industry, including energy efficiency improvements, use of low-carbon heat and bioenergy, and product substitution. Current policies to incentivise the implementation of these measures operate mainly at the EU or UK level, and include the EU ETS, Climate Change Agreements, the Renewable Heat Incentive and the CCS demonstration programme.

Low-carbon heat

The latest available figures on the extent of low-carbon heat in the devolved administrations show that:

- In **Scotland**, 0.44 GW of renewable heat capacity was operation in 2010, producing an estimated 1,696 GWh of renewable heat energy, an almost doubling of output since the previous estimate in 2008/09. 2010 output was the equivalent of 2.8% of Scotland's forecast non-electrical heat demand in 2010. This rate of progress is commensurate with the pace required to meet the Scottish Government's target of 11% of Scotland's heat demand to be met from low-carbon sources by 2020.
- In **Wales**, installed capacity of renewable heat stood at 6.4 MW in 2010/11.

The main policy to achieve 2020 targets in Scotland and Wales will be the GB-wide Renewable Heat Incentive (RHI), which provides support for a range of low-carbon technologies (see section 5 of Chapter 3 for further details). The scheme opened to non-residential schemes in November 2011. As at 31 March 2012, a total of 20 renewable heat installations had been accredited by Ofgem, 1 of which is in Wales, and 6 in Scotland. For the domestic sector, the Renewable Heat Premium Payment is also available to households in Scotland and Wales.

- In **Northern Ireland**, around 1.7% of heat demand is met from renewable sources (mainly biomass boilers). The Executive has set a target to increase this to 10% by 2020 (requiring an increase from 300 GWh/year of renewable heat now to 1,600 GWh/year by 2020), though it is estimated that over the longer term 15% of Northern Ireland's heat demand could be met from biogas alone (reflecting the large agriculture sector).

  The Executive has recently consulted on the introduction of a separate RHI for Northern Ireland to reflect the differences in the heat market compared to the rest of the UK (i.e. an oil- rather than gas-based heating market), and in the meantime has introduced a forerunner to the RHI in the form of a Renewable Heat Premium Payment available for residential customers.

4. Transport

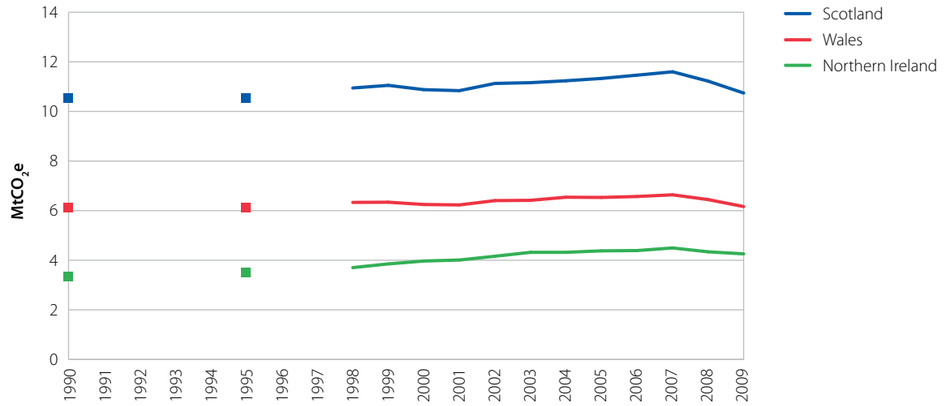
Emissions trend and drivers

Reductions (Figure 8.12) in total transport emissions[4] across the devolved administrations in 2009 were driven by reductions in road transport emissions, which form the largest proportion of transport emissions across all of the devolved administrations.

- Total transport emissions in **Scotland** were 10.7 $MtCO_2e$ in 2009, accounting for 22% of total GHGs. Despite a 4% fall in 2009, emissions were still 2% higher than in 1990. The majority of emissions (9.5 $MtCO_2e$) are from road transport. Road transport emissions fell 4% in 2009 but were still 4% higher than in 1990.
- In **Wales**, total transport emissions were 6.2 $MtCO_2e$ in 2009, 14% of total GHGs. 2009 emissions fell 4%, bringing them to the same level as 1990. The majority of emissions are from road transport (5.7 $MtCO_2e$), and although emissions fell 4% in 2009, were still 2% higher than in 1990.
- In **Northern Ireland**, total transport emissions were 4.3 $MtCO_2e$, 22% of total GHGs. Total emissions fell 2% in 2009 but remained significantly above 1990 levels (28% higher). Road transport accounted for a total of 3.9 $MtCO_2e$ in 2009 and although emissions fell 1% during 2009, overall road transport emissions were 30% higher than in 1990. This increase largely reflects a catching up in car ownership rates, which are now comparable with the UK average. Northern Ireland is also characterised by the highest share of emissions from rural driving (e.g. 62% of car emissions are from rural driving compared to 50% in Scotland, 53% in Wales, and 39% across the UK as a whole).

4 Includes domestic, but not international aviation and shipping emissions.

Figure 8.12: Transport emissions in Scotland, Wales and Northern Ireland (1990-2009)



Source: NAEI (2011).
Note: Inventory GHG data are not available for the devolved administrations for 1991-1994 or 1996-1997.

Emission reductions in 2009 are likely to have reflected reductions in travel due to the recession, and increased fleet efficiency as inefficient old cars were replaced by efficient new cars.

- In **Scotland**, overall road traffic fell by 251 million vehicle-km in 2009 (1% drop), which was mainly driven by reductions in light and heavy goods vehicles.
- Total road traffic in **Wales** also fell 1%, or 394 million vkms in 2009. This was driven by a combination of falls in car traffic (of 216 million vehicle-kms) as well as goods vehicles (of 119 million vehicle kms).
- In **Northern Ireland**, although overall traffic-kms increased (by 2%) in 2009 there were continued improvement in vehicle efficiency (as below).
- New car efficiency continued to improve in 2009, with new car emissions in the devolved administrations falling in line with the UK average (Figure 8.13):
  - In Scotland, new car emissions fell 5% in 2009 to 148 gCO_2/km.
  - In Wales, new car emissions fell 6%, to 145 gCO_2/km.
  - In Northern Ireland, new car emissions fell 5% to 147 gCO_2/km.

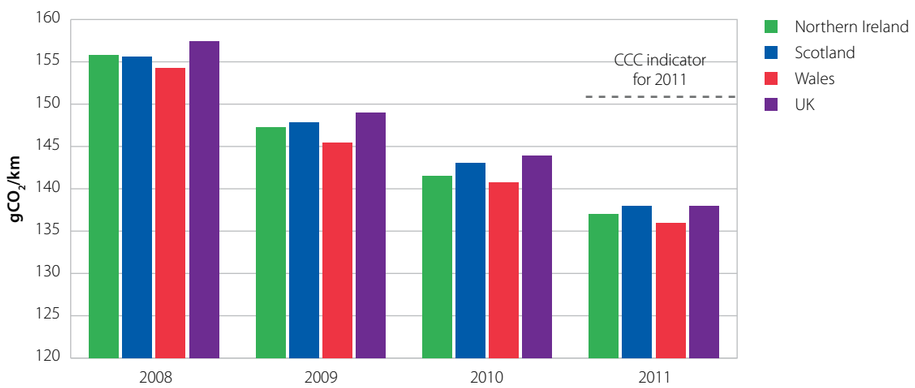
Trends in road traffic for 2010 show that vehicle-km travelled fell even further across the devolved administrations:

- In **Scotland**, road traffic (across all motor vehicle types) fell 1.7% in 2010. This can mainly be attributed to a fall in car traffic, where 800 million less vehicle-km were travelled in 2010 relative to 2009.
- In **Wales**, motor traffic fell 1.9% in 2010, a reduction of 522 million vehicle km. Distance travelled fell across all vehicle types except LGVs. Car traffic fell 2.4%, a reduction of 532 million vehicle kms.
- 2010 data for **Northern Ireland** is not yet available.

The consequence of reduced miles travelled is that, other things being equal, road transport emissions in 2010 would have fallen by the same proportion. In fact, reductions are likely to have been greater than this, given continued progress reducing new car emissions in 2010 and 2011, which are now well below the Committee's indicator trajectory level of 151 gCO_2/km for 2011 (see Chapter 5 and Figure 8.13):

- By 2011, new car emissions in Scotland had fallen to 138 gCO_2/km, a reduction of 11% since 2008
- New car emissions in Wales stood at 136 gCO_2/km in 2011, a fall of 12% since 2008
- Northern Ireland's new car emissions were 137 gCO_2/km in 2011, a reduction of 12% since 2008.

Figure 8.13: New car efficiency in Scotland, Wales, Northern Ireland and the UK (2008-2011)



Source: The Society of Motor Manufacturers and Traders (2012).
Note:

Progress developing electric vehicle markets

Our analysis suggests that a very high penetration of electric vehicles will be required to meet long-term emission targets, and that the development of electric vehicle markets should begin now to prepare for this. In order to support market development, it is important that a public battery charging infrastructure is put in place.

Scotland and Northern Ireland were both successful in becoming one of DfT's Plugged in Places (PiPs) pilot areas:

- The **Scottish Government** is supporting this with funding for an Electric Vehicle Procurement Scheme for the public sector in (£4.3m in 2010/11 and £4.2m in 2011/12). The first phase supported the purchase of 145 low-carbon vehicles and, in conjunction with Plugged in Places funding, installation of 74 charging points. The 2011/12 phase is due to assist with the purchase of a further 120 electric vehicles and deliver 120 charging points, while PiPs is due to deliver an additional 140 charging points in 2012/13.
- Almost 50 charging points have now been installed in **Northern Ireland**, while the latest registration data shows 31 electric vehicles registered in Northern Ireland in 2010.
- In **Wales**, we had previously recommended government support for electric vehicle charging infrastructure, although the approach in Wales is to engage with private sector schemes on the location of charging posts (e.g. Nissan's plans for 65 charging points in the UK and Chargemaster Plc's plans for 4,000 points across the UK, including in Cardiff and Swansea). However there is a question of whether private schemes will be commercially viable in the early stages of market development, suggesting the need for public funding if required investment is to follow.

Changing consumer behaviour

- In **Scotland**, the Smarter Choices Smarter Places demonstration programme (covering 50,000 households over 2008-2012) is due for full evaluation in 2012.. The Energy Saving Trust and Sustrans are currently funded to provide support, including for travel planning to organisations and schools respectively.

  A £50 million sustainable transport fund has been made available for the next four years, though this is largely aimed at capital investment in infrastructure (including the electric vehicle support outlined above).

- In **Wales** a 4-year £4m Personalised Travel Planning Programme was launched in September 2011, aimed at contacting 63,000 households in Cardiff (equivalent to 5% of Wales' households) in its first year.

  Wales' eco-driving programme in 2011/12 aimed to contact 5,000 individuals. If achieved, this would compare well to 8,000 who received training in England in 2011, given population shares. However, across the UK as a whole, 300,000 drivers would be required to receive eco-driving training each year in order to exploit available emission reduction potential by 2020.

- In **Northern Ireland**, the Executive has recently consulted on an active travel strategy, which proposes to continue to invest in workplace and school travel plans, personalised travel planning and £3m for active travel demonstration projects. A behaviour change initiative (Travelwise) encourages switching to walking, cycling, public transport and car sharing, across schools, businesses and commuters.

The Scottish Government has estimated that its current policies for the transport sector could save 1.4 $MtCO_2$ by 2020, but with additional measures could save up to 2.5 $MtCO_2$. Our estimate of savings across supply and demand side measures for Scotland is around 2.1 $MtCO_2$ by 2020. The Welsh Government is aiming for savings of 1.4 $MtCO_2$ from the transport sector by 2020 which is broadly in line with our estimate of potential abatement.

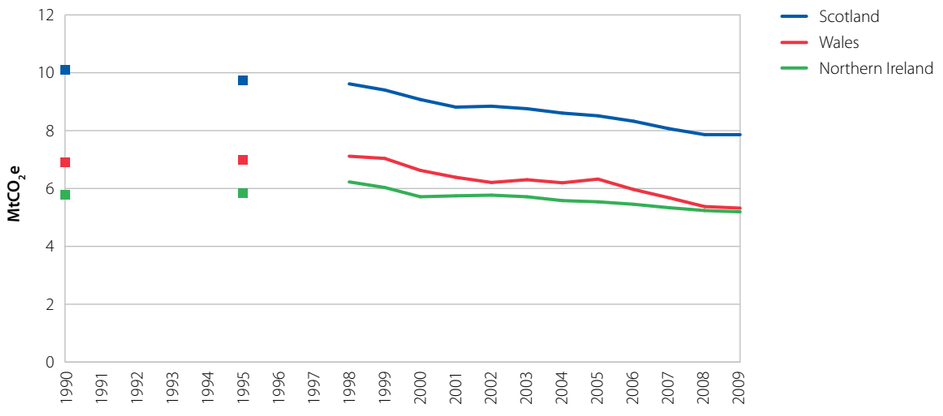
5. Agriculture and land use

Agriculture emissions

Agriculture emissions in 2009 were flat in **Scotland** and fell slightly in Wales and Northern Ireland (Figure 8.14).

- Agriculture sector emissions in Scotland were 7.9 $MtCO_2e$ in 2009, 16% of the total. Emissions overall are 22% lower than in 1990, though remained level in 2009 as a fall in methane emissions was offset by increased nitrous oxide emissions. The fall in methane emissions was less than the percentage fall in livestock output in Scotland in 2009, suggesting an increase in emissions intensity of production. However despite nitrous oxide emissions (associate with fertiliser use) increasing, crop out increased by a greater proportion than emissions suggesting improved emissions intensity of output.

Figure 8.14: Agriculture emissions in Scotland, Wales and Northern Ireland (1990-2009)



Source: NAEI (2011).
Note: Inventory GHG data are not available for the devolved administrations in 1991-1994 or 1996-1997.

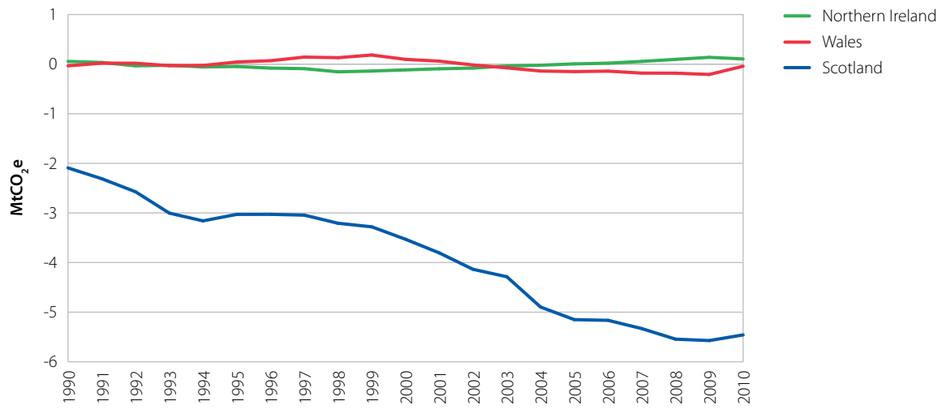
- Emissions from agriculture in **Wales** amounted to 5.3 $MtCO_2e$ in 2009, or 12% of Wales' total GHG emissions. Emissions were overall 24% lower than in 1990 and fell 1% in 2009. The 2009 fall was driven by a 2% reduction in methane emissions, as N_2O emissions remained level. Livestock output fell by a smaller proportion than emissions in 2009, suggesting an improvement in productivity and reduction in emissions intensity of production. Although nitrous oxide emissions remained level, there was a large increase in crop output in Wales, again suggesting an improvement in productivity and reduced emissions intensity of production.
- Emissions from agriculture in **Northern Ireland** were 5.2 $MtCO_2e$, accounting for 27% of Northern Ireland's total GHG emissions. Emissions overall are 11% lower than in 1990 and fell 1% in 2009, due to a fall in methane emissions as N_2O remained level.

Agriculture policy is devolved within the UK, with each of the devolved administrations operating programmes:

- The Scottish Government has estimated that between 0.3 and 0.9 $MtCO_2e$ savings could be made in agriculture in **Scotland**. Currently the main policy to deliver this is the Farming for a Better Climate initiative, which is a voluntary scheme aimed at knowledge provision and funding for improved knowledge transfer relating to measures to improve farm efficiencies. At this stage we are unable to fully assess progress in implementing this key policy as the monitoring framework is still under development.
- In **Wales**, the 5-year Glastir programme provides support for farmers to develop sustainable land management practices, including preservation of soil carbon and promoting on-farm renewable energy generation. In our progress report to the Welsh Government in October 2011 we concluded that while these measures should have a positive impact in reducing emissions, it was unclear what these measures were aimed at achieving and should be aligned with underlying abatement potential.

  In its response, the Welsh Government has indicated that targets for Glastir are governed by the EU Common Monitoring and Evaluation Framework, which sets targets in terms of land area as opposed to GHGs. However the Welsh Government has committed to consider further how best to assess the impact of Glastir on GHG emissions.
- In **Northern Ireland**, the Executive and industry bodies have formed an Agriculture and Forestry GHG Stakeholder Group, which produced a GHG Reduction Strategy and Action Plan in 2011. The key objective of the strategy is to promote the adoption of a programme of technical efficiency measures on-farm that will lead to improved business performance and help reduce GHG emissions. The ambition is to reduce emissions per unit of commodity output and have a robust measurement methodology on which to base targets for reduction by 2013. The Committee will be working with the Executive over the coming year to review the methodology for this indicator framework.

Figure 8.15: Emissions from land use, land use change and forestry in Scotland, Wales and Northern Ireland (1990-2009)



Source: NAEI (2012).

Land use emissions

More recent data is available for emissions from land use, land use change and forestry (LULUCF). This shows that in 2010 the size of the net sink fell slightly in Scotland, while land use emissions remained overall flat in Wales and Northern Ireland (Figure 8.15):

- The size of the net sink provided by LULUCF in **Scotland** increased by 161% between 1990 and 2010, from -2.1 $MtCO_2e$ to -5.5 $MtCO_2e$. There was a slight reduction in sink size between 2009 and 2010, as the extensive conifer plantations established in the mid-20th century are now reaching felling age.
- In **Wales**, LULUCF is currently a small net sink of emissions (-0.04 $MtCO_2e$), with emissions from cropland and settlements being offset by sequestration from forestry and grassland. The size of the net balance between emissions and removals has changed little since 1990, when the net sink was -0.03 $MtCO_2e$.
- In **Northern Ireland**, LULUCF is currently a small net source of emissions (0.1 $MtCO_2e$). The size of the net balance has changed little since 1990, when the sector was a small net source of 0.05 $MtCO_2e$ overall.

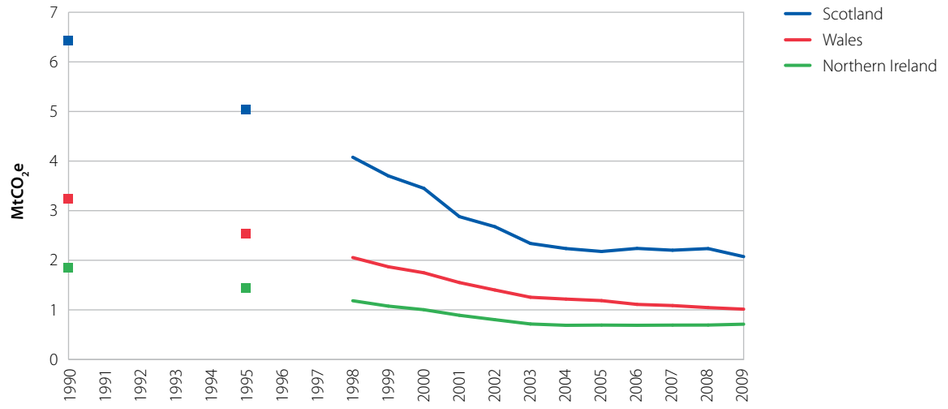
Going forward, there are ambitious targets for afforestation in the devolved administrations:

- **Scotland's** current target is to increase woodland creation rates to 10,000 ha per year by 2015 in order to achieve savings of 300 $ktCO_2$/year by 2020. The planting rate achieved in 2011 was 5,100 hectares, which is 62% of the new planting in the UK in 2011 (compared to 32% of the UK's land area) and double the levels achieved in recent years, indicating some success in the woodland creation policy and grants. More recent figures, based on grant approvals show that 2011/12 was expected to deliver 7,500 ha of additional woodland.

- New planting in **Wales** reached 300 hectares in 2011, 4% of the UK total (compared to 9% of the UK's land area). Planting rates have fallen recently, from 500 ha in 2007. The main policy on woodland creation in Wales is the Glastir woodland management programme which provides grants for woodland creation with the aim of increasing annual afforestation rates to 3,000 ha for 20 years from 2010. To date, nearly 400 applications for woodland creation have been submitted, covering an area of 1,100 hectares. Of these around 230 have been approved, covering an area of 687 hectares (as at November 2011).
- There was new planting of 200 hectares in 2011 in **Northern Ireland**, which was 2% of the UK total (compared to 6% of the UK's land area). New planting rates have been low in recent years, falling from 600 ha in 2008. Northern Ireland's forest policy seeks to double forest cover in Northern Ireland from 6% (86,000 ha) in 2006 to 12% by 2056. This would require an additional 1,720 ha each year from 2006 to achieve this by 2056.

A substantial increase from current planting rates is therefore required to meet each of these targets, though there are signs that afforestation is picking back up in Scotland. If these rates are achieved it would make a substantial contribution to meeting the abatement potential identified in the Committee's fourth budget advice (i.e. our central abatement scenario identified increased afforestation of an additional 10,000 hectares a year over 15 year period to deliver savings of at least 1 $MtCO_2e$ by 2030). However, as outlined in Chapter 6 barriers remain to increasing tree planting rates, including financial barriers and the amount of land available.

Figure 8.16: Waste emissions in Scotland, Wales and Northern Ireland (1990-2009)



Source: NAEI (2011).
Note: Inventory GHG data are not available for the devolved administrations for 1991-1994 or 1996-1997.

6. Waste

Waste emissions in 2009 fell in Scotland and Wales but increased in Northern Ireland (Figure 8.16).

- Emissions from waste management in Scotland amounted to 2.1 $MtCO_2e$ in 2009, 4% of Scotland's total GHG emissions. Emissions fell 7% in 2009 and overall are 68% lower than 1990.
- Waste emissions in Wales amounted to 1.0 $MtCO_2e$ in 1990, 2% of the total. Emissions fell 3% in 2009 and overall were 69% lower than in 1990.
- Waste emissions in Northern Ireland were 0.7 $MtCO_2e$ in 2009, 4% of total GHGs. Emissions increased 3% in 2009 but overall were 62% lower than in 1990.

Over the longer term, waste emissions in the devolved administrations (as recorded in the GHG inventory) are assumed to have been driven down by increasing methane capture rates at landfill sites. However, due to the absence of local data, the inventory assumes that the methane capture rate in England applies in the devolved administrations also.

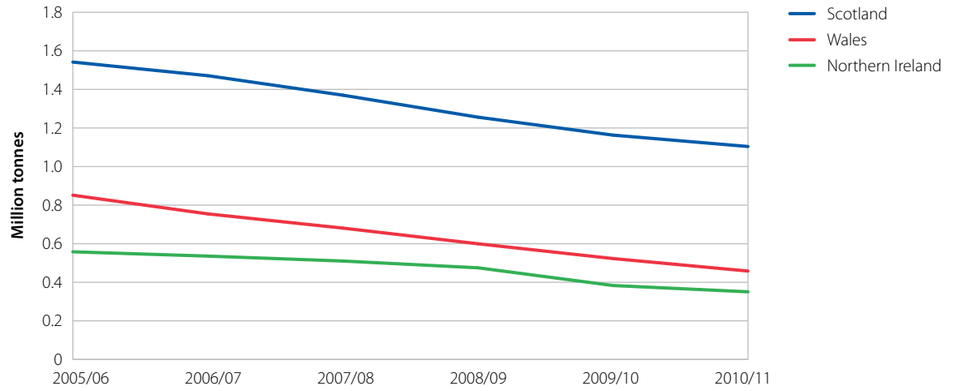
While emissions will also fall as waste is diverted from landfill, there is not a direct link between waste send to landfill (municipal solid waste – MSW) in a year and the methane emissions in that year – emissions in any given year reflect historic landfill, degradation and the pathway of a modelled methane release curve.

Waste sent to landfill has been driven down (Figure 8.16) by the EU landfill tax which applies to the devolved administrations. However, within the UK, waste management is a devolved issue, with each of the devolved administrations developing waste strategies and legislating various waste measures. Current recycling rates continue to increase across the devolved administrations (Figure 8.17), whilst more stringent regulations are in place for various aspects of waste management in each of the devolved administrations:

- In **Scotland**, the Zero Waste Strategy is supported by the Waste (Scotland) Regulations which were passed in Parliament in May 2012 and require:
  - All businesses to separate paper and card, plastic, metal and glass for recycling by January 2014.
  - Medium and large businesses to present food waste for collection 2013, and small businesses by 2015.
  - A ban on landfilling biodegradable material by 2020.
  - 70% recycling rate for household and all other waste streams by 2025.
  - Local authorities to begin roll-out of food waste collections by end of 2013, to be completed by end 2015.

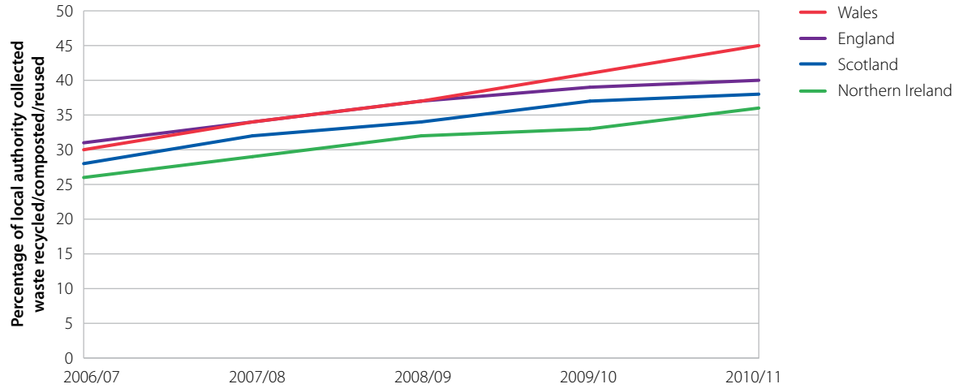
The Scottish Government has estimated that these measures could reduce waste emissions in Scotland by **0.7 $MtCO_2e$** by 2022.

Figure 8.17: Biodegradeable municipal waste landfilled in Scotland, Wales and Northern Ireland (2005/06-2010/11)



Source: SEPA, Environment Agency Wales and Northern Ireland Executive.

Figure 8.18: Recycling rates **in Scotland, Wales, Northern Ireland and England (1990-2009)**



Source: SEPA, Environment Agency Wales and Northern Ireland Executive.

- In **Wales**, 'Towards Zero Waste' is the overarching waste strategy and places statutory recycling targets on local authorities for minimum levels of preparing for reuse, recycling and composting of municipal waste (or face fines). These targets are as follows:
  - 2012/13 – 52%
  - 2015/16 – 58%
  - 2019/20 – 64%
  - 2024/25 – 70%

The Welsh Government's climate change strategy estimated that the range of waste management measures in the strategy could result in savings of **0.7 $MtCO_2e$** in Wales by 2020.

- In **Northern Ireland**, Waste Regulations (Northern Ireland) 2011 set new targets of:
  - 50% of weight of waste from households to be prepared for reuse or recycle by 2020.
  - 70% of by weight of Construction and Demolition wastes to be subject to materials recovery to 2010.

The Northern Ireland Waste Strategy is currently under review, with a proposal to legislate an increase in municipal waste for recycling/preparing for reuse/composting to 60% by 2020. The Executive has estimated that based on current policies, waste emissions could reduce by 94 $ktCO_2e$, or 14% by 2020 from today's levels.

The UK Government has estimated that based on the EU Landfill Directive, UK waste emissions could reduce by 3.7 $MtCO_2e$ by 2020. The relatively high emission reductions estimated in Scotland and Wales reflect more stretching targets, and a stronger policy framework.

7. Conclusions and future work of the Committee with the devolved administrations

Given the lack of up-to-date emission data at the devolved level, it is difficult to make definitive conclusions about recent progress and the impact of the implementation of measures on emissions.

The data that are available suggest that positive areas of recent progress include renewables deployment (particularly in Scotland), continued implementation of additional energy efficiency schemes and programmes to tackle fuel poverty, electric vehicle charging infrastructure in Scotland and Northern Ireland, ambitious targets on afforestation, and firm targets on waste reduction (supported by legislation).

However, we noted at the UK level that the first budget period is characterised by a lower ambition and lower implementation of measures than the second and third carbon budgets, to allow a lead time for policy development and introduction. With the first carbon budget period ending this year, this highlights the need now for a step change in the implementation of measures across the UK in order to meet future carbon budgets as well as devolved administration targets.

Key areas of devolved powers include transport demand-side measures, energy efficiency, waste, agriculture and land use, though there is also an important role in supporting the development and implementation of UK-level policies such as the Electricity Market Reform.

Over the coming year we will continue to work with the devolved administrations in the development and monitoring of climate change policy:

- We will provide our second report to the Welsh Government on progress reducing emissions and preparing for climate change in October this year.
- We will provide our second report on Scotland's progress reducing emissions in January 2013, considering the first statutory target (for 2010).
- We will be working with the Northern Ireland Executive throughout the year on the methodology to measure emissions per unit of commodity output in the agriculture sector.

Key findings

- Emissions in Scotland, Wales and Northern Ireland together account for **20% of the UK's total GHG emissions**.
- In 2009 **emissions fell 7%, 14% and 8% in Scotland, Wales and Northern Ireland respectively**, primarily due to the drop in economic activity and energy demand as a result of the recession.
- The cold winter months are likely to have **increased energy demand and emissions in 2010** across the devolved administrations.
- **Emissions are likely to have fallen in 2011** due to milder temperatures and significant emission reductions in the energy intensive sectors.
- Progress includes **increased renewable capacity** (e.g. Scotland now accounts for half the UK's installed capacity), commitments to continue **fuel poverty programmes** in each devolved administration, and **ambitious waste reduction targets**, supported by legislation.
- Future carbon budget and devolved targets **require an increase in the current rate of underlying emission reduction** in each sector.
- Key areas of devolved powers include **transport demand-side measures, energy efficiency, waste, agriculture and land use**, while there is also an important role in supporting implementation of UK policy, such as the Electricity Market Reform.

Future work of the Committee

The Committee has a number of deliverables over the next two years, either required under the Climate Change Act or requested by Government:

Mitigation

Carbon leakage and competitiveness: This report will consider the implications of abatement policies for industry costs and competitiveness – the scale of impact on costs, the variation in impact across industries, the potential impact of these cost changes for leakage, and options to limit competitiveness impacts. It will also consider differences between production and consumption accounting and implications for setting carbon budgets. The review will be completed in March 2013 and the results will feed into future reports, particularly the review of the fourth carbon budget.

Progress reports to Parliament to be published in June 2013 and July 2014 respectively: These reports will incorporate latest data to consider progress against indicators in 2012 and 2013. The 2013 report will also provide advice on the case for 'banking' any outperformance of the first budget forward to the next budget period, reflecting provisional data for 2012 that will complete the emissions picture for the first budget period. The 2014 progress report, reflecting availability of final emissions data for 2012, will set out an assessment on the way in which the budget for the first period was or was not achieved, and on actions taken during the period to reduce UK net emissions.

Review of the fourth carbon budget to be published in 2013-14: This will consider implications of progress in international negotiations and at EU level towards tightening the 2020 emission reduction target (e.g. to 30%) and towards setting targets beyond 2020 – specifically latest expectations for future caps under the EU ETS. It will consider issues including competitiveness impacts for energy-intensive industry, implications of possible low gas prices for decarbonisation and latest technology cost estimates and emissions projections.

Potential role of forestry in mitigating climate change: The Committee has been asked by Defra to assess the effectiveness of forestry in mitigating climate change.

We will also advise Northern Ireland, Scotland and Wales:

- **Advice to the Welsh Government:** Annual reports on progress in reducing emissions and preparing for climate change in autumn 2012 and 2013.
- **Advice to the Scottish Government:** Annual reports on progress in reducing emissions in line with legislated targets in early 2013 and 2014.
- **Advice to the Northern Ireland Executive** on a review of the methodology to measure greenhouse gas emissions per unit of commodity output at the farm-gate by March 2013.

Adaptation

Annual assessment of UK preparedness: The 2012 assessment will focus on managing risks of flooding and water shortages, two of the largest risks to the UK identified by the Climate Change Risk Assessment.

Frameworks for delivering national-level climate risk assessments: An independent review of the UK's first climate change risk assessment and the national assessments of other countries will be completed in autumn 2012.

Advice to the Government on the second round of adaptation reporting powers: Before the Government publishes its first National Adaptation Programme, it should publish its strategy for the second round of adaptation reporting powers. The Adaptation Sub-Committee will provide targeted advice to help the Government formulate its strategy in autumn 2012.

Glossary

Achievable Emissions Intensity
The minimum average annual emissions intensity of electricity generation that could be achieved in a given year, given the installed capacity, projected demand and the projected profile of that demand.

Adaptation
Adjustment of behaviour to limit harm, or exploit beneficial opportunities, arising from climate change.

Anaerobic Digestion (AD)
A treatment process breaking down biodegradable material, particularly wastes, in the absence of oxygen. Produces a methane-rich biogas that can substitute for fossil fuels.

Availability
For an electricity generating station, this is the proportion of the time that the generator is physically able to supply electricity.

Battery Electric Vehicle (BEV)
A vehicle that receives all motive power from a battery.

Biofuel
A fuel derived from biomass and used to power vehicles (can be liquid or gas). Biofuels are commonly derived from cereal crops but can also be derived from other plant material, trees and even algae.

Biogenic CO_2
Carbon dioxide that is recycled naturally in the carbon cycle and assumed to have no impact on climate change (e.g. through burning carbon sourced from naturally renewable materials such as food and paper/card waste).

Biomass
Biological material that can be used as fuel or for industrial production. Includes solid biomass such as wood and plant and animal products, gases and liquids derived from biomass, industrial waste and municipal waste.

Bunker fuels
Fuels consumed for air and maritime transportation.

Carbon Capture and Storage (CCS)
Set of technologies to capture the carbon dioxide emitted from industrial processes or from burning fossil fuels or biomass, transport it, and store it in secure spaces such as geological formations, including old oil and gas fields and aquifers under the seabed.

Carbon dioxide equivalent (CO_2e) concentration
The concentration of carbon dioxide that would give rise to the same level of radiative forcing as a given mixture of greenhouse gases.

Carbon dioxide equivalent (CO_2e) emission
The mass of carbon dioxide emission that would give rise to the same level of radiative forcing, integrated over a 100-year time period, as a given mixture of greenhouse gas emissions.

Carbon leakage
Carbon leakage occurs when there is an increase in emissions in one country/region as a result of emissions reduction by a second country/region with a strict climate policy.

Carbon price
The price at which 1 tCO_2e can be purchased. We use projections for the carbon price as a comparator for judging cost-effectiveness of potential emissions reduction measures.

Carbon price underpin/floor
Policy to ensure a set minimum amount is paid for every unit of carbon dioxide emitted.

Carbon Reduction Commitment (CRC)
A mandatory carbon reduction and energy efficiency scheme for large non-energy intensive public and private sector organisations. The CRC captures CO_2 emissions not already covered by Climate Change Agreements and the EU Emissions Trading System.

Carbon sink
An absorber of carbon (usually in the form of carbon dioxide). Natural carbon sinks include forests and oceans.

CERT
CERT (Carbon Emissions Reduction Target) is an obligation placed by Government on gas and electricity suppliers to deliver a reduction in household carbon savings across England, Scotland and Wales.

Combined Cycle Gas Turbine (CCGT)
A gas turbine generator that generates electricity. Waste heat is used to make steam to generate additional electricity via a steam turbine, thereby increasing the efficiency of the plant.

Combined Heat and Power (CHP)
The simultaneous generation of heat and power, putting to use heat that would normally be wasted. This results in a highly efficient way to use both fossil and renewable fuels. Technologies range from small units similar to domestic gas boilers to large scale CCGT or biomass plants which supply heat for major industrial processes.

Community Energy Saving Programme (CESP)
CESP targets households across Great Britain, in areas of low income, to improve energy efficiency standards, and reduce fuel bills. The programme is delivered through the development of community-based partnerships between local authorities, community groups and energy companies, via a house-by-house, street-by-street approach.

Contract for Difference (CfD)
Form of hedging on the future price of a commodity in which a strike price is pre-specified. Payments are made between counterparties depending on the difference between the strike price and the market price at the time.

Credits
Emissions credits purchased in international carbon markets, generally corresponding to 1 tCO_2e per credit. Also referred to as 'carbon units' in the Climate Change Act. It is not clear how carbon markets will develop by the 2020s. Therefore, where we refer to credits for the 2020s these could be allowances purchased in schemes such as the current EU ETS, or offset credits from project-based schemes (e.g. such as those generated under the Kyoto treaty's project-based flexibility mechanisms, Joint Implementation and Clean Development Mechanism).

Devolved administrations
The national authorities of Scotland, Wales and Northern Ireland.

Discount rate
The rate at which the valuation of future costs and benefits decline. The social discount rate (3.5%) represents that society prefers consumption now over the future – so £1.035 *next year* is equivalent to £1 today. It reflects (a) pure time preference for consumption now over having to wait; (b) the value of the extra £1 is less as incomes in the future are higher; (c) a small risk of catastrophe means that future benefits are never enjoyed. Discount rates in the private sector generally reflect the real cost of raising capital, or the real interest rate at which consumers can borrow.

Display Energy Certificate (DEC)
The certificate shows the actual energy usage of a building and must be produced every year for public buildings larger than 1,000 square metres.

Eco-driving
Eco-driving involves driving in a more efficient way in order to improve fuel economy. Examples of eco-driving techniques include driving at an appropriate speed, not over-revving, ensuring tyres are correctly inflated, removing roof racks and reducing unnecessary weight.

Electric vehicle
Vehicle capable of full electric operation fuelled by battery power driven by an electric motor. These include battery electric (BEV), plug-in hybrid electric (PHEV) and hydrogen fuel-cell vehicles.

Electricity Market Reform
Reform of the electricity market, including provision of support for low-carbon generation through Feed-in Tariffs with Contracts for Difference (FiT CfDs)

Electricity Networks Strategy Group (ENSG)
Joint government and industry group addressing key strategic issues affecting electricity networks in the shift to a low carbon economy.

Emissions Performance Standard (EPS)
Regulation setting a maximum level of allowable emissions from power plants.

Energy Company Obligation (ECO)
A new Energy Company Obligation will replace CERT, CESP and Warmfront from autumn 2012 to deliver carbon savings and help alleviate fuel poverty. The cost of the measures will be passed through to energy consumer bills.

Energy Performance Certificate (EPC)
The certificate provides a rating for residential and commercial buildings, showing their energy efficiency based on the performance of the building itself and its services (such as heating and lighting). EPCs are required whenever a building is built, sold or rented out.

Enteric fermentation
Fermentation process that takes place in the digestive systems of ruminant animals (e.g. cattle and sheep) to break down hard-to-digest grassy materials, leading to the release of methane.

European Commission
Executive arm of the European Union.

European Union Allowances (EUAs)
Emissions credits traded within the EU ETS.

European Union Emissions Trading Scheme (EU ETS)
Cap and trade system within the EU covering the power sector, energy intensive industry, and from the start of 2012 all domestic and international aviation.

Extended Ambition scenario
Emissions reduction scenario for measures to 2020, developed in our 2008 report and updated in our 2009 and 2010 progress reports. We recommended that the measures in this scenario should be implemented given the need to prepare for the 2050 target and the relative cost-effectiveness of many of the measures.

Feed-in-tariffs
A type of support scheme for electricity generators, whereby generators obtain a long term guaranteed price for the output they deliver to the grid.

Fluorinated Gases (F-gases)
Family of greenhouse gases containing fluorine. Hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF_6) are used in industrial processes, refrigeration and air conditioning. They have a high global warming potential.

Fuel poverty
A household is said to be in fuel poverty if it needs to spend more than 10 per cent of its income on fuel to maintain an adequate level of warmth.

Grazing returns
Excreta (dung and urine) from livestock kept outdoors (mainly cattle and sheep) deposited directly on land as the animal grazes and are not subject to management.

Green Deal
The Green Deal is a new financial mechanism enabled through the Energy Act 2011. It eliminates the need to pay upfront for energy efficiency measures and instead allows the costs to be paid back through savings on the electricity bill. The Green Deal charge is attached to the property, not the owner.

Green Investment Bank (GIB)
The Green Investment Bank has been set up by the UK Government under the Companies Act to provide financial solutions to accelerate private sector investment in the green economy. It will initially be capitalised with £3 billion.

Greenhouse Gas (GHG)
Any atmospheric gas (either natural or anthropogenic in origin) which absorbs thermal radiation emitted by the Earth's surface. This traps heat in the atmosphere and keeps the surface at a warmer temperature than would otherwise be possible.

Gross Domestic Product (GDP)
A measure of the total economic activity occurring in the UK.

Gross Value Added (GVA)
The difference between output and *intermediate consumption* for any given sector/industry.

Gt
A gigatonne (1,000 million tonnes).

Heat pumps
Working like a 'fridge in reverse', heat pumps use compression and expansion of gases or liquid to draw heat from the natural energy stored in the ground or air. Both air source and ground source heat pumps can provide heating for buildings.

Heating degree day
The number of degrees that a day's average temperature is below a baseline temperature (typically either 15.5°C or 18.3°C) , below which buildings need to be heated.

Heavy Goods Vehicle (HGV)
A truck over 3.5 tonnes (articulated or rigid).

Hybrid vehicle
A vehicle powered by an internal combustion engine and electric motor that can provide drive train power individually or together. E.g. Toyota Prius.

Hydrocarbon
A chemical compound comprised of hydrogen and carbon atoms, often of fossil fuel origin. Examples include methane, crude oil and oil products (e.g. petroleum, diesel and kerosene). Hydrocarbons release CO_2 upon combustion.

Intended budget
As proposed in our 2008 report, the Intended budget (2008-2022) corresponds to the UK share of an EU 30% 2020 target. We recommended it should be enacted in the context of a global deal to reduce emissions.

Intergovernmental Panel on Climate Change (IPCC)
The IPCC was formed in 1988 by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP). It is designed to assess the latest scientific, technical and socio-economic literature on climate change in a way which is neutral with respect to policy.

Interim budget
As proposed in our 2008 report, the Interim budget corresponds to the UK share of an EU 20% 2020 target. This is the current set of legislated budgets to 2022.

Joule
The standard international unit of energy. Related units are: Kilojoule (kJ) = 1000 Joules, Megajoule (MJ) = 1 million Joules, and Gigajoule (GJ) = 1 billion Joules.

Kilowatt-hour (kWh)
A unit of energy, equal to the total energy consumed at a rate of 1,000 watts for one hour. Related units are: Megawatt-hour (MWh) = 1,000 kWh, Gigawatt-hour (GWh) = 1,000 MWh and Terawatt-hour (TWh) = 1,000 GWh. The kilowatt-hour is equal to 3.6 million Joules.

Kyoto gas
A greenhouse gas covered by the Kyoto Protocol; specifically carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), sulphur hexafluoride (SF_6), hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs).

Kyoto Protocol
Adopted in 1997 as a protocol to the United Nations Framework Convention on Climate Change (UNFCCC), the Kyoto Protocol makes a legally binding commitment on participating countries to reduce their greenhouse gas emissions by 5% relative to 1990 levels, during the period 2008-2012.

Levelised cost
Lifetime costs and output of electricity generation technologies discounted back to their present values to produce estimates of cost per unit of output (e.g. p/kWh).

Load factor
A measure of the output of an electricity generator relative to the maximum output it could produce.

Low Carbon Transition Plan (LCTP)
White paper from the Department of Energy and Climate Change (DECC) published in 2009.

Major Infrastructure Planning Unit (MIPU)
Advisory body to the Secretary of State on the determination of planning applications of large infrastructure projects (e.g. over 50 MW).

Marginal Abatement Cost Curve (MACC)
Graph showing costs and potential for emissions reduction from different measures or technologies, ranking these from the cheapest to most expensive to represent the costs of achieving incremental levels of emissions reduction.

Mechanical Biological Treatment (MBT)
A treatment process for waste involving breaking down mixed waste (e.g. by shredding) and removing any recyclable material. The remaining waste is then either composted, incinerated, digested (producing biogas) or sent to landfill.

Methane (CH_4)
Greenhouse gas with a global warming potential of 21 (1 tonne of methane emission corresponds to 21 tonnes CO_2e). Arises in the agriculture sector as a result of enteric fermentation in the digestive systems of ruminant animals (e.g. cattle and sheep) as well as in manures. Arises in the waste sector as biodegradable waste decomposes in landfill sites in the absence of oxygen.

Mitigation
Action to reduce the sources (or enhance the sinks) of factors causing climate change, such as greenhouse gases.

Mt
Million tonnes.

National Atmospheric Emissions Inventory (NAEI)
Data source compiling estimates of the UK's emissions to the atmosphere of various (particularly greenhouse) gases.

National Renewable Energy Action Plan (NREAP)
Document submitted to the Commission by each EU member outlining how they intend to meet their required contribution towards the target of 20% of EU energy to be supplied by renewable sources by 2020.

NER 300
EU financing instrument consisting of 300 million allowances set aside from the New Entrant's Reserve of the EU ETS for subsidising innovative renewable technologies and CCS.

Nitrous oxide (N_2O)
Greenhouse gas with a global warming potential of 310 (1 tonne of nitrous oxide emission corresponds to 310 tonnes of CO_2e). Arises naturally in agricultural soils through biological processes and is influenced by a variety of soil and nutrient management practices and activities (e.g. synthetic fertiliser application).

NO_X
Oxides of nitrogen, defined as the sum of the amounts of nitric oxide (NO) and nitrogen dioxide (NO_2).

Offset credits
See credits.

Ofgem (Office of Gas and Electricity Markets)
The regulator for electricity and gas markets in Great Britain.

Plug-in hybrid Electric Vehicle (PHEV)
A vehicle that receives motive power from both a battery and a secondary source (e.g. an internal combustion engine). The battery will generally be charged in the same way as that in a BEV, but all electric range will be more limited (e.g. 40 rather than 100 miles).

Real household disposable income
The amount of income in real terms available to households after taxes, National Insurance, pension contributions and interest have been paid.

Renewable Energy Directive (RED)
A European directive that sets targets for all member states, such that the EU will reach a 20% share of energy from renewable sources by 2020 and a 10% share of renewable energy specifically in the transport sector.

Renewable Energy Strategy (RES)
Government plan to meet the European target of 15% of energy (including electricity, heat and transport) from renewable sources by 2020.

Renewable Heat Incentive (RHI)
A feed-in-tariff type mechanism to provide long-term financial support to producers of renewable heat.

Renewables
Energy resources, where energy is derived from natural processes that are replenished constantly. They include geothermal, solar, wind, tide, wave, hydropower, biomass and biofuels.

Renewables Obligation Certificate (ROC)
A certificate issued to an accredited electricity generator for eligible renewable electricity generated within the UK.

Smarter Choices
Measures that influence people's travel behaviour towards less carbon intensive alternatives to the car such as public transport, cycling and walking by providing targeted information and opportunities to consider alternative modes.

Solar photovoltaics (PV)
Panels that generate electricity from sunlight.

Turbocharging
A type of forced induction system, which compresses the air flowing into a petrol or diesel combustion engine, squeezing more air into a cylinder, then allowing more fuel to be added. A turbocharged engine produces more power overall from each explosion in each cylinder, improving the power-to-weight ratio of the engine. One advantage is that it reduces fuel consumption without compromising engine performance.

Vehicle Excise Duty (VED)
Commonly known as road tax, an annual duty which has to be paid to acquire a vehicle licence for most types of motor vehicle. VED rates for private cars have been linked to emissions since 2001, with a zero charge for the least emitting vehicles (under 100 gCO_2/km).

Warmfront
Treasury funded fuel poverty programme in England to deliver energy efficiency and heating measures. Funding will expire at the end of financial year 2012-13.

Abbreviations

AD	Anaerobic Digestion
BEV	Battery Electric Vehicle
CAP	Common Agricultural Policy
CCA	Climate Change Agreement
CCL	Climate Change Levy
CCC	Committee on Climate Change
CCGT	Combined-Cycle Gas Turbine
CCS	Carbon Capture and Storage
CERT	Carbon Emissions Reduction Target
CESP	Community Energy Saving Programme
CfD	Contract for Difference
CH_4	Methane
CHP	Combined Heat and Power
CLG	Department for Communities and Local Government
CRC	Carbon Reduction Commitment
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
DEC	Display Energy Certificate
DECC	Department for Energy and Climate Change
Defra	Department for Environment, Food and Rural Affairs
DfT	Department for Transport
DUKES	Digest of UK Energy Statistics
EC	European Commission
ECO	Energy Company Obligation
EMR	Electricity Market Reform
ENSG	Electricity Network Strategy Group
EPC	Energy Performance Certificate
EPS	Emissions Performance Standard
EU	European Union
EU ETS	European Union Emissions Trading Scheme
EUA	European Union Allowance
FIT	Feed-in Tariff
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GIB	Green Investment Bank

GVA	Gross value added
HDD	Heating Degree Days
HGV	Heavy goods vehicle
IEA	International Energy Agency
IPC	Infrastructure Planning Commission
IPCC	Intergovernmental Panel on Climate Change
LCA	Life-cycle assessment
LCTP	Low Carbon Transition Plan
LULUCF	Land use, land use change and forestry
MACC	Marginal abatement cost curve
MBT	Mechanical Biological Treatment
MIPU	Major Infrastructure Planning Unit
N_2O	Nitrous oxide
NAEI	National Atmospheric Emissions Inventory
NER	New Entrant's Reserve
NO_x	Oxides of nitrogen
NPS	National Policy Statement
NREAP	National Renewable Energy Action Plan
NTS	Non-Traded Sector
NVZ	Nitrate Vulnerable Zone
Ofgem	Office of the Gas and Electricity Markets
ONS	Office for National Statistics
PHEV	Plug-In Hybrid Electric Vehicle
RED	Renewable Energy Directive
RES	Renewable Energy Strategy
RHI	Renewable Heat Incentive
RHPP	Renewable Heat Premium Payment
RO	Renewable Obligation
ROC	Renewable Obligations Certificate
RPI	Retail Prices Index
SEA	Strategic Environment Assessment
SHETL	Scottish Hydro Electric Transmission Limited
SMEs	Small & Medium Enterprises
SMMT	Society of Motor Manufacturers and Traders
STW	Scottish Territorial Waters
VED	Vehicle Excise Duty

Figures, Tables and Boxes index

Figures index

Tables index

Boxes index

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