Meeting Carbon Budgets – ensuring a low-carbon recovery

2nd Progress Report to Parliament
Committee on Climate Change
June 2010

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30 June 2010

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Climate Change Act 2008


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Foreword

This is our second annual report as required under the Climate Change Act. It follows only nine months after our first report to Parliament. From now on, however, our annual reports will be delivered at 12 monthly intervals in June each year.

In our first report, published last October, we showed that emissions fell only slightly in the five year period before the recession. We therefore argued that a step change in the pace of emissions reduction is required to achieve carbon budgets.

In this report, we consider latest trends in annual emissions relative to current budget limits, and we assess progress against our forward indicators which determine whether we are on track to meet future budgets.

The UK's greenhouse gas emissions fell 8.6% from 2008 to 2009 with reductions of 9.7% in CO_2 and 1.9% in non-CO_2 emissions. But the reduction was largely due to the recession and other exogenous factors, which we estimate could reduce emissions by up to 6% over the first budget period. Underlying progress, which we assess by looking at the impact of specific policy measures, was limited relative to that needed to put the UK on the path towards the 2050 target, implying that a step change in the pace of emissions reduction is still required.

We therefore reiterate our recommendation (set out in our first annual report) that outperformance in the first budget period should not be banked. We raise the issue of whether the second and third budgets should be tightened in the face of the easier short term challenge – for instance by moving to the Commmitee's "Intended budget" even in the absence of a new global agreement. And we recommend that new policies are introduced to strengthen incentives for energy efficiency improvement, investment in low-carbon power generation, development of an electric car market, and introduction of new practices in agriculture.

This report is the first of four this year. In July, we will publish our review of the approach to low-carbon R&D in the UK. In September we will publish our advice on the second phase cap for the Carbon Reduction Commitment Energy Efficiency Scheme. Our main report this year will be the advice on the fourth carbon budget. This will include assessment of recent developments in climate science, progress moving towards a new global agreement, and the UK path for emissions reductions in the period to 2030. We will publish our advice on the fourth carbon budget before the end of the year as required in the Climate Change Act.

The Committee and Secretariat have worked very hard in the last year to publish our first report to Parliament, our advice on the future of UK aviation, our advice to the Scottish government, and this report. On behalf of the Committee, I would like to thank the Secretariat for their dedication and professionalism.

The Committee on Climate Change

Lord Adair Turner, Chair
Lord Turner of Ecchinswell is the Chair of the Committee on Climate Change and Chair of the Financial Services Authority. He has previously been Chair at the Low Pay Commission, Chair at the Pension Commission, and Director-General of the Confederation of British Industry (CBI).

David Kennedy, Chief Executive
David Kennedy is the Chief Executive of the Committee on Climate Change. Previously he worked on energy strategy 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.

Dr Samuel Fankhauser
Dr Samuel Fankhauser is a Principal Research Fellow at the Grantham Research Institute on Climate Change at the London School of Economics. He is a former Deputy Chief Economist of the European Bank for Reconstruction and Development and former Managing Director (Strategic Advice) at IDEAcarbon.

Professor Michael Grubb
Professor Michael Grubb is Chair of the international research network Climate Strategies. He is a senior research associate at Cambridge University and holds a visiting professorship at Imperial College. Previously he was Head of the Energy and Environmental Programme at Royal Institute of International Affairs, and Professor of Climate Change and Energy Policy at Imperial College.

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.

Professor Julia King
Professor Julia King CBE FREng is 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.

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.

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: Owen Bellamy, Russell Bishop, Ute Collier, Ben Combes, Kristofer Davies, Neil Golborne, Philip Hall, David Joffe, Alex Kazaglis, Swati Khare-Zodgekar, Anna Leatherdale, Eric Ling, Nina Meddings, Laura McNaught, Sarah Naghi, Akshay Paonaskar, Stephen Smith, Kavita Srinivasan, Jonathan Stern, Indra Thillainathan, Mike Thompson, Claire Thornhill, Emily Towers and Jo Wilson.

A number of individuals who provided significant support: Luke Davison, Mario Deconti, Simon Green, Katherine Kinninmonth, Roger Lampert, Margaret Maier, Stella Matakidou, Stephen Oxley, Michele Pittini, David Wilson.

A number of organisations for their support, including Association of Electricity Producers, British Institute of Energy Economics, Carbon Trust, Commission for Integrated Transport, DECC, Defra, DfT, Energy Saving Trust, Environment Agency, Heating and Hotwater Industry Council, Market Transformation Programme, National Insulation Association, Northern Ireland Executive, Office for Nuclear Development, Office for Renewable Energy Deployment, Ofgem, RenewableUK, Rural Climate Change Forum, Scottish Government, Shell, Society of Motor Manufacturers and Traders, UK Business Council for Sustainable Energy, Welsh Assembly Government.

A wide range of stakeholders who engaged with us, attended our expert workshops, or met with the Committee bilaterally.

Structure of the report

The report comprises five chapters:

Chapter 1: Overview of progress towards meeting carbon budgets summarises emissions trends in the UK based on latest data for 2008 and 2009. It reiterates the case for early action to reduce emissions in the UK, and considers the extent to which observed reductions are a result of the recession or other exogenous factors versus underlying progress in the implementation of measures. It considers progress against our indicator framework, which includes both the implementation of measures and policy milestones. It also comments on the monitoring framework set out in departmental carbon budget delivery plans.

The four sectoral chapters – covering power, buildings and industry, surface transport and agriculture – each include an assessment of latest emissions data, and progress against our indicators for measures and policy milestones. Specific topics include:

- **Chapter 2: Power** looks at levels of investment in 2009, and progress on the underpinning actions (such as planning and transmission reform to support future investment in renewables, CCS and nuclear generation). It also contains recommendations on electricity market reform, a floor price on carbon and the role of a Green Investment Bank.
- **Chapter 3: Buildings and Industry** assesses progress on loft and cavity wall insulation and other indicators, together with policy milestones. It contains recommendations relating to policy proposals for a new National Energy Efficiency Programme, the Renewable Heat Incentive and the wider roll-out of Energy Performance Certificates and Display Energy Certificates.
- **Chapter 4: Surface transport** examines the scale of reduction in emissions from purchase of lower-carbon new cars and considers the extent to which this is recession-related. It evaluates progress in measures to encourage the purchase of electric vehicles and to develop an electric vehicle charging network, and in demand-side measures for emission reduction, including the roll-out of smarter choices recommended in our first progress report. It examines the potential to reduce emissions through the proposed EU framework for new vans.
- **Chapter 5: Agriculture** presents new analysis of emission reduction potential, and considers this against the reduction targeted for England in the Low Carbon Transition Plan, suggesting additional abatement is possible. It recommends a range of policy measures be considered to unlock this potential, proposes a draft framework of indicators to monitor progress, and highlights the need to develop a more robust evidence base.

Executive Summary

This is our second annual report to Parliament on progress reducing emissions and meeting carbon budgets as required under the Climate Change Act. It follows our first report to Parliament in October 2009, which under the Act was delayed slightly from our normal June reporting date. This allowed the Government to respond to our advice on the level of carbon budgets (December 2008), through legislating carbon budgets (May 2009) and publishing the Low Carbon Transition Plan (July 2009). In future, the Act requires that we report annually every June (i.e. our next progress report to Parliament will be in June 2011).

In our first report to Parliament we concluded:

- CO_2 emissions fell by only 0.6% annually in the period before the recession, relative to 2-3% annual cuts required in the period to 2020 to meet carbon budgets. Going forward, therefore, a step change in the pace of emissions reduction is needed – in line with emissions trajectories in DECC's Low Carbon Transition Plan.
- New approaches to energy efficiency improvement in buildings, decarbonisation of the power sector and reducing emissions from transport are necessary to deliver the step change.
- Emissions will fall as a result of the recession. However, this should not be regarded as evidence of the step change. Given the impacts of the recession, the aim should be to outperform budgets through implementation of measures, and not to bank outperformance through to the second budget.

We also set out indicators covering both measures and policy milestones to drive emissions reductions, and against which progress meeting carbon budgets could be assessed.

In this report, we do three things:

- We consider the latest emissions data and the extent to which emissions reductions have ensued as a result of the recession and other exogenous factors, or through implementation of measures.
- We consider progress against the indicators set out in our first report to Parliament.
- We present an updated analysis of emissions reduction opportunities in agriculture, and extend our indicator framework to cover this sector.

The main messages in the report reflect the fact that it is only nine months since our first report to Parliament, and we would therefore expect that there has been only limited progress towards the required step change:

- UK greenhouse gas emissions fell by 1.9% in 2008 and 8.6% in 2009, mainly due to the recession and other exogenous factors (e.g. fuel price rises).
- Implementation of measures together with the impacts of the recession should result in emissions lower than legislated for the first budget. Given the need for implementation of measures in preparation for the deeper emissions cuts required in future, the aim should be to outperform the first budget, and not to use this outperformance to reduce effort in the second budget.
- Our indicator framework envisaged limited progress on implementation of measures in 2009, based on modest ambitions in policies that were firm and funded in 2008. This is generally what has followed, for example with progress on loft and cavity wall insulation in line with our indicators. There has been outperformance against our indicator for new car efficiency, due largely to the impact of the recession and fossil fuel price increases in recent years, reinforced by policies (e.g. vehicle excise duty differentiation according to fuel efficiency).

- However, our indicator framework also builds in a step change in the pace of implementation across the range of measures (e.g. residential and non-residential energy efficiency improvement, renewable heat and electricity, and electric cars) moving towards the second budget period. There is no evidence of broad outperformance on implementation of measures in 2009, and therefore a step change is still required. In the absence of such a step change (i.e. based on the rate of implementation of measures in 2009) there would be a gap of around 35 Mt CO_2 relative to the (currently legislated) third Interim carbon budget, and 150 Mt CO_2 relative to the Intended third budget.

Progress has been made developing approaches to drive the step change, but new policies are required in order to reduce emissions in power, buildings, transport and agriculture sectors:

- **Strengthening incentives for investment in low-carbon power generation:** Three key areas where there is a need for strengthening incentives are reform of the electricity market arrangements, underpinning the carbon price, and demonstrating coal and gas carbon capture and storage (CCS) generation.
  - **Electricity market reform.** The Energy Market Assessment (EMA) concludes that current electricity market arrangements are unlikely to result in required electricity sector decarbonisation in the period to 2030. It is crucial now to proceed with energy market reform, to which the new Government is committed, considering in detail the range of options set out in the EMA, and to introduce a new system with appropriate incentives for investment in secure and low-carbon power generation.
  - **Carbon price floor.** The carbon price within the EU Emissions Trading Scheme (ETS), and future expected prices, remain low. For the interim period before new electricity market arrangements are introduced, and in the absence of EU-wide action, there is a strong case for introduction of a UK carbon price floor (i.e. minimum price, as proposed by the new Government). This should, together with the carbon price in the EU ETS, provide sufficient incentives for investment in low-carbon power generation.
  - **CCS demonstration.** A new framework for CCS was announced in November 2009, but no demonstration plant has yet been chosen. Also since our October 2009 report, new analysis has suggested a significant potential role for gas CCS. It will be important to demonstrate CCS technology on both coal and gas generation. The Emissions Performance Standard proposed in the Coalition Agreement could, depending on detailed design, provide appropriate signals about the very limited role for conventional coal generation in the 2020s. A coherent approach to fossil fuel fired generation requires that the Government should also seriously consider an Emissions Performance Standard for conventional gas generation (e.g. to require that all new coal and gas plant beyond 2020 should have CCS fitted).
- **Developing new delivery mechanisms and incentives to improve energy efficiency of buildings:** The new Government's commitment to a National Energy Efficiency Programme, to be supported by early legislation and a 'Green Deal', requires detailed implementing arrangements. These include financing arrangements (the balance between 'Pay As You Save' and additional funding to support the implementation of more expensive measures and free energy efficiency measures for the fuel poor); how homeowners will be incentivised to participate (e.g. provision of energy audits, financial incentives, standards); the specific roles of local authorities, energy companies and other players; and standards for the private rented sector.
- **Encouraging a move to more carbon-efficient cars:** The recession has led to a change in car purchase behaviour towards more carbon-efficient models. Incentive mechanisms could be used to lock in this behaviour (e.g. further differentiation of VED on the basis of fuel-efficiency). In relation to electric cars, progress was made in 2009 through the Plugged in Places project. In order to develop this key technology for widespread roll-out in the 2020s, the Government should set ambitious targets for electric car penetration in the period to 2020, and commit to funding both the transitional cost premium of electric cars and the cost of a national battery charging network.

- **Introducing new policies for the agriculture sector**. Our new analysis of the agriculture sector suggests that there is significant scope for emissions reduction through a range of measures relating to soils and livestock, and through anaerobic digestion, with emissions reduction potential exceeding the target set out in the Low Carbon Transition Plan. We recommend a three pillar approach based on: improving the evidence base to better measure emissions and understand emissions reduction potential; serious consideration of the full range of policy options going beyond voluntary action; development of an indicator framework against which future progress reducing emissions can be assessed.

We also include in this report a high-level consideration of departmental carbon reduction delivery plans, as requested through our (Whitehall and Devolved Administrations) Sponsors Group. These plans are an important part of the framework for delivering carbon budgets. We recommend that they could be strengthened through the inclusion of trajectories for key measures against which progress can be assessed, and that they should include commitment to appropriate policies where these are currently absent.

We now provide a more detailed summary of these messages, with the complete underpinning analysis set out in the full report to Parliament[1]. We set out the summary in 6 sections:

1. Emission reductions during the recession
2. Step change still needed
3. Progress decarbonising the power sector
4. Progress reducing emissions from buildings and industry
5. Progress cutting surface transport emissions through low-carbon vehicles and alternatives to car travel
6. Opportunities for reducing emissions from agriculture

1 Available at www.theccc.org.uk

1. Emission reductions during the recession

Key emissions drivers

The context for 2009 emissions includes falling GDP, rising fuel prices (other than in transport), and lower temperatures but less cold days:

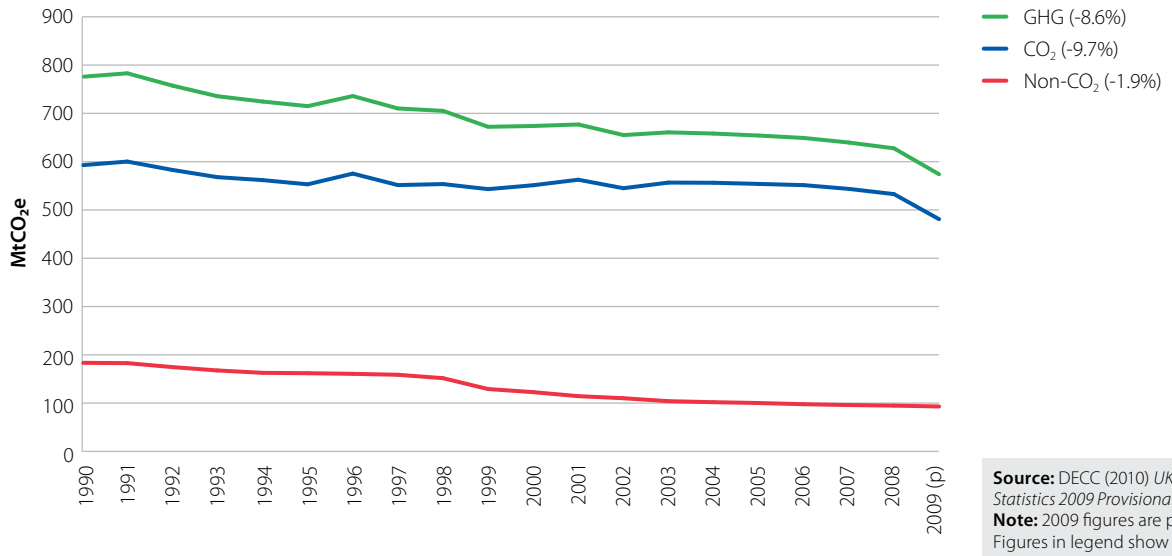
- Overall GDP fell by 5%, and within this manufacturing output declined 10%.
- Residential and industrial fuel prices generally rose in 2009 – with residential gas prices up by 12% in real terms.
- Whilst average temperatures in December and January 2009 were lower than in the same months in 2008, overall 2009 had fewer days with temperatures below the heating threshold, with these two effects largely balancing in terms of energy demand.

Economy-wide emissions

Greenhouse gas emissions (GHGs) fell by 8.6% (provisional) in 2009, driven mainly by reductions in CO_2 emissions of 9.7%, with a smaller 1.9% reduction in non-CO_2 (Figure 1). Emissions fell in each of the main emitting sectors (Figure 2):

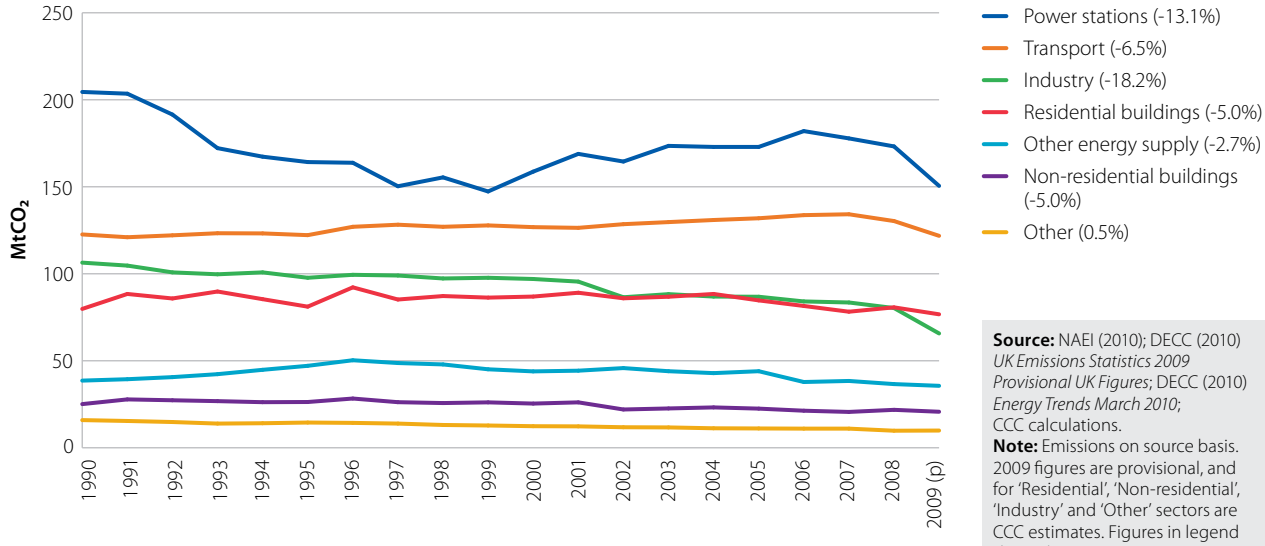
- Power sector CO_2 emissions fell by 13.1% in 2009.
- CO_2 emissions from buildings and industry fell by around 12% in 2009.
  - Direct emissions (i.e. from fuel burned) from the residential sector fell by 5%, while we estimate indirect emissions (i.e. from electricity used) fell 10%.
  - In the non-residential sector, we estimate that public sector direct emissions were flat and indirect emissions fell 7%. Commercial emissions fell an estimated 10% (direct) and 14% (indirect).
  - We estimate that direct industrial emissions fell by 18% while indirect emissions fell 19%.
- Transport emissions fell by 6.5% in 2009. Within this we estimate that CO_2 emissions from road transport fell by around 3.9% in 2009.
- Whilst sectoral GHG data for 2009 are not yet available, GHG emissions from agriculture fell by around 1% in 2008.

Figure 1 UK greenhouse gas emissions (1990-2009)



Source: DECC (2010) *UK Emissions Statistics 2009 Provisional UK Figures.*
Note: 2009 figures are provisional. Figures in legend show change in emissions in 2009.

Figure 2 UK CO_2 emissions by sector (1990-2009)



Source: NAEI (2010); DECC (2010) *UK Emissions Statistics 2009 Provisional UK Figures*; DECC (2010) *Energy Trends March 2010*; CCC calculations.
Note: Emissions on source basis. 2009 figures are provisional, and for 'Residential', 'Non-residential', 'Industry' and 'Other' sectors are CCC estimates. Figures in legend show change in emissions in 2009.

Non-traded sector emissions

In our 2009 progress report to Parliament, we projected that non-traded sector emissions (from heating, transport, agriculture, etc.) would fall significantly as a result of the recession. This would make the first carbon budget achievable with less emissions reduction effort than was envisaged at the time that it was set (i.e. the budget did not build in expected impacts of the recession).

However, we argued that it is important that measures to reduce emissions are implemented in the first budget period in order to prepare for meeting subsequent budgets. Therefore we argued that the aim should be to outperform the first budget (i.e. the combination of emissions reductions through the recession and implementation of measures would go beyond what is required to meet the budget), and not to bank (i.e. carry forward and credit, as allowed under the Climate Change Act) outperformance through to the second budget.

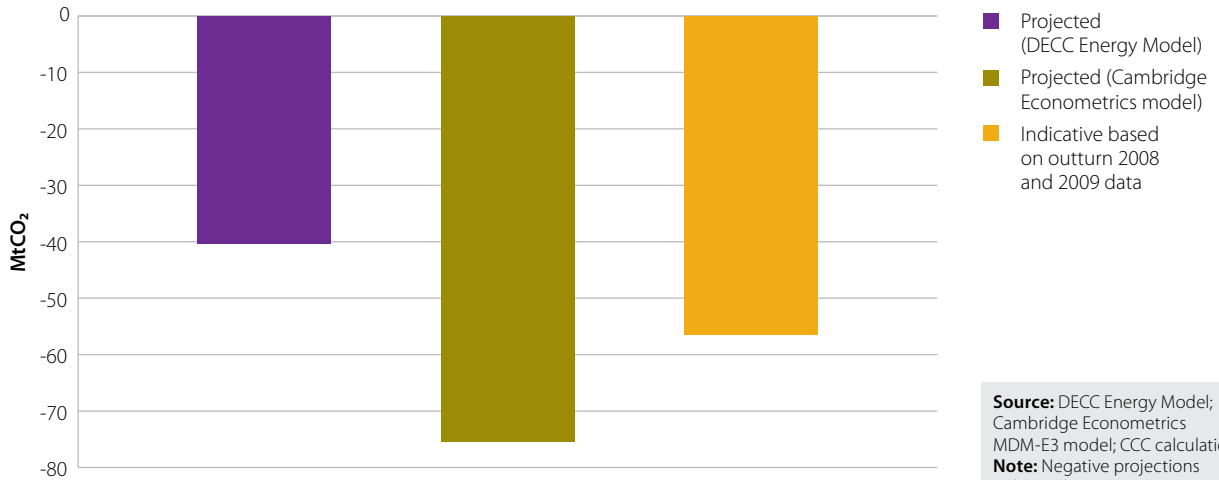
In our 2009 report, we projected emissions reductions due to the recession and other exogenous factors of around 3-6% across the first budget:

- Projections from the DECC Energy Model suggested impacts of around 3%.
- Projections from the Cambridge Econometrics model, which assumes more income responsive energy demand, suggested impacts of around 6%.

Actual emissions data for 2008 and 2009 now confirms a strong reduction, with our new analysis suggesting that emissions will be around 4% lower than we originally envisaged for the first budget period (i.e. within the range of the DECC and Cambridge Econometrics projections, Figure 3).

We have considered the possibility that reduced emissions in 2008 and 2009 are due to implementation of measures, rather than the recession and other exogenous factors. However, our analysis suggests that implementation of measures can only account for a small part of the total emissions reduction (Table 1). Therefore we continue to recommend that the aim, through the combination of recession impacts and implementation of measures required in the remainder of the first budget, should be to outperform the first budget (e.g. by up to 75 $MtCO_2$, around 6%, projected by the Cambridge Econometrics modelling, and not to bank outperformance.

Figure 3 Projected outperformance of first budget (2008-2012) in the non-traded sector due to the recession and other changes



Source: DECC Energy Model; Cambridge Econometrics MDM-E3 model; CCC calculations.
Note: Negative projections indicate that emissions are expected to be below budget (i.e. an outperformance is expected to occur).

Table 1 Actual versus expected delivery of CO_2 emissions reduction measures in the non-traded sector in 2008 and 2009

	Uptake/improvement			Emissions reductions ($MtCO_2$)		
	Expected	**Outturn**	**Outperformance**	**Expected**	**Outturn**	**Outperformance**
Domestic sector						
Loft insulation (professional)	1.0 m	1.6 m	0.6 m	0.2	0.3	0.1
Loft insulation (DIY)	0.0 m	0.9 m	0.9 m	0.0	0.2	0.2
Cavity wall insulation	1.1 m	1.1 m	0.0 m	0.6	0.6	0.0
Solid wall insulation	0.05 m	0.03 m	-0.02 m	0.1	<0.1	<-0.1
Efficient boilers	2.0 m	2.3 m	0.3 m	1.0	1.1	0.1
Road transport						
New car gCO_2/km	2% improvement	9% improvement	7%	0.1	0.4	0.3
Biofuels (by volume)	+1.9 percentage points*	+1.9 percentage points*	0 percentage points	2.0	2.0	0.0
Total						
				4.0	4.8	0.8

Source: Uptake – Insulation: Ofgem, DECC; Boilers: Heating and Hotwater Industry Council, CLG, CCC; New car CO_2: Society of Motor Manufacturers and Traders; Biofuels: HMRC. Emissions reductions – CCC calculations.

Note: *i.e. increase in share from 1% to 2.9% by volume. Uptake figures for insulation and boilers are cumulative installations in 2008 and 2009.

Under previous HMT forecasts and more conservative forecasts by the Office of Budget Responsibility (OBR) for the June 2010 Budget, the impact of the recession will continue through the first three budget periods (e.g. HMT projected GDP to be 7% lower in 2014 and 6% lower in 2020 than anticipated when the carbon budgets were set; OBR project GDP in 2015 to be 10% lower). This raises a question about whether and when the UK should move from the Interim to Intended budgets, with costs of achieving the Intended budget now lower as a result of the recession. We will return to this consideration in the context of our advice on the fourth carbon budget (2023-27), to be provided by the end of the year.

Traded sector emissions

Emissions from the electricity generation sector and energy-intensive industries are capped Europe-wide under the EU ETS. From 2008 to 2009 the UK cap remained flat at 246 $MtCO_2$. However, actual emissions from UK firms covered by the EU ETS fell 12.5% to 232 $MtCO_2$ in 2009. As a result UK firms were able to sell more allowances into the EU market, or to bank them towards meeting future caps.

In assessing the traded sector, we recognise that since emissions are capped the budget will always be achieved by definition (e.g. as emissions are increased, the EU ETS requires that this must be offset by the purchase of emissions reductions in European or global carbon markets, which is reflected in the UK Net Carbon Account as defined under the Climate Change Act).

However, our approach reflects the need to reduce emissions in the traded sector over the first three budget periods, particularly given the priority to prepare for decarbonisation of the power sector in the period to 2030. Therefore our focus in monitoring progress is on measures and polices to support low-carbon investment and technologies for cutting emissions in power generation and other energy-intensive industries.

At the European level (where the cap was also flat from 2008 to 2009), traded sector emissions fell by 11.6%, largely due to reduced output of energy intensive industries during the recession, as well as some fuel switching from coal to gas in power stations in response to relatively low gas prices. The implication of this is that the EU ETS cap can be met with less emissions reduction effort than was envisaged at the time that the cap was set and that the EU ETS price will be lower than widely predicted before the recession.

In 2009, we revised our 2020 carbon price projection down from around €55/tCO_2 to around €20/tCO_2. The current market price is around €15/tCO_2, with market estimates of a 2020 price in the range €25 – 40/tCO_2. A price of €25/tCO_2 or lower in 2020 (e.g. if it turns out that there has been over-allocation of allowances, or if more offset credits are allowed into EU ETS) may not be sufficient to support required investments in low-carbon power generation. In the absence of EU-wide tightening of the cap, therefore, the case for underpinning the carbon price should be seriously considered, possibly as an interim measure before more fundamental electricity market reforms are introduced (Section 3); the new Government has recognised this, and announced in the recent budget it's intention to consult on options for carbon price strengthening in the autumn.

The effectiveness of a carbon price floor will depend on detailed design. Specifically, this should deliver a target carbon price which together with the EU ETS is sufficient to support investment in low-carbon power generation. Factors to be considered in setting the precise level of the carbon price floor should include:

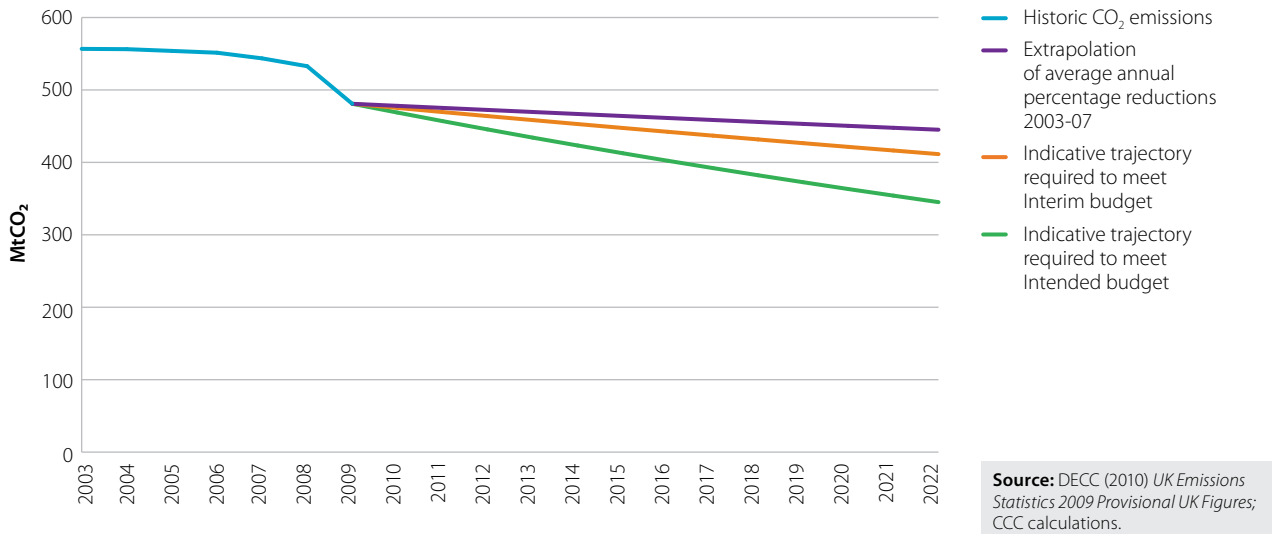
- The projected carbon price under an EU 30% GHG emissions reduction target for 2020.
- The level of support required for ***new*** low-carbon generation (as opposed to existing generation, which should not benefit from windfall profits) under various assumptions about fossil fuel prices.
- The present value of the marginal abatement cost associated with meeting the target in the Climate Change Act to reduce 2050 emissions by 80% relative to 1990 levels.

2. Step change still needed

Our first report to Parliament considered emissions data for the five-year period prior to the recession and concluded that a step change in the pace of emissions reduction is required in order that carbon budgets are achieved.

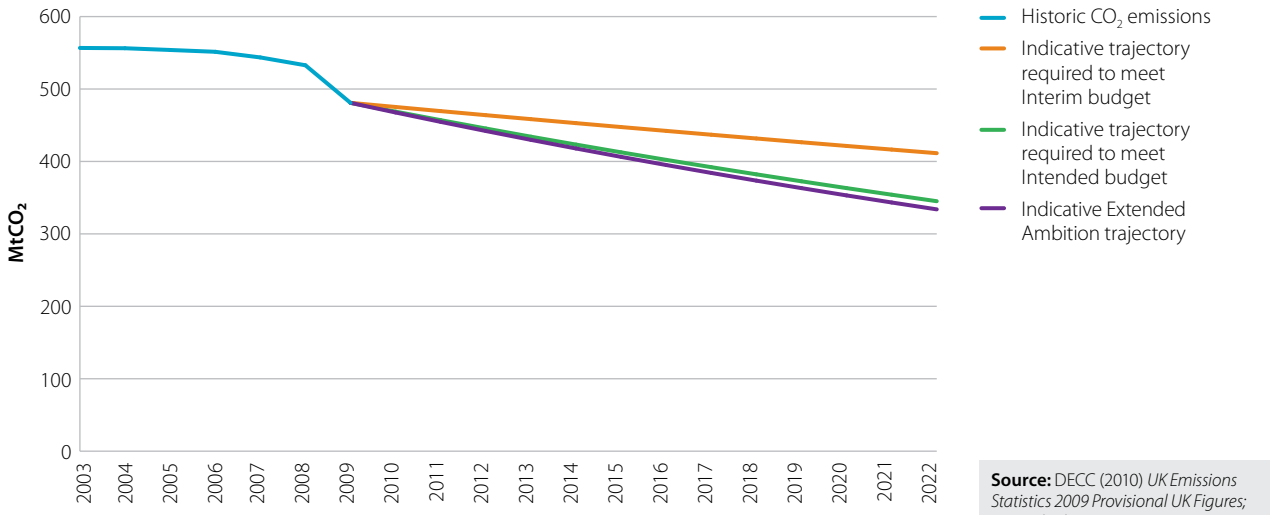
The recession has led to a step down in the level of emissions but not to a step change in underlying progress. If GDP were to return to trend growth,

Figure 4 Indicative economy-wide CO_2 reductions required to meet budgets versus pre-recession trend (2003-2022)



Source: DECC (2010) *UK Emissions Statistics 2009 Provisional UK Figures;* CCC calculations.

Figure 5 Indicative economy-wide CO_2 Extended Ambition trajectory incorporating additional recession impacts versus budget requirements (2003-2022)



Source: DECC (2010) *UK Emissions Statistics 2009 Provisional UK Figures;* CCC calculations.

and before allowing for any ***further*** bounce-back in emissions (e.g. due to re-stocking of inventories, disproportionate growth in output and emissions of energy-intensive industries), analysis in this report shows that with progress either at the rate for the period 2003-07, or based on implementation of measures in 2009, carbon budgets will not be achieved (Figure 4):

- The purple line in Figure 4 projects emissions on the basis of average annual reductions in the five years before the recession; this is similar to a projection based on underlying progress during the recession (not shown in Figure 4).
- Even with the impact of the recession (shown by the kink in the blue line), reverting to the pre-recession rate of reduction (the purple line) would not be sufficient to meet the Interim Budget (shown by the orange line) or the Intended budget (shown by the green line).

Therefore a step change is still needed. The requirement for progress can be considered in three categories of measures:

- Increasing the pace of emissions reduction in areas where there was some (limited) progress in 2009 (e.g. cavity wall insulation).
- Locking in to changed car purchase behaviour during the recession, and ensuring further progress on purchase of more efficient cars.
- Building up momentum in areas where there has been very limited progress implementing measures to date (e.g. low-carbon power generation, solid wall insulation, SME energy efficiency improvement, renewable heat, new van efficiency, Smarter Choices, agriculture).

If these measures were to be implemented, then this could be sufficient to meet the Intended budget (Figure 5):

- The purple line in Figure 5 shows emissions under an assumption that the impact of the recession persists and measures in the Committee's Extended Ambition scenario are implemented, including measures which are cost-effective and measures which are required to develop technologies for deployment in the 2020s.
- This is below both the orange line representing the Interim budget, and the green line representing the Intended budget.

As noted above, this raises a question about whether and when the UK should move to the Intended budget, which we will consider as part of our advice on the fourth carbon budget.

3. Progress decarbonising the power sector

Progress reducing power sector emissions

In 2009, power sector emissions fell by 13.1% due to both a demand reduction and a fall in carbon intensity (Figure 6, Figure 7, Figure 8):

- Electricity demand remained constant in 2008 and fell by 7% in 2009.
- Carbon intensity of power generation fell from 545 gCO_2/kWh in 2008 to 496 gCO_2/kWh in 2009. This reflects an increase in nuclear generation and a reduction in coal-fired generation, along with a small increase in renewable generation:
  - The share of nuclear generation increased from 13% in 2008 to 19% in 2009 as two plants which had outages throughout 2008 returned to operation.
  - Due to low gas prices in 2009 and despite a low carbon price, much of the additional nuclear generation displaced coal rather than gas. The share of coal-fired generation fell from 32% in 2008 to 28% in 2009, whilst the share of gas-fired generation stayed constant at around 45%.
  - Generation from renewables continued to follow a gradual upward trajectory, increasing its share of total generation from 6.1% to 7.3%.

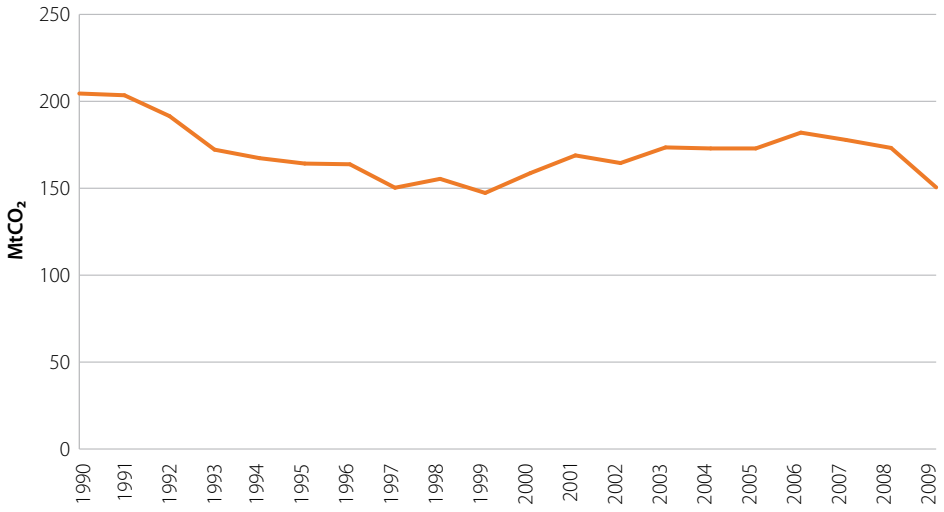
Progress increasing the level of renewable electricity generation

In 2009 and early 2010, around 0.7 GW of new wind capacity was added to the system, in line with our indicators. However, the required addition in the period to 2020 is over 3 GW annually in the third budget period.

In order to facilitate significantly increased levels of investment, improvements in the planning process will be required. Although there were planning applications for around 5 GW of new plant in 2009, the planning period remains too long (15 months in 2009, and over 40 months for larger projects), and the planning approval rate for smaller projects fell slightly. Therefore planning remains a major risk for development of renewable electricity, and proposed replacement of the Infrastructure Planning Commission should be managed in a way which avoids creating further uncertainty.

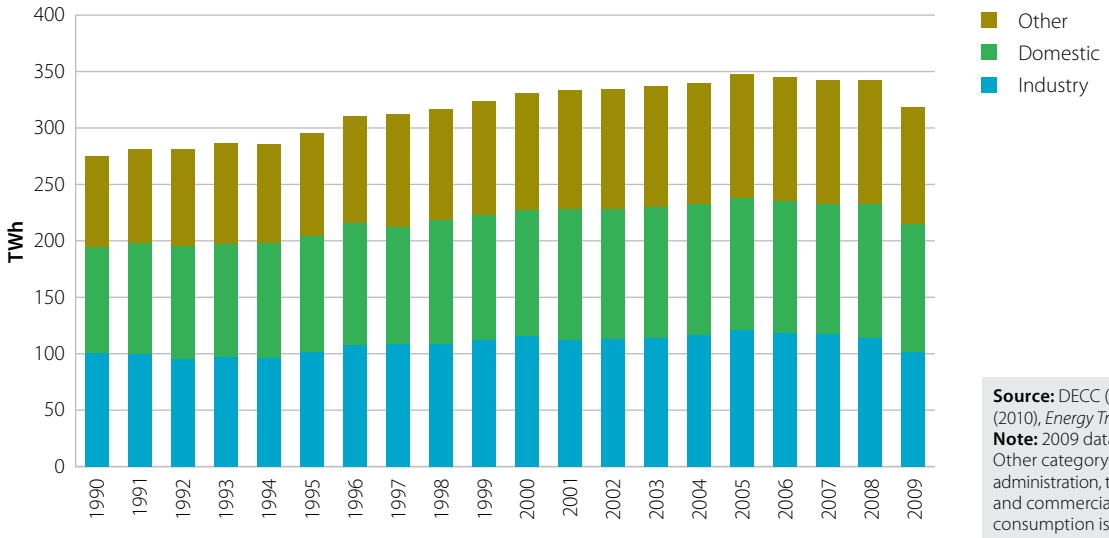
There was some progress in 2009 as regards investments in the transmission grid required to support increased levels of renewable generation (e.g. towards enduring regimes for onshore and offshore grid access). However, agreement of investments identified in the Electricity Network Strategy Report has slipped, and this should be remedied in order that investments proceed and become operational as required in 2015.

Figure 6 CO_2 emissions from power stations (1990-2009)



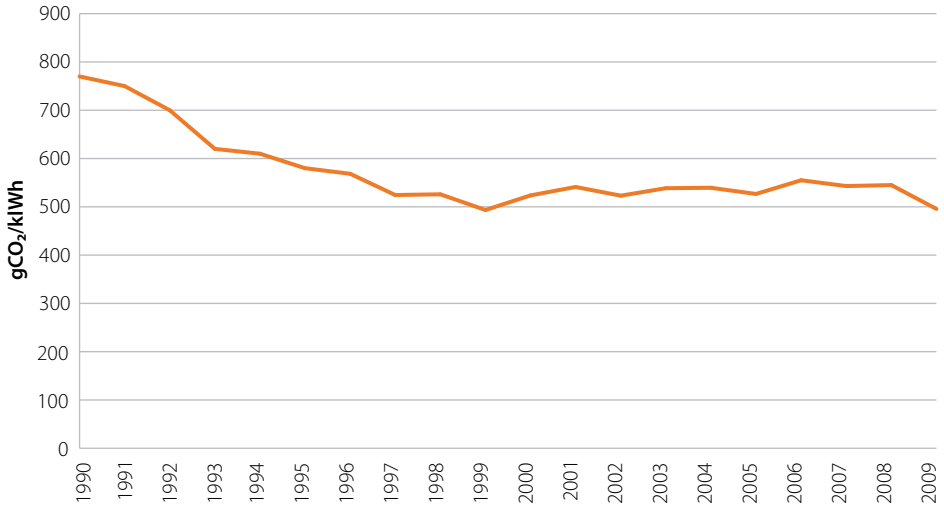
Source: DECC (2010) *Energy Trends March 2010.*
Note: 2009 data are provisional.

Figure 7 Electricity consumption (1990-2009)



Source: DECC (2009) *DUKES*; DECC (2010), *Energy Trends March 2010.*
Note: 2009 data are provisional. Other category includes public administration, transport, agriculture and commercial sectors. Electricity consumption is net of energy industry electricity use, and transmission and distribution losses.

Figure 8 Carbon intensity of electricity generation (1990-2009)



Source: CCC calculations based on: DEFRA (2009) *GHG Conversion Factors*; DECC (2010) *Energy Trends March 2010.*
Note: 2009 data are provisional. Intensity is based on energy supplied from major power producers and all renewable generators and is net of transmission and distribution losses.

Progress towards nuclear new build

Our analysis suggests that new nuclear is likely to be a cost-effective low-carbon technology, and could be added to the system from 2018, potentially playing an important role in sector decarbonisation through the 2020s.

Progress on new nuclear has been in line with our indicators (e.g. issuing of draft National Policy Statements). Key challenges for 2010 include getting Parliamentary agreement on the National Policy Statement and Regulatory Justification, together with progress approving new reactor designs and establishing funding arrangements for decommissioning and waste. Progress is required in all of these areas if new plant is to come on to the system from 2018.

Progress developing CCS technology

The new Government's commitment to delivering four CCS demonstration projects is key to developing options for power sector decarbonisation in the 2020s. However, the first project is slightly behind schedule, and further slippage must be avoided if new capacity is to come on to the system by 2015.

The competition covering the next three demonstration projects should proceed this year given the need for demonstration and early decisions (e.g. by 2018) on deployment.

The Energy Act 2010 provides a high-level financial and regulatory framework for CCS and is a major step forward in developing this potentially crucial technology. However, uncertainty remains both over financing of CCS retrofit to demonstration plants and operation of plants. Further details in both areas (e.g. a commitment to support finance for retrofit, and a limit on conventional coal generation in the 2020s, for example through an Emissions Performance Standard as proposed in the Coalition Agreement) would improve the investment climate for CCS and should therefore be seriously considered.

There is likely to be an important role for gas CCS, given:

- New analysis suggesting the potential competitiveness of gas CCS.
- The need for flexible forms of low-carbon power generation in the future (e.g. for seasonal electric heating).
- The large capacity of capture-ready unabated gas plant that will be on the system by 2020.

The Committee therefore recommends that serious consideration should be given to including at least one natural gas CCS demonstration plant in the second competition, and possibly more depending on bids received; demonstration of gas CCS under the second competition would provide the option of deployment in the UK from the early to mid 2020s.

Extending an Emissions Performance Standard to cover gas generation (e.g. through requiring that CCS is fitted to any new plant beyond 2020) would provide a coherent approach to fossil fuel power generation. It would be consistent with the required path for power sector decarbonisation through the 2020s where the vast majority of investment at this time is in low-carbon generation. It should therefore seriously be considered.

We will provide a detailed assessment of gas CCS and supporting arrangements in our advice on the fourth carbon budget, to be provided by the end of the year.

Reform of electricity market arrangements

An Energy Market Assessment (EMA) was published in 2010, concluding that required investments in low-carbon generation capacity are unlikely to result under current electricity market arrangements. The EMA ruled out carbon price strengthening alone as providing an appropriate solution, and suggested further consideration should be given to approaches (consistent with measures we proposed) to provide confidence about the price paid and to require investment in low-carbon generation.

The Committee strongly welcomes the EMA and the new Government's commitment to reform the electricity market, and urges that serious consideration is now given to the range of options for strengthening incentives for investment in low-carbon generation. The Committee will set out a high-level assessment of options in the context of advice on the fourth carbon budget, to be published before the end of 2010.

4. Progress reducing emissions from buildings and industry

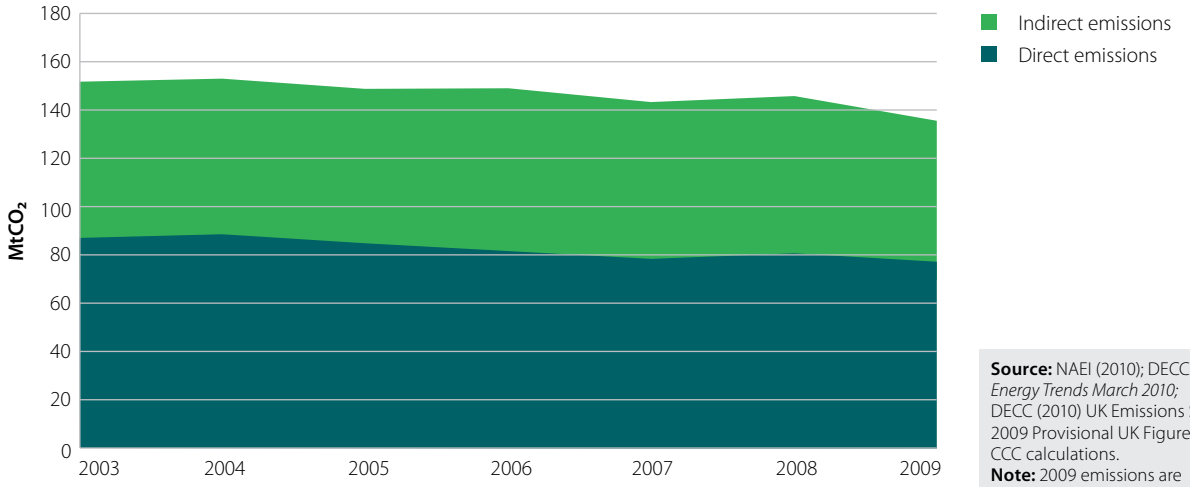
Buildings and industry emissions comprise around 350 $MtCO_2$ overall, of which 41% is from the residential sector, 38% from industry, 15% from the commercial sector, and 6% from the public sector. Total emissions comprise direct (i.e. due to the burning of fossil fuels for heat) and indirect (i.e. mainly electricity related) emissions in the following proportions: residential sector – 55%/45%; industry – 59%/41%; commercial sector – 21%/79%; public sector – 49%/51%.

Progress reducing residential emissions

Emissions from residential buildings grew by 2% in 2008 and fell by 7% in 2009, with reductions in both direct and indirect emissions (Figure 9), due mainly to rising fuel prices and the recession:

- Direct emissions rose by 3% in 2008 while indirect emissions stayed broadly flat.
- In 2009 direct emissions fell by 5%, while electricity emissions fell by 10%.

Figure 9 Residential CO_2 emissions (2003–2009)



Source: NAEI (2010); DECC (2010) *Energy Trends March 2010;* DECC (2010) UK Emissions Statistics 2009 Provisional UK Figures; CCC calculations.
Note: 2009 emissions are provisional and based on CCC estimates. Indirect emissions are based on consumption of electricity from power stations only.

Some savings are attributable to the installation of energy efficiency measures:

- Good progress was made on boiler replacement, with 1.2 million "A" rated boilers sold in 2009. High sales continued in early 2010, incentivised by boiler scrappage schemes in England, Wales and Scotland.
- Progress insulating lofts was on track relative to our indicator framework. In 2009, around 0.8 million lofts and 0.6 million cavity walls were insulated professionally under the Carbon Emissions Reduction Target (CERT), which additionally subsidised a large amount of DIY loft insulation material.
- There was very limited progress on solid wall insulation (e.g. 15,000 solid walls were insulated under CERT in 2009) and the sale of efficient appliances (e.g. only 0.1% of cold appliances sold were A++).

However, these measures together can account for only a small proportion of the observed emissions reduction in 2009 (e.g. around 1 $MtCO_2$ from a total 4 $MtCO_2$ reduction in direct emissions). Therefore it is likely that the 2009 reductions are primarily a result of rising energy prices (residential gas and electricity prices rose 12% and 3% respectively in real terms) and the recession.

In the future, it will be necessary – under the successor policy to CERT – to double the pace of cavity wall insulation and at least maintain the pace of loft insulation if the ambition to insulate all houses by 2016 (as set out in DECC/CLG's Household Energy Management Strategy (HEMS)) is to be achieved. This will become more challenging as loft and cavity wall insulation to date may be regarded as low hanging fruit (i.e. undertaken by people most willing to undertake these measures). A significant increase in the pace of emissions reduction through solid wall insulation, increased penetration of efficient appliances and a range of other low-carbon measures, will also be required to meet the second and third carbon budgets, and to prepare for delivering carbon budgets through the 2020s.

The new Government's announcement of an Energy Bill to deliver a national energy efficiency programme and a 'Green Deal' is a positive step towards strengthening incentives for residential energy efficiency improvement. In designing an implementing framework, a number of key areas should be clarified: how to incentivise householders to take up comprehensive whole house packages through marketing, provision of energy audits and financial incentives/standards; how partnerships between local authorities, energy companies and other organisations will translate into a neighbourhood approach; the appropriate balance between 'Pay As You Save' and socialised funding (i.e. spreading costs across the consumer base to provide free measures for the fuel poor and to subsidise some of the less cost-effective measures); standards for the private rented sector.

Progress reducing non-residential emissions

Emissions from non-residential buildings – comprising around 72% emissions from commercial buildings, and 28% from public sector buildings – are likely to have fallen significantly in 2009 due to reductions in commercial sector output:

- Around 80% of commercial sector emissions are indirect. Prior to the recession, commercial emissions were broadly flat. In 2008, direct emissions increased by 6%, with indirect emissions remaining flat, and average emissions increasing by 1%. Initial estimates for 2009 suggest significant reductions, with a reduction of 10% in direct emissions and 14% in indirect emissions. Commercial sector energy consumption fell by around 6%, reflecting reduced GVA of 5%.
- Total public sector CO_2 emissions in 2008 were broadly constant. We estimate indirect emission reductions of around 7% in 2009, as a result of a reduction in the emissions intensity of power generation, but direct emissions in 2009 were broadly unchanged.

Two key areas where new policies are required to strengthen incentives for reduction of non-residential emissions are:

- **Buildings energy performance:** CLG has consulted on extending Display Energy Certificates (DECs) to cover commercial buildings, and will be publishing – later this year – an impact assessment on the costs and benefits of rolling out Energy Performance Certificates (EPCs) to all non-residential buildings and setting EPC minimum ratings. Given the importance of better information in encouraging energy efficiency improvement and providing a basis for new policy approaches, proceeding with the EPC consultation and making a decision on both forms of certification in 2010 would support early roll out to all commercial and public sector buildings. It would also complement the Government's proposed 'Pay As You Save' approach to the non-residential sector.
- **SME energy efficiency:** We have identified significant potential for SME emissions reductions. Work is ongoing in DECC to address this potential through consideration of options to strengthen incentives for SME energy efficiency improvement. Timely conclusion of this project would allow an early decision on new policy approaches to help SMEs improve energy efficiency.

Progress reducing industry emissions

Industry CO_2 emissions fell 4% in 2008, with provisional data for 2009 suggesting further reductions, particularly in energy-intensive industries covered by the EU ETS, which account for two thirds of total UK industry emissions. For example, there was a 30% reduction in emissions from cement production and a 14% reduction from steel production in 2009.

Given limited evidence on detailed measures for reducing emissions we have not yet set out an indicator framework for industry. We have therefore not considered the precise extent to which industry emissions reductions are a result of implementation of measures or the recession. However, given that emissions reductions correspond to significant reductions in output it is likely that the recession played a key role in driving lower emissions in 2009.

Going forward, it will be important both to improve the evidence base on industry emissions, working towards defining progress indicators, and to ensure that appropriate policies are in place. We will provide more in depth analysis of industry in our advice on the fourth carbon budget, to be published before the end of the year.

Progress increasing renewable heat penetration

This is a cross-cutting issue given scope for deployment of renewable heat in residential and non-residential buildings and industry. Currently there is very low penetration of renewable heat technologies in the UK. Increased penetration is required to meet the first three carbon budgets, to meet the UK's obligations in the context of the EU's renewable energy target, and to develop technologies for roll-out in the 2020s.

The Renewable Heat Incentive proposals published in February 2010 suggest an ambition for deployment for the various technology options that is broadly consistent with our analysis. Further consideration of precise levels of support and delivery mechanisms may be required. In developing the approach to renewable heat, this should be fully integrated with the approach to energy efficiency (i.e. these should be reinforcing), to ensure the appropriate balance between measures is chosen.

5. Progress cutting surface transport emissions through low-carbon vehicles and alternatives to car travel

This summary focuses on road transport, which comprises 98% of surface transport emissions; the remainder of emissions are from rail, which is considered briefly in Chapter 4. Emissions from aviation and shipping are discussed in Chapter 1.

Progress reducing road transport emissions

Road transport emissions comprise around 62% from cars, 13% from vans, and 20% from HGVs, with the remainder (5%) primarily from buses and mopeds and motorcycles.

Car emissions

Emissions from cars fell by 3.1% in 2008 and around 2.7% in 2009[2], reflecting improved fuel/carbon efficiency and reduced car miles (Figure 10):

- Average car fleet emissions fell from 177 g/km in 2007 to 173 g/km in 2008 (a 2.5% reduction). This was accounted for both by improved fuel efficiency of new cars (around three-quarters of the 2.5%) and increased penetration of biofuels (around one-quarter).
- We estimate that the carbon intensity of the fleet reduced a further 1.6% in 2009, with improvement in fuel efficiency accounting for around two thirds of this reduction and the remainder due to increased biofuels penetration.
- Car miles fell from 420.2 billion vehicle km in 2007 to 417.7 billion (a 0.6% reduction) in 2008 and 412.8 billion (a 1.2% reduction) in 2009, reducing emissions by the same proportion.

Van emissions

Van emissions fell by 2.9% in 2008, mainly due to improved fuel/carbon efficiency. Van emissions are likely to have increased slightly (by around 0.3%) in 2009:

- Average van emissions improved 2.5% from 231 g/km in 2007 to 226 g/km in 2008. We estimate that most of this improvement (around 2 percentage points) was due to use of biofuels, with the remainder (0.5 percentage points) due to improvement of the fuel efficiency of the van fleet.
- Van miles fell by 0.4% in 2008 but increased by 1% in 2009.

HGV emissions

HGV emissions fell by 3.4% in 2008 due mainly to reduced miles travelled, and are likely to have decreased further by around 9% in 2009:

- HGV miles fell from 30.3 billion vehicle km in 2007 to 29.6 billion in 2008 and 27.2 billion in 2009, resulting in emissions reductions of 2.3% in 2008 and 8.4% in 2009.
- There was also some improvement in HGV fuel efficiency, from 800 g/km in 2007 to 792 g/km in 2008, resulting in emissions reductions of 1.1%.

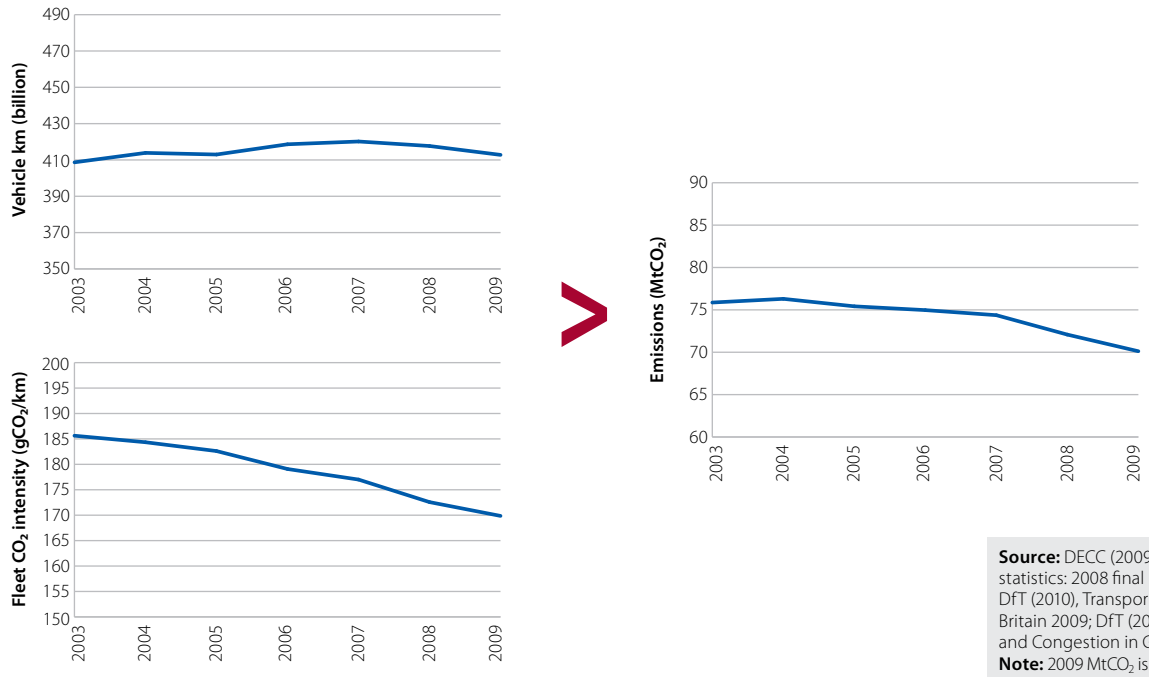
Progress reducing carbon intensity of vehicles

More efficient new cars

Carbon intensity of new cars fell from 158 g/km in 2008 to around 149 g/km in 2009, therefore outperforming our indicator for 2009 of 157.8 gCO_2/km. Our analysis suggests that changed car purchase behaviour reflects the recession and increased oil prices, the impacts of which have been reinforced by various policies (the car scrappage scheme, VED differentiation, fuel duty, company car tax). Further progress towards a 95 g/km target in 2020 would be incentivised by strengthened fiscal incentives (e.g. increasing VED differentiation according to fuel efficiency, and offsetting any oil price reductions through increased fuel duty).

2 2009 emissions data has not yet been published; we have therefore estimated emissions based on data on 2009 petrol and diesel fuel sales, mileage and our own estimate of the reduction in CO_2 intensity of the vehicle fleet.

Figure 10 Car mileage, carbon intensity of the car fleet and CO_2 emissions (2003-2009)



Source: DECC (2009), UK emissions statistics: 2008 final UK figures; DfT (2010), Transport Statistics Great Britain 2009; DfT (2010) Road Traffic and Congestion in Great Britain.
Note: 2009 $MtCO_2$ is a CCC estimate, and 2009 gCO_2/km is based on a CCC assumption.

Developing an electric car market

Electric cars are a key technology for decarbonising transport in the 2020s and should be developed as an option in the period to 2020. We have suggested that it is feasible and desirable to have up to 1.7 million electric cars on the road in 2020 on the path to widespread deployment required to meet carbon budgets in the 2020s.

Progress has been made in setting up electric car pilot projects through the Plugged in Places programme, which has selected three cities for pilots and will select another 3-6 cities shortly.

In order to develop this option for roll-out in the 2020s, we recommend that the Government should adopt ambitious targets for deployment of electric cars in the period to 2020. It should commit to funding both towards the purchase of electric cars (to offset a transitional cost premium) and investment in a national battery charging network

Reducing van emissions

In October 2009 the EU proposed a draft framework for reducing new van emissions. Our analysis shows that this framework is achievable and desirable in the context of meeting carbon budgets, and should therefore be welcomed by the Government. Agreement on a final framework and introduction of measures for uptake of more efficient vans would provide the basis for emissions reductions in this sector, rather than a return to the trend of rising emissions before the recession.

Alternatives to car travel

Reductions in car miles in 2009 are likely to be due to the recession rather than implementation of policies, given very limited policy effort in this area. However, we have identified two areas in our indicator framework where there is scope for significant emissions reduction under new policy approaches:

- **Roll out of Smarter Choices.** New evidence from the Sustainable Travel Towns shows that Smarter Choices initiatives aimed at reducing car travel (e.g. through working from home, car pooling, and use of public transport) result in car emissions reductions of around 5-7% and wider economic benefits. However, policy on Smarter Choices has moved backwards following the withdrawal of the planned Sustainable Travel City project in March 2010. Emissions reductions from Smarter Choices would make a cost-effective contribution to achieving carbon budgets, and therefore an early commitment to roll out this policy across UK towns and cities would reverse recent negative policy developments.
- **Integration of land use and transport planning.** In our first report to parliament we showed scope for constraining transport emissions growth through design of new developments (e.g. these might be close to workplaces, facilitating commuting by public transport rather than car). Recent evidence from the Commission for Integrated Transport reinforces our assessment. The proposed review of planning policy by the new Government provides an opportunity to consider scope for designing new developments in a way that limits additional transport emissions. This is in a context where there will be potentially large numbers of new houses and other developments in the next two decades, and where location decisions could have impacts for meeting carbon budgets.

6. Opportunities for reducing emissions from agriculture

Estimated agriculture emissions, which are primarily of non-CO_2 greenhouse gases, fell slightly (1%) in 2008, which is the most recent year for which data is available. In the longer term, emissions have fallen by around 20% since 1990, due to reduced use of fertiliser as well as reduced livestock numbers in response to reform of the EU's Common Agricultural Policy.

In response to our 2008 analysis on scope for reducing agriculture emissions, the Low Carbon Transition Plan included a 3 $MtCO_2e$ cut from this sector in England in 2020 (compared to UK non-CO_2 emissions of 44 $MtCO_2e$ in 2008). In this report we present new analysis which suggests that emissions reductions above 3 $MtCO_2e$ may be possible.

The current approach to unlocking emissions reduction is based around voluntary action by the industry in partnership with the Government. However, this is not the chosen approach in other sectors (e.g. energy efficiency improvement in commercial buildings), where policies with stronger incentives have been introduced or are being considered. It is highly likely that in future alternative policy measures will be required, making full allowance for the specific complexities of the agriculture sector (e.g. difficulties measuring farm-level emissions, the possibility of production leakage to other countries); therefore the full range of policy options should be considered.

Given the uncertainty over scope for emissions reductions, and the multiple emissions drivers, the focus in assessing progress reducing emissions should be implementation of measures. In agreeing an agriculture indicator framework, it will be important to further develop the evidence base, to underpin trajectories for productivity indicators (e.g. related to fertiliser use and livestock productivity and indicators for farming best practice).

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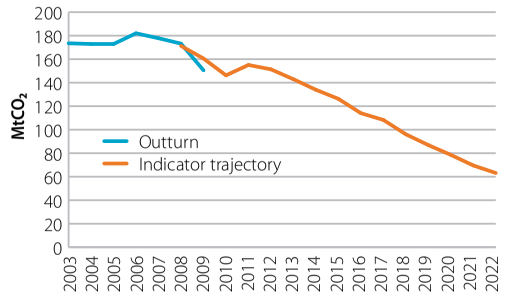
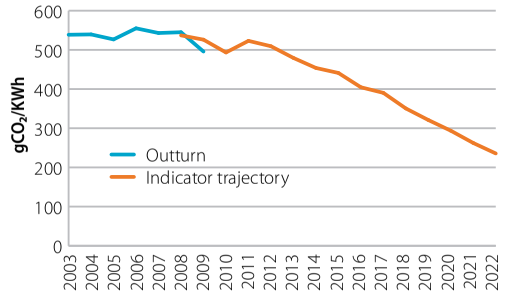
In summary, emissions fell significantly in 2009, mainly due to the recession and other exogenous factors. There was implementation of measures in line with our indicators. However, our indicators for 2009 only built in the modest ambition of policies that were firm and funded in 2008. The required step change in the pace of emissions reduction has not yet happened. In order to achieve the step change, new policies are required to strengthen incentives for action in the power sector, buildings, industry, transport and agriculture. Given new policies, we are confident that individuals and businesses will respond, taking advantage of affordable opportunities to reduce emissions, and contributing both to meeting carbon budgets and the wider economic benefits that this will bring.

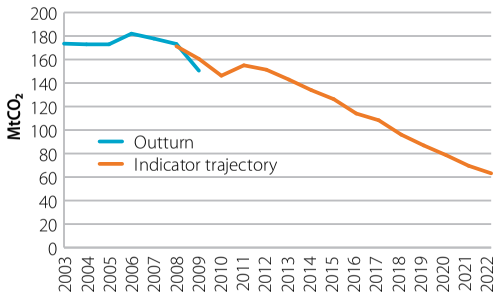
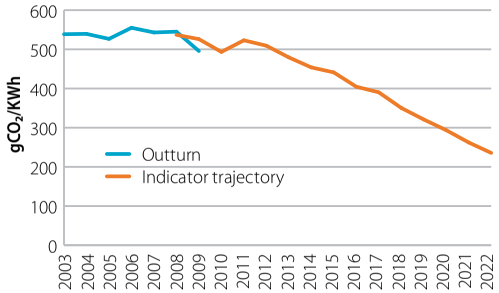
Summary of progress against indicators and future challenges

Economy-wide

Significant fall in emissions in 2009 probably reflects recession.
Implementation of measures in 2009 broadly on track but ambition was modest. Still need to see the step-change in delivery going forward.
Progress made in developing policies but further detail required to provide confidence that these will deliver sufficient emissions reductions, and new policies required in some areas.

		Progress against indicators and miletones	Challenges
Power			
Emissions  Emissions intensity  	**Market**	Initial findings of Energy Market Assessment published in March 2010, accepts need for intervention, and sets out options. New Government commitment to energy market reform.	Short window for reform to occur if key investments are to go ahead in time. Full range of options available should now be considered in detail.
	Transmission	Enduring access regime in place, offshore enduring regime on track, some slippage on agreement of onshore grid investments.	Important that there is no further slippage in the agreement for onshore grid investments.
	Planning	Decision times improving but still slower than indicator.	Important that replacement of IPC does not adversely affect planning efficiency.
	Renewables	2009 expected wind capacity delivered with some delays; some supply chain development. Green Investment Bank announced.	Required rate of installation of new wind capacity will be much higher from now to 2020.
	Nuclear	Draft National Policy Statement published in 2009 plus other enabling actions on track.	Progress on enabling actions now depends on decisions of Ministers and Parliament.
	CCS	Demonstrations increased to four, commitment to rolling review from 2018. First project slightly behind schedule.	More clarity on financing for retrofit and operation of unabated plant into 2020s is needed. Demonstrations on gas should be considered.

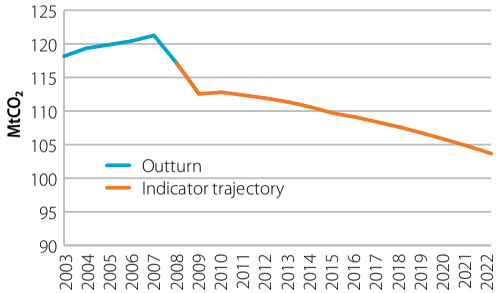
Summary of progress against indicators and future challenges

		Progress against indicators and miletones	Challenges
Buildings & industry			
Direct emissions  Indirect emissions  	**Residential**	On track with modest expected uptake of loft and cavity wall insulation and efficient boilers in 2008-09. Home Energy Management Strategy published March 2010 and political commitment to National Energy Efficiency Programme and 'Green Deal'. Building regulations tightened in 2010, in line with achieving zero carbon new build houses by 2016.	Need to maintain/increase pace on lofts/cavity walls; "low hanging fruit" taken. Significant increase in uptake of solid wall insulation required to 2020. Further details needed around specific policy delivery elements of National Energy Efficiency Programme. Housing stock turnover is slow – refurbishment of hard-to-treat existing stock is crucial, including large number of 'Hard-to-Treat' (e.g. solid wall) homes.
	Non-residential	Consultation on DEC roll-out. Impact Assessment underway on EPC roll-out & minimum rating. Analysis of policy options for SMEs underway, proposals due end 2010. Carbon Reduction Commitment Scheme launched. Consultation on achieving zero-carbon new builds by 2018.	Time required to change primary legislation. More effective compliance mechanism required. Policy required to unlock SME abatement potential. Need to set appropriate cap to deliver abatement (advice to follow). Building stock turnover is slow – refurbishment of existing stock is crucial.
	Industry	CCA renegotiation underway for next phase (to 2017), 2010 targets tightened by 4.4%.	Need to ensure CCA targets are continually binding. Need to improve evidence base on scope for longer term emissions reductions in industry.
	Renewable heat	RHI proposals published February 2010.	Need to ensure RHI is integrated with energy efficiency policy and barriers to deployment are addressed.

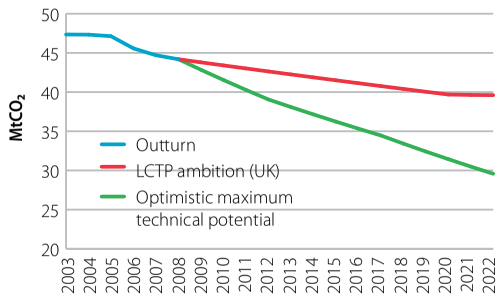
Note:

1. Please refer to chapters for sources and notes to tables.

Summary of progress against indicators and future challenges

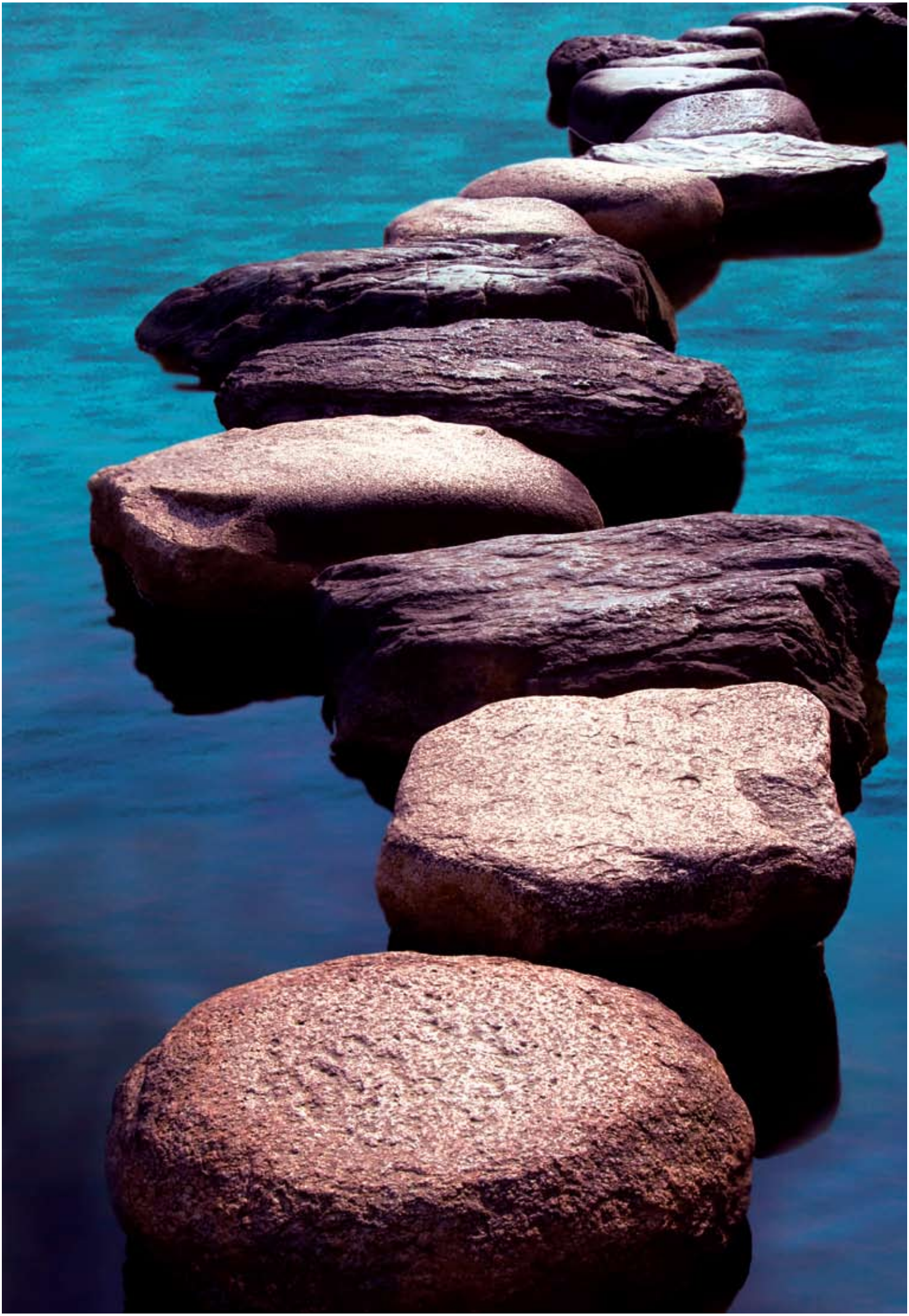
		Progress against indicators and miletones	Challenges
Road transport			
Direct emissions 	**New car fuel efficiency**	Significant reductions in new car gCO_2/km.	Need to lock in improvement; EU targets should deliver continued improvement but UK unlikely to reach or exceed EU target without policy on consumer choice.
	Reducing van emissions	EU draft framework for new van emissions published October 2009.	Need to agree ambitious framework.
	Increased use of biofuels	Increasing as expected.	Need to understand likely availability of sustainable biofuels beyond 2020 and potential contribution to emissions reductions.
	Development of electric car market	Price support for new electric and plug in hybrid cars announced; Commitment from new Government to mandate national charging network; Plugged In Places pilot projects announced and first three pilots selected.	Need deployment targets for 2020. Greater price support may be required to support early market.
	Smarter Choices	Policy on Smarter Choices has moved backwards following the withdrawal of the planned Sustainable Travel City project in March 2010.	No policy for roll out across UK towns and cities.
	Eco driving	Limited car driver training delivered in 2009 but Government exploring options for wider delivery.	Need to consider potential delivery mechanisms for wider roll out.
	Land use/transport planning	Limited progress in developing integrated transport and land use strategy so far.	Proposed review of planning policy by the new Government provides an opportunity to consider new approach.

Summary of progress against indicators and future challenges

		Progress against indicators and miletones	Challenges
Agriculture			
GHG emissions 	**Agriculture**	Target developed for England (although appears low relative to technical potential). Policy framework developed for delivery through voluntary action and improved advisory services.	Need to develop more robust evidence base on current farming practice and emissions impact of changed practice. Need to consider policies beyond provision of information/encouragement to address barriers. Need to find additional longer-term abatement options and develop policy mechanisms to unlock further potential.

Note:

1. Please refer to chapters for sources and notes to tables.



Chapter 1: Overview of progress towards meeting carbon budgets

Introduction and key messages

In our first report to Parliament we noted that emissions had fallen only slightly in the five-year period (2003-07) before the recession both for the economy as a whole and for each of the key emitting sectors. We therefore argued that a step change is required in order to deliver the sustained deep cuts in emissions required to meet carbon budgets. DECC accepted the need for a step change to deliver the emissions reductions in its Low Carbon Transition Plan, and the need for new policy approaches to drive this.

We presented analysis suggesting that the recession would result in a significant fall in emissions which would make the first carbon budget easier to achieve. However, we argued that it is important to implement measures to reduce emissions now, and to develop new policy frameworks. This will lay the foundations for sustained emissions reductions following a return to economic growth and mitigate risks to meeting the second and third budgets. Therefore we argued that the aim should be to outperform the first budget, supplementing emissions reductions due to the recession with implementation of measures.

We start this chapter by noting recent controversies in climate science, together with progress towards a global deal to reduce emissions. We then consider latest emissions data, focusing on the extent to which emissions have fallen during and as a result of the recession. We also provide a high-level overview of progress against our indicator framework, which includes both implementation of measures (e.g. number of lofts and cavity walls insulated, GW of wind generation entering construction, average emissions of new cars) and policy milestones to drive the required step change in emissions reduction. We compare our indicator framework with the monitoring framework in the departmental carbon budget delivery plans.

The main messages in the chapter are:

- The case for early action in the UK remains strong: the fundamental science is robust notwithstanding recent controversies; there has been some progress towards an international agreement; there are low-cost opportunities to reduce emissions and build a low-carbon economy in the UK.
- Greenhouse gas (GHG) emissions fell by 8.6% in 2009 largely due to the recession and other exogenous factors. We estimate that these impacts will reduce emissions across the first budget period in line with our 2009 projections (i.e. within the range 40-75 $MtCO_2$). We recommend that the aim should be to outperform the first budget and that outperformance should not be banked through to the next budget period. This recommendation was accepted by the previous Government.
- Our indicator framework envisaged limited progress on implementation of measures in 2009, based on modest ambitions in policies that were firm and funded in 2008. This has been confirmed, for example with progress on loft and cavity wall insulation, broadly in line with our indicators.
- However, our indicator framework also builds in a step change in the pace of implementation across the range of measures (e.g. residential and non-residential energy efficiency improvement, renewable heat, electric cars, renewable electricity) moving towards the second budget period. There is no evidence of broad outperformance on implementation of measures in 2009, and therefore a step change is still required. In the absence of a step change (i.e. based on the rate of implementation of measures in 2009) there would be a shortfall of around 35 $MtCO_2$ relative to the (legislated) Interim third carbon budget and 150 $MtCO_2$ relative to the Intended third budget.

- Progress has been made developing new policies for the power sector, buildings and industry, and transport. However, further detail is required to provide confidence that these will drive the step change and deliver sufficiently to achieve carbon budgets.
- The departmental carbon budget management framework is a key part of the governance framework for delivering emissions reductions and could be strengthened by including ambitious trajectories for key indicators against which future success in delivery can be assessed.

We set out the analysis that underpins these messages in five sections:

1. Context: the case for early action in the UK
2. Economy-wide emissions trends
3. Aviation and shipping emissions
4. Progress against the Committee's indicators
5. Departmental carbon budgets and delivery plans

1. Context: the case for early action in the UK

Before assessing UK progress in reducing emissions we consider the underpinning case for action in the light of recent scientific controversies and the outcome of global negotiations in Copenhagen in December 2009.

Scientific controversies and the robustness of the fundamental science

While there is high confidence in the link between GHG emissions and global warming, there are uncertainties in the exact level of warming and impacts that will result from a given future emissions path. This has implications for carbon budgets. Specifically, in our December 2008 report, we recommended that targets should be flexible to improvements in understanding and committed to review the science periodically, drawing out implications for carbon targets as appropriate.

There have been two recent and high profile controversies relating to climate science:

- **Leaked emails from the University of East Anglia's Climate Research Unit (CRU).** Large numbers of CRU emails were hacked and made public in November 2009, with the contents used to accuse CRU staff of manipulating scientific evidence in order to bolster claims of global warming. A series of independent reviews into the activity of CRU have since been carried out. Specifically, the Science Assessment Panel chaired by Lord Oxburgh concluded that there was 'no evidence of any deliberate scientific malpractice'[1].

1 *'Report of the International Panel set up by the University of East Anglia to examine the research of the Climatic Research Unit'*. Available at http://www.uea.ac.uk/mac/comm/media/press/CRUstatements/SAP

- **Inaccuracies in the IPCC 4th Assessment Report.** In early 2010 media reports claimed errors in the IPCC's most recent assessment of climate impacts, adaptation and vulnerability. These claims refer to a small number of aspects (such as likely timescales for loss of Himalayan glaciers) within the large report by Working Group 2 of the IPCC on impacts, adaptation and vulnerability. None of these were cited as major conclusions in the overall assessment, and none of the claimed errors apply to the Working Group 1 report on the physical science basis of climate change. An independent inquiry is being carried out by the InterAcademy Council to evaluate the procedures and processes of the IPCC, and to ensure that factual errors are avoided in future, and is due to report later this year[2].

These controversies have not changed the fundamental science, which continues to support the case for early action:

- Global surface temperatures have increased on average by more than 0.15°C per decade since the mid-1970s. The 10 hottest years on record have occurred since 1997.
- It is very likely that most of the temperature increase since the mid 20th century is due to increasing concentrations of greenhouse gases in the atmosphere, which in turn can be linked to burning of fossil fuels and other human activities.
- There is significant risk of dangerous climate change and devastating consequences for human welfare on a business as usual emissions path.
- Central estimates of global temperature can be kept close to 2°C above pre-Industrial levels through early action such that global emissions peak by 2020, fall by about 50% in 2050, and continue to fall thereafter.

The Committee will set out a full review of these developments, plus other advances in climate science since 2008, as part of advice on the fourth budget (2023-27) to be published by the end of 2010.

Moving towards a global agreement

Climate negotiations in Copenhagen in December 2009 were disappointing in that a legally binding deal on global emissions reductions was not achieved.

However, the Copenhagen Accord which resulted from the UNFCCC negotiations included at least four positive aspects:

- There was agreement that the objective should be to constrain global temperature increase to 2°C; this is broadly consistent with the objective and targets underpinning the UK's Climate Change Act as recommended by the Committee.
- There was agreement for developed countries to submit, by 31st January 2010, commitments for emission reductions in 2020 and for developing countries to submit intended mitigation actions that are quantifiable.
- There were commitments to provide finance for developing countries, approaching US$30bn for the period 2010-2012 and US$100bn a year by 2020.
- There was a commitment to support avoided deforestation by establishing a mechanism to enable mobilisation of financial resources from developed countries.

To date, over 70 countries covering around 80% of global emissions have signed the Accord. Preliminary analysis suggests that commitments under the Accord could result in peaking of global emissions by 2020, though further detailed analysis is required to establish this. Given significant emissions reductions post 2020, it is plausible that global emissions will be on a path broadly consistent with the 2°C objective.

2 http://reviewipcc.interacademycouncil.net/committee.html

The case for early action

The case for early action in the UK therefore remains strong given scope for limiting risks of dangerous climate change, current low-cost opportunities to reduce emissions and potential co-benefits of measures to reduce emissions:

Climate change risk

- Together with the efforts of other countries, early action will limit risks of dangerous climate change.

Mitigation costs

- Emissions reductions can be achieved at affordable cost (e.g. less than 1% of GDP in 2020), with some of the measures required to meet carbon budgets resulting in cost savings (e.g. energy efficiency improvement in residential and commercial buildings).
- Costs for a given reduction in cumulative emissions increase if action is delayed, requiring greater emissions cuts in future when abatement costs are likely to be higher[3].
- Early action precludes locking in to high-carbon assets (e.g. conventional coal-fired power generation) which would become stranded in a world of increasingly stringent carbon constraints.

Green economy

- There may be an opportunity to gain first mover advantage in developing low-carbon industries, leading to high value jobs as global demand for low-carbon technologies increases.

Co-benefits of mitigation

- There are a range of co-benefits from measures to reduce carbon emissions including security of supply, air quality and health.
  - Power and transport decarbonisation will reduce reliance on imported gas and oil from countries where there may be a high degree of geopolitical risk, therefore reducing risks of supply interruption and price volatility and the possibility of sustained high prices.
  - Mitigation measures can reduce local air pollution (e.g. through ultra low-carbon vehicles, renewable electricity generation which does not involve combustion). A recent Defra report[4] estimated that climate change policies could yield air pollution benefits worth £15-40 billion (net present value) in the UK by 2050.
  - Recent work on Health and Climate Change[5] showed that substantial health benefits (including reduced cardiovascular disease, depression, diabetes and dementia) could be gained from more walking and cycling and less motor vehicle use.

The Committee will provide a full assessment of the international framework and implications for the UK, including possibly moving from the Interim to Intended carbon budgets, as part of the advice on the fourth budget (2023-27) to be published by the end of 2010.

2. Economy-wide emissions trends

In this section we consider emissions trends at economy-wide, sectoral and regional levels. We provide a high-level assessment of emissions reductions in 2008 and 2009 and, in particular, we consider the extent to which emissions reductions are due to the recession and other exogenous factors or to implementation of measures (e.g. energy efficiency improvement, improved fuel efficiency of new cars). We consider the implications for the approach to the non-traded sector in terms of aiming to outperform the first budget and not banking outperformance for use in the second budget. We also consider implications for the traded sector budget, which work primarily at the European level through the impact of the recession on the carbon price. At the economy-wide level (i.e. including non-traded and traded sectors), we consider the extent to which a step change in the pace of emissions reductions is still required. Finally, we present emissions at the Devolved Administration level.

3 For example, MARKAL analysis for our 2008 report showed costs rising to over £200/tCO_2 in 2050, compared to costs around £50/tCO_2 in 2020 under scenarios consistent with carbon budgets to 2020 and the 80% target for reducing economy-wide emissions by 2050.

4 Defra (2010), *Air Pollution: Action in a Changing Climate* http://www.defra.gov.uk/environment/quality/air/airquality/strategy/documents/air-pollution.PDF

5 The Lancet (2009), *Health and Climate Change Series* http://www.thelancet.com/series/health-and-climate-change

We set out our analysis in five sections:

(i) Emissions trends in 2008 and 2009

(ii) Implications for the non-traded sector

(iii) Implications for the traded sector

(iv) The need for a step change

(v) Regional emissions

(i) Emissions trends in 2008 and 2009

Key emissions drivers

The context for 2009 emissions includes falling GDP, rising fuel prices (other than in transport), and lower temperatures but less cold days:

- Overall GDP fell by 4.9% in 2009 and within this manufacturing output declined 10%.
- Residential and industrial fuel prices generally rose in 2009, with residential gas prices up by 12% in real terms.
- Whilst average temperatures in December and January 2009 were lower than in the same period in 2008, overall 2009 had fewer days with temperatures below the heating threshold, with these two effects largely balancing in terms of energy demand.

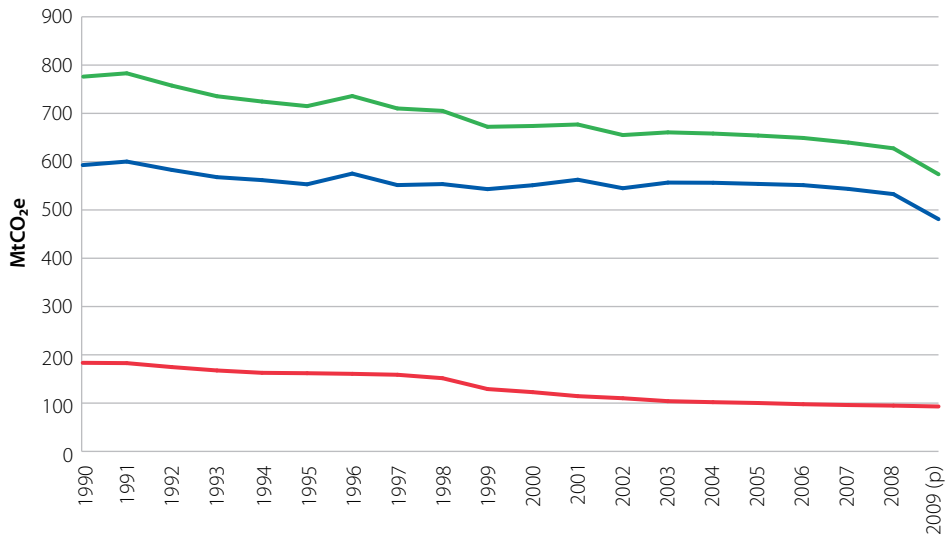
Total emissions, CO_2 versus non-CO_2 and by sector

Since our 2009 progress report, new final emissions data is available for 2008, and preliminary data is available for 2009, suggesting that UK greenhouse gas emissions fell by 1.9% in 2008 and a further 8.6% in 2009 (Figure 1.1, Figure 1.2 and Figure 1.3):

- CO_2 emissions fell by 2.0% in 2008 and 9.7% in 2009, with sectoral reductions in energy supply (power generation and other energy supply), buildings (residential and non-residential), industry and transport.
  - Emissions from power generation fell by 2.6% in 2008 and 13.1% in 2009. The emissions reduction in 2009 was due both to demand reduction (particularly in commercial and industrial sectors) and return of nuclear plant which had previously been off the system.
  - Emissions from other energy supply (refineries, off-shore gas etc.) fell by 4.7% in 2008 and 2.7% in 2009.
  - Direct emissions (e.g. related to burning fossil fuels for heat) from buildings and industry were flat in 2008 and fell by 11% in 2009. The reduction in 2009 was driven by reductions in the residential (5%) and industrial (18%[6]) sectors.
  - Transport emissions fell by 2.9% in 2008 and 6.5% in 2009. Road transport emissions fell by 3.5% in 2008 and 3.9%[7] in 2009.
- Non-CO_2 emissions fell by 1.3% in 2008 and 1.9% in 2009, with reductions in most sectors in 2008[8]:
  - Emissions from agriculture fell by 1.1% in 2008.
  - Emissions from the energy sector fell by 3.0% in 2008.
  - Emissions from the industrial process sector fell by 1.3% in 2008.
  - However, emissions from waste fell by only 0.3% in 2008.

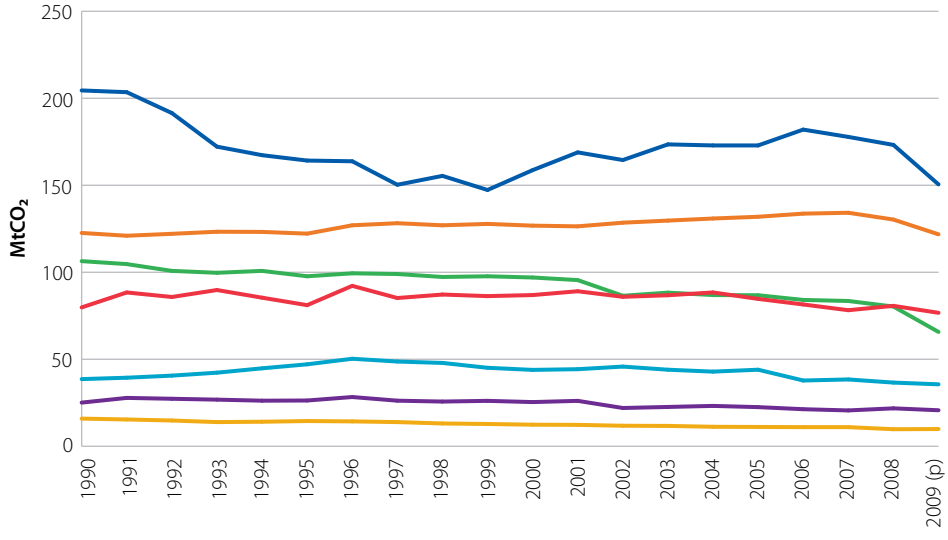
6 CCC estimate.
7 CCC estimate.
8 Provisional 2009 non-CO_2 emissions are not available by sector.

Figure 1.1 UK greenhouse gas emissions (1990-2009)



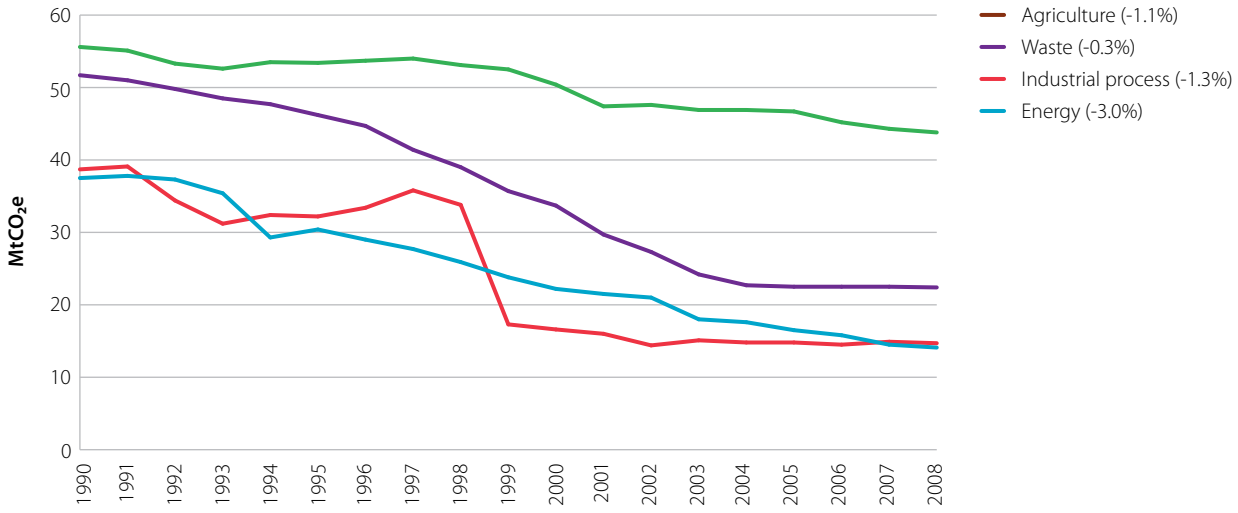
Source: DECC (2010) *UK Emissions Statistics 2009 Provisional UK Figures.*
Note: 2009 figures are provisional. Figures in legend show change in emissions in 2009.

Figure 1.2 UK CO_2 emissions by sector (1990-2009)



Source: NAEI (2010); DECC (2010) *UK Emissions Statistics 2009 Provisional UK Figures*; DECC (2010) *Energy Trends March 2010*; CCC calculations.
Note: Emissions on source basis. 2009 figures are provisional, and for 'Residential', 'Non-residential', 'Industry' and 'Other' sectors are CCC estimates. Figures in legend show change in emissions in 2009.

Figure 1.3 UK non-CO_2 emissions by sector (1990-2008)



Source: NAEI (2010).

Traded and non-traded sector emissions

The Climate Change Act distinguishes between the non-traded sector (not covered by the EU ETS e.g. heat, transport, non-CO_2) and the traded sector (relating to power generation and energy-intensive industry sectors covered by EU ETS). Emissions in 2009 fell in both the non-traded and traded sectors:

- Non-traded sector emissions rose by 0.4% in 2008[9] but fell by 5.7% in 2009.
- Traded sector emissions fell by 4.8% in 2008 and 12.5% in 2009.

In our 2009 progress report we projected that emissions would fall in 2009 and that this would have important implications for the approach to the non-traded and traded sectors. We now revisit this analysis in light of new emissions data.

(ii) Implications for the non-traded sector

Our December 2008 advice on the appropriate level of the first carbon budget reflected emissions projections made prior to the recession. These projections therefore assumed annual economic growth of around 3% driving up emissions, which would be offset by implementation of measures under firm and funded policies (e.g. CERT, voluntary agreements for increased fuel efficiency of new cars, biofuels policy). The net impact of these effects and other assumptions (e.g. population growth, movements in fossil fuel prices) was a projected 0.9% annual emissions reduction in the non-traded sector through the first budget period.

In our 2009 progress report, we provided an assessment of the potential impact of the recession on non-traded sector emissions. We showed that the first budget could be achieved with limited emissions reduction effort once the impact of the recession is accounted for, and that implementation of measures envisaged for the first budget period could lead to outperformance of the first budget by up to 75 $MtCO_2$. We argued that it is important during the first budget to lay the foundations for meeting the second, third and subsequent budgets. We therefore argued that the aim should be to outperform the first budget by up to 75 $MtCO_2$ and not to bank this outperformance through to the second budget.

9 Including installations that opted out of the EU ETS before 2008.

Emissions data for 2008 and 2009 are consistent with the analysis in our 2009 progress report. Specifically, emissions reductions in the last two years, together with further reductions in 2010, are likely to result in emissions reductions over the first budget period in line with our 2009 projections. (Figure 1.4 and Box 1.1):

- Our 2009 emissions projections using the DECC Energy Model suggested cumulative emissions would be lower by 40 $MtCO_2$ (3%) than our 2008 projections as a result of the recession and other exogenous changes over the first budget period.
- Our 2009 emissions projections using the Cambridge Econometrics model, which assumes a greater responsiveness of demand to income than the DECC model, suggested cumulative emissions would be 75 $MtCO_2$ (6%) lower over the same period.
- Our new analysis reflecting the latest data for 2008 and 2009 suggests that, together with implementation of measures, cumulative emissions for the first budget period will be of the order 55 $MtCO_2$ lower than required to meet the budget (i.e. within the range 40-75 $MtCO_2$).

We have considered whether emissions reductions may be attributed to implementation of measures rather than the recession and other exogenous factors (e.g. increases in fossil fuel prices). However, our analysis suggests that policies have generally delivered at the (modest) level expected rather than outperforming expectations (Table 1.1) and that the bulk of emissions reductions are therefore due to the recession/other factors rather than implementation of measures.

Going forward, it continues to be important to implement measures under current policies in order to prepare for meeting the second and third carbon budgets. Given successful implementation in addition to impacts of the recession, the result would be outperformance of the first budget. The aim should therefore be to outperform the first budget (e.g. by up to 75 $MtCO_2$, as projected by the Cambridge Econometrics model) and – in order to maintain incentives for sustained action – not to bank this outperformance.

Although one possibility would be to amend the first budget and build in this level of outperformance, however, we recommend that the budget should not be amended given uncertainties over the precise impact of the recession. However, given outperformance there is the possibility that the Intended budget could now be achieved at lower cost through domestic action, strengthening the case to move from the Interim to the Intended budget (Section 1(iv)).

Box 1.1 Impact on non-traded sector emissions due to the recession and other changes over the first budget period

In our 2009 progress report, we reported new emissions projections from the DECC Energy Model and the Cambridge Econometrics model (MDM-E3). Both sets of projections showed a large impact of the recession and other exogenous factors on emissions in 2009, which persisted to 2012.

Outturn CO_2 emissions in the non-traded sector were 268 $MtCO_2$ in 2008 and 249 $MtCO_2$ in 2009:

- Cumulative 2008-2009 emissions were 14 $MtCO_2$ lower than the original (2008) projections on which the first budget was set and which did not reflect the impact of the recession.
- The 2009 outturn is between the levels we projected when using the DECC and Cambridge models for our 2009 progress report.

Assuming that emissions in 2010 to 2012 follow the shape of the trend projected by the DECC or Cambridge models (i.e. the impact seen in 2009 persists to the following years), cumulative emissions over the first budget period will be of the order 55 $MtCO_2$ lower than projected when the budget was set.

Figure 1.4 Projected outperformance of first budget (2008-2012) in the non-traded sector due to the recession and other changes

Source: DECC Energy Model; Cambridge Econometrics MDM-E3 model; CCC calculations.
Note: Negative projections indicate that emissions are expected to be below budget (i.e. an outperformance is expected to occur).

Table 1.1 Actual versus expected delivery of CO_2 emissions reduction measures in the non-traded sector in 2008 and 2009

	Uptake/improvement			Emissions reductions ($MtCO_2$)		
	Expected	**Outturn**	**Outperformance**	**Expected**	**Outturn**	**Outperformance**
Domestic sector						
Loft insulation (professional)	1.0 m	1.6 m	0.6 m	0.2	0.3	0.1
Loft insulation (DIY)	0.0 m	0.9 m	0.9 m	0.0	0.2	0.2
Cavity wall insulation	1.1 m	1.1 m	0.0 m	0.6	0.6	0.0
Solid wall insulation	0.05 m	0.03 m	-0.02 m	0.1	<0.1	<-0.1
Efficient boilers	2.0 m	2.3 m	0.3 m	1.0	1.1	0.1
Road transport						
New car gCO_2/km	2% improvement	9% improvement	7%	0.1	0.4	0.3
Biofuels (by volume)	+1.9 percentage points*	+1.9 percentage points*	0 percentage points	2.0	2.0	0.0
Total						
				4.1	4.8	0.6

Source: Uptake – Insulation: Ofgem, DECC; Boilers: Heating and Hotwater Industry Council, CLG, CCC; New car CO_2: Society of Motor Manufacturers and Traders; Biofuels: HMRC. Emissions reductions – CCC calculations.

Note: *i.e. increase in share from 1% to 2.9% by volume. Uptake figures for insulation and boilers are cumulative installations in 2008 and 2009.

(iii) Implications for the traded sector

The 12.5% reduction in traded sector emissions, to 232 $MtCO_2$, in 2009 resulted from both emissions reductions in power generation and other energy-intensive industries:

- The 13.1% reduction in power sector emissions resulted due to:
  - A 7% fall in electricity demand between 2008 and 2009.
  - A reduction in coal generation due to low gas prices during 2009.
  - Two nuclear power stations coming back online after outages in 2008, increasing the share of nuclear generation from 14% in 2008 to 19% in 2009.
- There was an 11% reduction in emissions from other energy-intensive industries covered by the EU ETS.

These emissions reductions will not affect achievement of the traded sector budget: under the Climate Change Act traded sector emissions are accounted for on a net basis (i.e. net of purchases of European Union Allowances or offset credits), and the traded sector budget will therefore always be achieved by definition given that the traded sector is capped under the EU ETS. From 2008 to 2009 the UK cap remained flat at 246 MtCO2. As such the fall in actual emissions to 232 MtCO2 in 2009 meant that UK firms were able to sell more allowances into the EU market, or to bank them towards meeting future caps.

Our approach to the traded sector has been based on the principle that power sector decarbonisation is key to wider economy decarbonisation in the 2020s (e.g. both through the impact on power sector emissions, and the extension of low-carbon power to other sectors, notably road transport and heat). Therefore it is vital that progress is made towards power sector decarbonisation over the next decade, both through investments in low-carbon generation and the introduction of new arrangements to support a scaling up of low-carbon investment in the 2020s; we set out detailed indicators for the power sector and consider progress against these in Chapter 2.

One key lever to drive low-carbon investment both in the power sector and other energy-intensive sectors is the carbon price. However, we previously suggested that the impact of the recession would be to reduce the carbon price in the period to 2020:

- The carbon price depends both on the EU ETS cap and the emissions reduction required to meet this cap.
- The recession has reduced output and emissions in energy-intensive industries across the EU, therefore requiring less emissions reduction effort (e.g. fuel switching from coal to gas in power generation) to meet the cap.

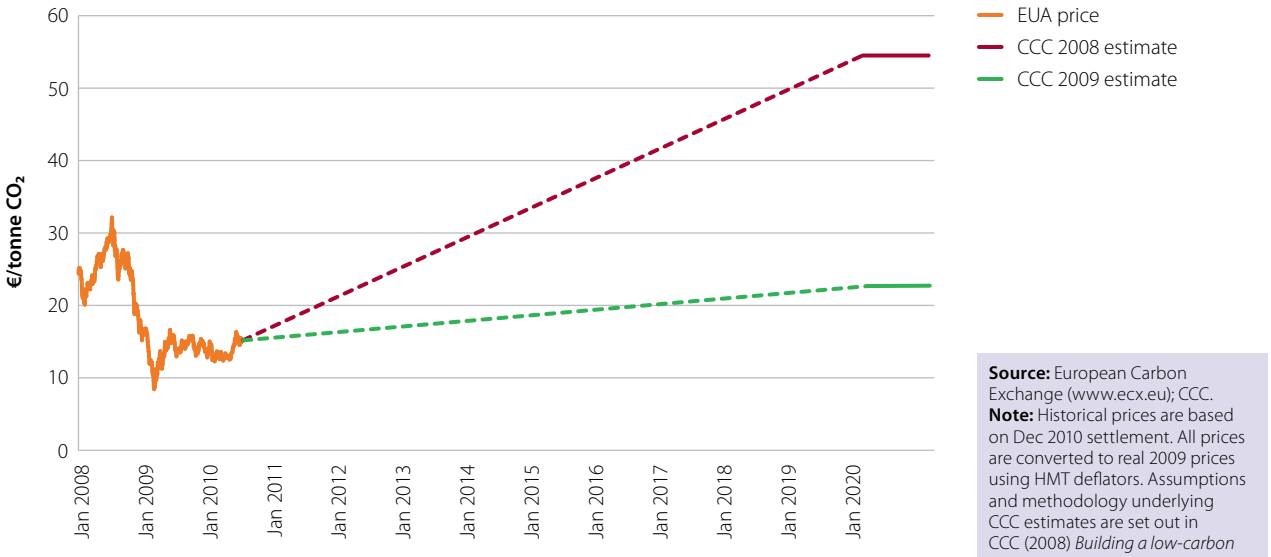
The projection that the carbon price will remain low to 2020 is supported by developments since our 2009 progress report:

- Latest data for the European energy-intensive sector suggests emissions have fallen by 12% in 2009 as a result of the recession.[10]
- Failure to agree a global deal at Copenhagen did not provide the confidence in future emissions reductions and global carbon markets that could have triggered a price increase.

The impact of these factors is manifest in carbon prices at a similar level in May 2010 (15 euros/tCO_2) as in our last report in October 2009 (14 euros/tCO_2), and most market analysts continue to project a carbon price for 2020 consistent with those we reported in October 2009 (now on average around €30) and still well below our pre-recession projection of €56 in 2020 (Figure 1.5, Figure 1.6).

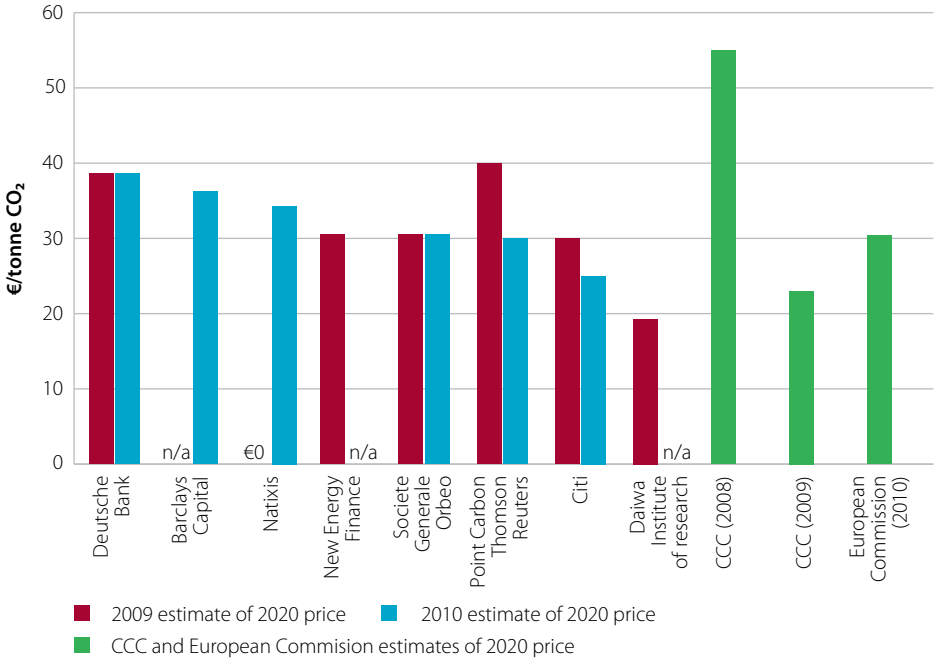
10 Source: Community Independent Transaction Log (CITL).

Figure 1.5 Actual carbon prices (January 2008 to June 2010) and CCC carbon price projections for 2020



Source: European Carbon Exchange (www.ecx.eu); CCC.
Note: Historical prices are based on Dec 2010 settlement. All prices are converted to real 2009 prices using HMT deflators. Assumptions and methodology underlying CCC estimates are set out in CCC (2008) *Building a low-carbon economy* and CCC (2009) *Meeting Carbon Budgets*.

Figure 1.6 Recent market projections of the EUA price in 2020



Source: Deutsche Bank (July 2009 and April 2010); Barclays Capital (April 2010); Natixis E&I (July 2009 and May 2010); New Energy Finance (July 2009); Societe Generale Orbeo (May 2009 and April 2010); Point Carbon Thomson Reuters (July 2009 and June 2010); Citi Investment Research and Analytics (July 2009 and April 2010); Daiwa Institute of Research (February 2009); CCC (2008) *Building a low-carbon economy;* CCC (2009) *Meeting Carbon Budgets*; European Commission (2010) *Analysis of options to move beyond 20% greenhouse gas emission reductions.*
Note: Estimates are taken either from published sources or supplied directly from analysts. N/A indicates that no estimate was available. Nominal forecasts were converted to real 2009 prices using an assumed annual inflation rate of 2%. The Natixis estimate does not incorporate an estimate of the cost of carry. The European Commission estimate is based on a 30% GHG target, with a reduction of 25% made within the EU and 5% through the use of international offsets. Point Carbon Thomson Reuters estimate is a probability weighted Phase III average.

Given the impact of the recession, the carbon price is therefore likely to provide a less robust signal than it otherwise would. There is a risk that at current levels the carbon price will be insufficient to support low-carbon investments. The new Government has recognised this and proposed to introduce a carbon price floor, which should – in combination with the EU ETS – provide a very clear signal for low-carbon investment (e.g. this should be pre-announced for a time period commensurate with asset life of low-carbon investments, rising to a level sufficient to cover cost differentials of low-carbon technologies versus conventional fossil fuel alternatives, possibly indexed on the gas price). Other options for strengthening incentives to invest in low-carbon power generation should also be seriously considered to complement strengthening of the carbon price; we consider these in more detail in Chapter 2.

Another means to strengthen the carbon price signal would be to tighten the EU ETS cap:

- This would strengthen incentives for investment in low-carbon power generation, and would strengthen incentives in other energy-intensive sectors without introducing risks of intra-European competitiveness impacts.
- It would also provide the basis for moving from the EU economy-wide 20% GHG emissions reduction target for 2020 to a 30% target, which will be required in the context of a new global emissions reduction deal; increasing the level of EU ambition could now be achieved at a lower cost than previously envisaged given the current abundance of low-cost abatement opportunities in the traded sector.

We will consider the case for a move to a 30% EU emissions target for 2020 in the context of our advice on the fourth budget, which will include an assessment of the evolving international framework, to be published by the end of 2010.

(iv) The need for a step change

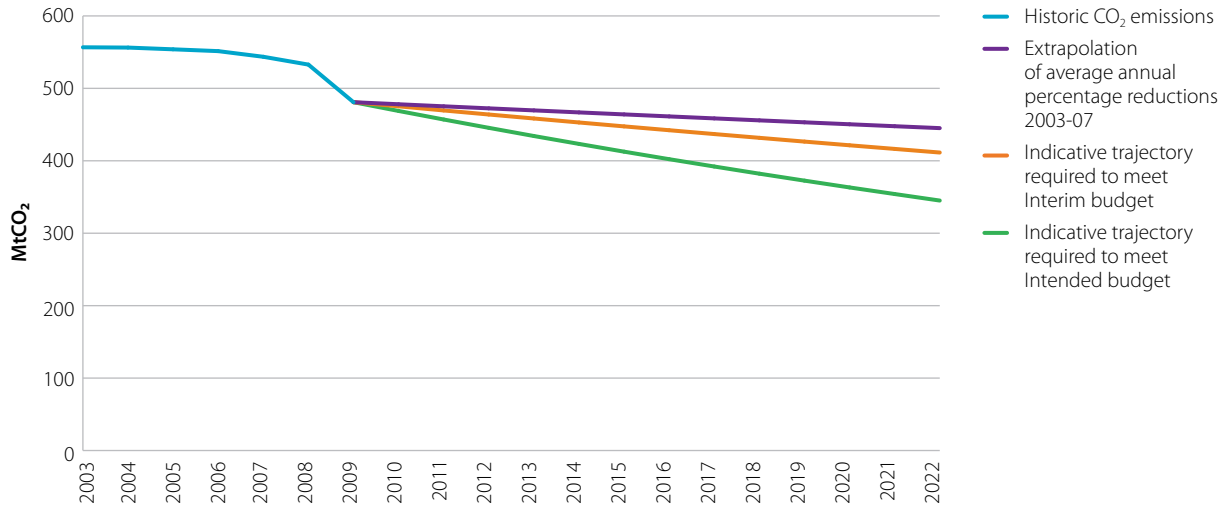
In our 2009 progress report we argued that recent emissions reductions were far slower than those required going forward and therefore a step change was required:

- Economy-wide GHG emissions fell under 1% per year on average from 2003 to 2007,
- Economy-wide CO_2 emissions fell 0.6% per year on average from 2003 to 2007,
- From 2008, GHG emissions would have to fall at 1.7% per year to meet the Interim budget and 2.6% per year to meet the Intended budget, with most of the fall coming from CO_2 given lower opportunities for reducing non-CO_2 emissions (e.g. our Extended Ambition scenario, incorporating feasible and desirable measures, models annual average reductions in CO_2 of 2.7%).

Given the emissions reduction in 2009, the required rate of emissions reduction to 2020 is reduced. However, a step change in underlying progress is still required if carbon budgets are to be achieved:

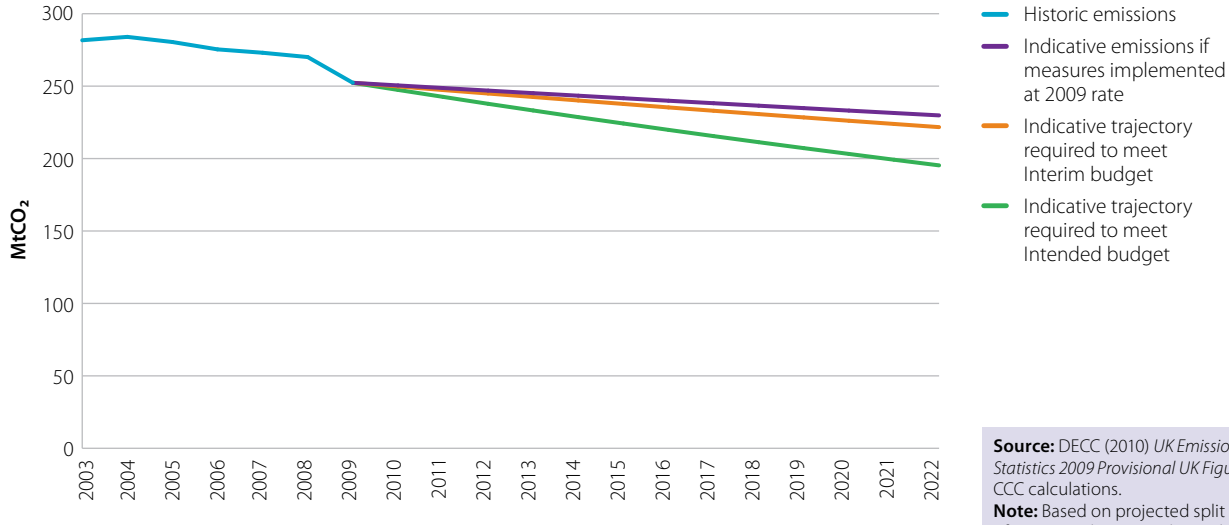
- Economy-wide GHG emissions would have to fall at 1.1% per year from 2009 levels to meet the Interim budget, or at 2.2% per year to meet the Intended budget, with the bulk of emissions reductions coming from CO_2 (i.e. more than the 0.6% per year falls in CO_2 for 2003-2007) (Figure 1.7),
- Furthermore, delivery of emissions reduction measures across the economy remains well below the level we have identified in our Extended Ambition scenario required both to meet the first three carbon budgets and to lay the foundations for meeting subsequent budgets (Table 1.2):
  - Less than 1 GW of new renewable electricity generation capacity was deployed in 2009, compared to over 3 GW required annually on average in the third budget period.
  - Uptake of solid wall insulation in homes under CERT was around 15,000 in 2009, compared to annual installations of over 250,000 required on average in the third budget.
  - Sales of electric vehicles in 2009 were negligible compared to the annual sales of over 80,000 required in the third budget and there was very limited progress on increasing sales of more efficient vans.

Figure 1.7 Indicative economy-wide CO_2 reductions required to meet budgets versus pre-recession trend (2003-2022)



Source: DECC (2010) *UK Emissions Statistics 2009 Provisional UK Figures;* CCC calculations.

Figure 1.8 Indicative non-traded sector CO_2 emissions based on rate of implementation of measures achieved in 2009 versus budget requirements (2003-2022)



Source: DECC (2010) *UK Emissions Statistics 2009 Provisional UK Figures;* CCC calculations.
Note: Based on projected split of emissions between the traded and non-traded sectors in 2020.

- Non-traded sector CO_2 emissions would fall by around 0.7% annually if progress implementing measures in 2009 could be sustained. However, this would not be sufficient to achieve the third carbon budget for the non-traded sector, which would require annual CO_2 reductions from 2010 of 1.0% under the Interim budget or 1.9% under the Intended budget (Figure 1.8). Sustaining progress in 2009 (e.g. in energy efficiency improvement, new car fuel efficiency, biofuels) through the first and subsequent carbon budget periods would itself be challenging and would require new policies.

Therefore emissions reductions in 2008 and 2009 cannot be regarded as evidence of the step change in progress required to meet the second and third carbon budgets. We discuss, at a high level in section 5 below and in more detail in Chapters 2-5, the progress that has been made in putting in place new policies to drive the step change in delivery, and identify areas where further development is required.

If this step change in delivery is achieved, and the emissions reduction in 2009 is permanent (Box 1.2), our analysis shows that it could now be possible to meet the Intended budget through domestic effort alone and, specifically, through implementation of measures in our Extended Ambition scenario (Figure 1.9). This raises a question about whether and how it is appropriate to move to the Intended budget, which we will consider in detail in the context of our advice on the fourth carbon budget, to be published before the end of the year.

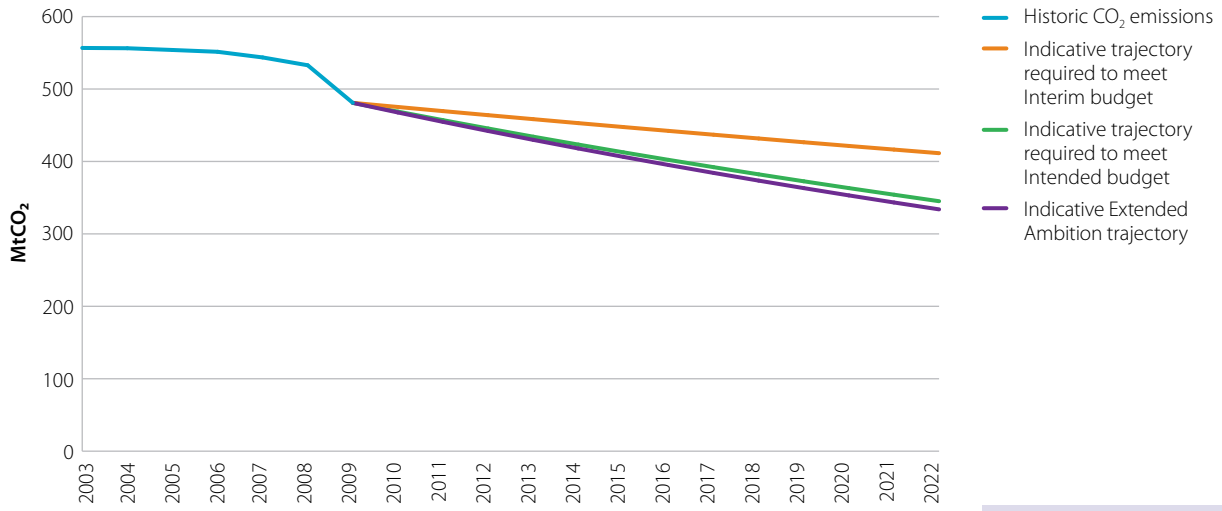
Table 1.2 Implementation of measures in 2009 compared to rate required in second and third budgets

		Annual uptake/improvement		
		Outturn 2009	**Budget 2 average**	**Budget 3 average**
Power				
Capacity (GW)	Onshore wind	0.4	1.0	1.4
	Offshore wind	0	1.0	1.8
Domestic buildings				
Loft insulation (CERT professional)		0.80m	2.08m*	–*
Loft insulation (DIY & other schemes)		0.62m		
Cavity wall insulation		0.59m	1.41m*	–*
Solid wall insulation		0.02m	0.15m	0.22m
Efficient boilers		1.15m	0.87m	0.66m
A++ rated cold appliances		~0.5 pp	2.9 pp	5.4 pp
A+ rated wet appliances		~2.0 pp	4.7 pp	3.7 pp
Renewable heat				
Renewable heat penetration		n/a	0.8pp	2.3 pp
Transport				
New car gCO_2/km		5.4%	4.5%	4.4%
Biofuels (by volume)		0.6pp	0.7pp	0.4pp
Total EV sales		140	50,000	86,000
Car drivers undertaking eco-driving		~20,000	340,000	340,000

Source: Outturn – Wind capacity: DECC; Insulation: Ofgem, DECC; Boilers: Heating and Hotwater Industry Council, CLG, CCC calculations; Appliances: Market Transformation Programme, CCC calculations; New car CO_2: SMMT; Biofuels: HMRC; EV sales: Society of Motor Manufacturers and Traders; Eco-driving: Energy Saving Trust. Budget 2 and 3 averages – CCC modelling.

Notes: *maximum uptake is achieved by 2015 under the Extended Ambition scenario. pp= percentage points.

Figure 1.9 Indicative economy-wide CO_2 Extended Ambition trajectory incorporating additional recession impacts versus budget requirements (2003-2022)



Source: DECC (2010) *UK Emissions Statistics 2009 Provisional UK Figures;* CCC calculations.

(v) Regional emissions

The 2007 emissions data reported in our 2009 progress report remains the most up to date available for the Devolved Administrations. While we cannot directly assess recent regional emissions at present, consideration of the drivers of emissions suggests it is likely that regional emissions will have broadly followed the downward UK trend over 2008 and in to 2009.

- The various available indices for GDP, manufacturing, production, construction and services, and labour market data for 2009 suggest similar trends for the UK and Devolved Administrations. Therefore to the extent that emissions in the UK as a whole have fallen due to the recession, emissions will also have fallen in the Devolved Administrations.
- The latest electricity and gas sales data available for Wales and Scotland[11] show that in 2008, sales of electricity and gas to all consumers (domestic, commercial and industrial) fell across Scotland and Wales in similar proportions to Great Britain as a whole.

Going forward, each of the Devolved Administrations will have to implement measures to reduce emissions in order both to meet domestic climate change goals, and to make their contribution to meeting UK carbon budgets (Box 1.3). In the near term, this will require ongoing implementation of existing policy with the limited ambition that this entails. Beyond the near term, new policies will be required to drive the required step change to meet national and UK emissions targets. More details on implementation of measures are provided in chapters 2-5.

11 Source: DECC 'Sub-national energy consumption statistics 2008'. Coverage is currently for GB only due to prior disclosure concerns in Northern Ireland. Following changes to the market in Northern Ireland in November 2007, DECC aims to publish electricity consumption data for the whole of the UK from December 2010.

Box 1.2 Permanence of emission reductions due to the recession

The latest GDP forecasts from the Office for Budget Responsibility (OBR) imply that, whilst the economy would return to growth, the recession would lead to a permanent loss of output compared to pre-recession projections[12]. The substantial reduction in emissions in 2009 suggests that emissions remain linked to growth and, therefore, a permanent reduction in output may be taken to imply a permanent reduction in emissions.

At least some of the recessionary impact in 2009 is likely to be permanent:

- As GDP has been permanently reduced, so manufacturing output and domestic incomes will be lower in 2020 than previously anticipated. As firms produce less goods and households have less to spend, so the demand for energy from each is likely to be lower.
- There have been some permanent closures of major emitting industrial installations and shifts of production to more efficient plant (e.g. in the cement sector).
- In transport, there is evidence of a shift towards purchase of more fuel-efficient vehicles (Chapter 4), which will remain in the fleet for some time.

It is also possible that the full impact of the recession on emissions has not yet been seen. For example, it may take some time for lower incomes to filter fully through to consumer product choices (e.g. cars and appliances are not replaced every year) or to behaviours (e.g. turning down thermostats and eco-driving). 2010 GDP growth is also projected to be below trend (OBR's central projection is 1.3%).

However, some of the emission reduction in 2009 may be transitory, and emissions may "bounce back" to higher levels. For example:

- There is likely to have been some reduction in existing inventories, that may lead to re-stocking as output returns to growth, and hence a larger swing in production from energy-intensive manufacturing.
- Some industrial sectors (e.g. steel) reduced output without permanent closures, and through the mothballing of plant that may reopen in the longer term.
- Consumers may have implemented temporary changes in behaviour, and could revert to previous behaviours in energy use as economic growth resumes.

There is limited evidence available on how emissions respond after the initial impacts of a major recession. In our 2009 work, both the DECC and Cambridge Econometrics models projected a slight lag before the full impact of a recession is felt, rather than a bounce-back in emissions. We will continue to monitor this issue as part of our regular reporting on progress.

12 Office for Budgetary Responsibility (June 2010) *Pre-Budget forecast*.

Box 1.3 Recent developments in Climate Change policy in the Devolved Administrations

Scotland

Subsequent to the Climate Change (Scotland) Act receiving Royal Assent on 4th August 2009, Scottish Ministers asked the Committee for advice relating to a number of the key provisions of the Act, specifically:

- The highest achievable interim target for 2020,
- Annual targets for 2010-2022,
- The methodology for including international aviation and shipping emissions in targets and use of non-CO_2 multipliers,
- Use of offset credits to meet Scottish targets.

In providing the advice, which was published in February 2010, the Committee also developed a methodology for apportioning Scotland a share of the UK EU ETS cap, a set of reference emissions for Scotland, and analysed the abatement potential in Scotland.

These provisions and the Committee's advice were reflected in a package of secondary legislation laid before the Scottish Parliament on 21st April 2010. Amongst other things this package reaffirmed the Scottish Government's commitment to reduce emissions of all greenhouse gases in Scotland by 42% by 2020 and proposed annual targets for 2010-22.

In May 2010 the Scottish Parliament voted against the statutory instrument setting annual targets and the Scottish Government is now convening a short-life cross-party working group to consider the issue further. The Committee has agreed to provide advice to this group. After the group completes its consideration, a new statutory instrument will be introduced. A Report on Proposals and Policies to achieve the required emission reductions will also be published later in 2010.

Wales

Throughout 2009, the Welsh Assembly Government consulted on both its Climate Change Strategy policy statement and Programme of Action. These two elements set out targets to reduce greenhouse gases by 3% p.a. in areas of devolved competence from 2011, and consulted on the policy developments to achieve this target. In response to a request by the Welsh Assembly Government, the Committee provided advice in October 2009 in relation to the level of ambition set out in the strategy and on the abatement policy measures outlined in the programme of action. A final strategy for Wales is due to be published in autumn 2010.

Northern Ireland

As noted in last year's report Northern Ireland aims to reduce greenhouse gases by 25% on 1990 levels by 2025. In November 2009 the Northern Ireland Assembly's Environment Committee reported on its inquiry into climate change. The inquiry remit was to understand the implications of climate change for Northern Ireland and to make recommendations on government policies to mitigate the impacts of climate change, examine economic implications and identify suitable adaptation initiatives. The Assembly Committee's report agreed that Northern Ireland should make a fair and proportionate contribution to UK greenhouse gas emission targets and develop an implementation strategy to address both mitigation and adaptation. In May 2010, the Northern Ireland Executive agreed to a proposal by the Minister of the Environment to establish a Cross Departmental Working Group on greenhouse gas emissions. This group aims to produce an agreed mitigation programme by December 2010.

3. Aviation and shipping emissions

(i) Aviation emissions

Emissions Trends

Aviation emissions (on a bunker fuel basis) fell by 4% in 2008 as passenger demand fell 2%. In 2009, demand fell by a further 7%, due to the recession, suggesting that aviation emissions will show a significant decline for 2009 when the data is released in 2011.

There have been emissions reductions in both international and domestic aviation (Figure 1.10):

- International aviation emissions fell by around 4% in 2008 from 35.4 $MtCO_2$ to 34.1 $MtCO_2$,
- Emissions from domestic aviation dropped by 5% in 2008 from 2.3 $MtCO_2$ to 2.2 $MtCO_2$.

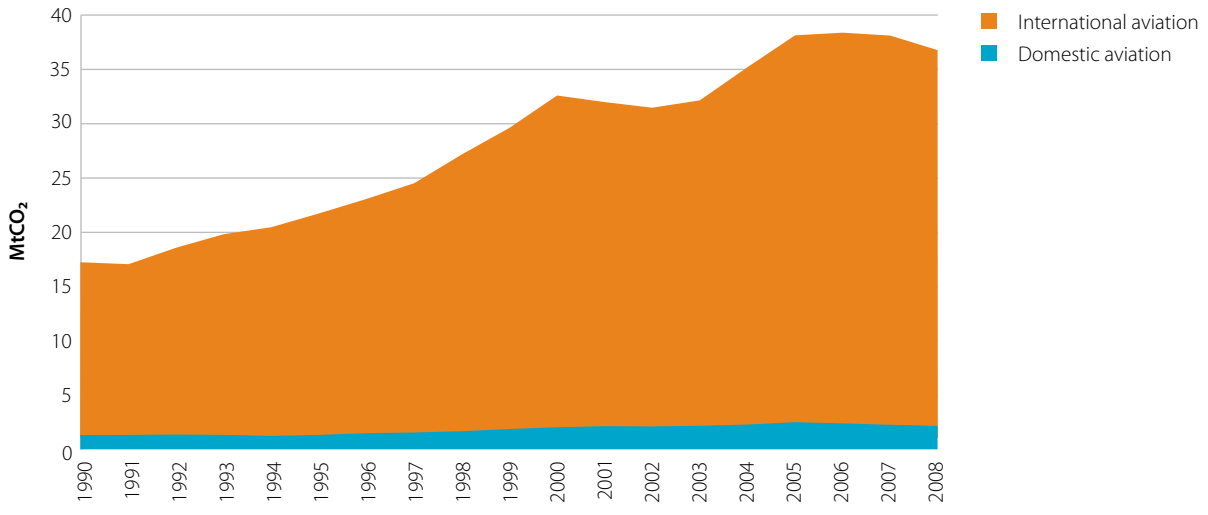
Growth in demand and emissions is expected to resume as GDP returns to growth. Analysis for the Committee's review of UK aviation emissions[13] suggests that there is scope for limited demand growth (e.g. 60%) in the period to 2050 consistent with the economy-wide 80% emissions reduction target:

- The emissions impact of demand growth could be offset by improvements in the carbon intensity of flying.
- Given likely improvements in carbon intensity, demand growth of up to 60% would be compatible with returning aviation emissions to 2005 levels in 2050. Higher levels of demand growth would be possible if more rapid improvements in carbon intensity occur.
- With aviation emissions at 2005 levels, and together with deep cuts in other sectors (e.g. 90% in domestic CO_2 emitting sectors), this could achieve an 80% emissions cut economy-wide in 2050.

We noted that the 60% passenger demand increase could be consistent with a range of policies as regards capacity expansion at specific airports and carbon taxes. The new Government has announced plans to cancel runway expansion at Heathrow and Stansted and is considering whether to replace air passenger duty with a per-plane tax; further analysis is required to establish whether these approaches could limit demand growth to 60%.

We expect that the Government will respond to the Committee's recommendations on the aviation sector in 2010.

Figure 1.10 UK aviation CO_2 emissions (1990-2008, bunker fuels basis)



Source: DECC (2010) *UK Emissions Statistics 2008 Final UK Figures.*

13 CCC (2009) *Meeting the UK aviation target – options for reducing emissions to 2050.*

Carbon budgets and the EU ETS

We previously advised that international aviation emissions should be reflected but not explicitly included in the first three carbon budgets, pending resolution of potential discrepancies between current UK emissions estimates (on a bunker fuels basis) and possible EU ETS allocation methodologies. Since 2008, the monitoring and verification of aviation in the EU ETS has been finalised suggesting that inclusion of international aviation emissions in budgets will be appropriate in the near future:

- From 2012, aviation emissions (both domestic and international) will be covered by the EU ETS,
- The reporting framework suggests that emissions will be reported both by airline (for administration) and by Member State (for auctioning),
- Reporting by Member State is likely to be on the basis of all departing flights and as such could be consistent with the bunker fuels methodology,
- Explicit inclusion of international aviation emissions in carbon budgets would therefore be appropriate, subject to data availability and accuracy.

The Committee will consider this issue in more detail in conjunction with possible revisions to the first three budgets given the changing international framework, either later in 2010 or in 2011, or as part of specific advice required under the Climate Change Act on inclusion of international aviation and shipping in the net carbon account, due by 2012.

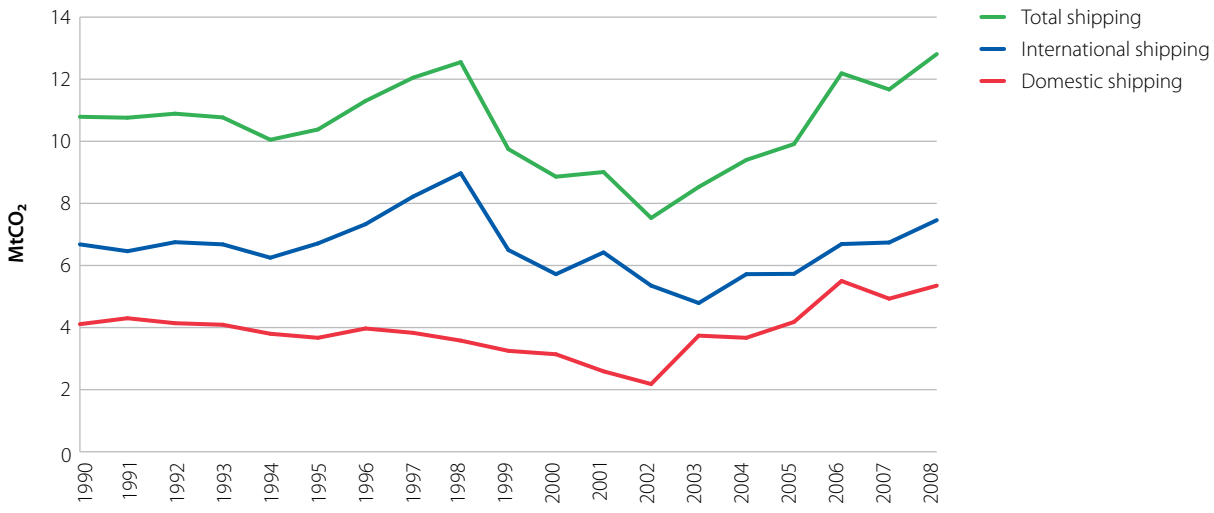
(ii) Shipping emissions

Emissions Trends

Shipping emissions as measured on a bunker fuels basis rose by 10% in 2008 to 12.8 $MtCO_2$ (Figure 1.11). Emissions rose in both international and domestic shipping:

- International shipping emissions rose by around 11% in 2008 from 6.7 $MtCO_2$ to 7.5 $MtCO_2$.
- Domestic shipping emissions grew by around 9% in 2008 from 4.9 $MtCO_2$ to 5.4 $MtCO_2$.

Figure 1.11 UK shipping CO_2 emissions (1990-2008, bunker fuels basis)



Source: DECC (2010) *UK Emissions Statistics 2008 Final UK Figures.*

Box 1.4 Allocating shipping emissions

Bunker fuels is the methodology used to report shipping emissions as a memorandum item to the UNFCCC. However, it is not clear that bunker fuel estimates of shipping fuels present an accurate picture of shipping emissions at the UK level, particularly for international shipping given scope for bunkering for fuel at multiple ports along shipping routes. For example, over the period 1990-2008, international traffic to/from UK ports grew by 32% whereas international shipping emissions on a bunker fuels basis grew by only 12%, suggesting that increasing UK activity is not being fully picked up in emissions estimates due to international bunkering patterns and UK refinery capacity.

Recent major studies at Global, EU and UK levels have all used methodologies based on shipping activity (e.g. estimates of actual fuel used onboard ships for movements), and these have found significantly higher emissions compared to bunker fuels.

The Committee will continue to monitor developments in emissions methodologies for shipping, with particular emphasis on evolving analysis on activity-based estimates and forecasts.

We have previously noted concerns with bunker fuels as a measure of emissions for shipping, suggesting that this may actually understate UK emissions, given that ships delivering to the UK may bunker for fuel elsewhere (Box 1.4).

Given the importance of shipping emissions in the context of the 2050 target, we will consider alternative methodologies for allocating emissions as part of a broader shipping review to be carried out in 2011. This will underpin advice on whether and how international shipping should be included in the net carbon account to be provided by 2012 as required under the Climate Change Act.

It will be important that growth in shipping emissions is constrained in order that climate change goals are achieved. In our December 2008 report, for example, we showed that the 80% emissions reduction target for 2050 could be achieved with shipping emissions in 2050 at around 2005 levels on a bunker fuel basis, and with cuts above 80% in other sectors. Conversely it is not clear how the 80% target could be achieved with significant growth in shipping emissions.

Levers for reducing emissions

We have previously argued that the ideal lever for constraining shipping emissions is a global sectoral agreement, with an EU-only approach as a second-best solution. However, there has been limited progress on implementing a global market-based instrument, notwithstanding IMO progress on energy efficiency design and operational indices for ships. In parallel, the EU has made a commitment to include international shipping in its climate and energy package and targets by 2013 if the IMO have not achieved an international agreement by end-2011.

We will consider appropriate levers further in the context of our review of shipping emissions to be carried out in 2011.

4. Progress against the Committee's indicators

Our October report set out a framework of indicators against which progress reducing emissions could be monitored, and which would provide early warning of risks around missing carbon budgets. The indicators should not be seen as fixed targets but as an evolving framework to be developed in the light of new analysis. The framework included both measures to be implemented (e.g. houses insulated, GW wind generation added, new car emissions) and policy milestones required to support sustained and deep emissions cuts through the first three budget periods and beyond.

In this report we apply the indicator framework to data for 2008 and 2009. Our analysis suggests that implementation of measures is generally on track. However, the level of ambition underpinning indicators for the first budget period reflected policies in place in 2008 which our analysis suggests are neither sufficiently ambitious nor provide sufficiently strong incentives to drive the required step change in the pace of emissions reduction.

Going beyond the first budget, new policies with increased ambition underpinned by stronger incentives will be required to drive the step change. In this respect, there has been progress developing a high-level policy framework for meeting carbon budgets.

However, further work is required to develop a detailed implementation framework in order to provide sufficient confidence that carbon budgets will be achieved. Specific areas where policy development is required include reform of the electricity market arrangements, design of an implementation framework to reduce emissions in the residential buildings sector, and setting of a medium/long-term vision for the electric car/plug-in hybrid market.

We consider progress against indicators for implementation of measures and policy milestones in detail in Chapters 2-4.

5. Departmental carbon budgets and delivery plans

The first set of departmental carbon budgets and delivery plans was published in March 2010. These form the basis of a governance framework to ensure that each department delivers emissions reductions identified in the Low Carbon Transition Plan.

We have been asked to comment on the departmental budgets and plans, and in doing this we focus on the extent to which these match the scope of and level of ambition in our indicators:

- **Power sector:** DECC's indicator framework covers the appropriate range of technologies – renewables, nuclear and CCS (although only for coal, not for gas) – and the full range of facilitative areas such as transmission and planning. The level of ambition for 2020 is broadly consistent with the level of ambition in the Committee's indicators.
- **Buildings and industry:** The overall ambition for these sectors is broadly consistent with the Committee's Extended Ambition scenario although ambition for individual measures, where specified, is lower in some cases (e.g. loft and cavity wall insulation). In addition, a number of key indicators remain to be defined, e.g. ambition for renewable heat, minimum EPC ratings.
- **Transport**: The emissions trajectory for transport is less ambitious than our Extended Ambition scenario. In addition the delivery plan does not commit to a level of ambition for key measures (e.g. aiming to achieve the EU target for new car emissions, ambition on electric cars, ambition for rolling out Smarter Choices).
- **Agriculture:** our analysis suggests that a higher level of ambition is likely to be achievable in the agriculture sector than currently targeted, both in England and in the Devolved Administrations.

Therefore we conclude that the level of ambition both for emissions reductions and for specific measures could be increased in some areas (we discuss appropriate ambition in detail in chapters 2-5).

In addition, the departmental plans do not set out trajectories for emissions reduction measures for the years to 2020. This is problematic given that there is no basis in the plans for assessing whether sufficient progress is being made towards 2020 goals. We therefore recommend that trajectories for specific measures are defined, against which departments' progress can be monitored, and that these should be consistent with the trajectories in our indicator framework (see chapters 2-5).

In order to drive progress along these trajectories and to achieve appropriate emissions reductions in 2020, new policy approaches will be required (e.g. for energy efficiency improvement, more efficient vehicles, low-carbon power generation). We recommend that milestones corresponding to these new policies are included in the departmental delivery plans, and that progress developing policies is therefore a key part of the wider process of monitoring progress reducing emissions. We set out a high-level assessment of new policy approaches in key areas in chapters 2-5.

Chapter 2: Progress decarbonising the power sector

Introduction and key messages

Power sector emissions reduction is central to wider economy decarbonisation for at least three reasons:

- Emissions from the power sector account for a significant proportion of total emissions (31% of total CO_2 emissions and 26% of total greenhouse gas emissions in 2009).
- There are cost-effective opportunities for investment in low-carbon power generation (i.e. investment in new nuclear plants, renewables, and in future years, carbon capture and storage – CCS).
- Extension of low-carbon generation to other sectors, most notably through electric vehicles and modern electric heating (e.g. through air-source and ground-source heat pumps) is likely to be required in order to achieve future carbon budgets.

In our 2009 progress report, we set out an extensive set of indicators for the power sector, covering stages of the project cycle (e.g. GW capacity receiving planning approval, completing construction) and policy milestones. We also highlighted the need to seriously consider fundamental reform of the current electricity market arrangements given risks that these will continue to deliver predominantly gas-fired generation investment in the period to 2030.

In this chapter, we consider the latest power sector emissions data, and we apply our indicator framework to electricity generation for the first time (factors which impact on electricity demand are discussed in Chapter 3). The key messages in the chapter are:

- Power sector emissions fell by 13% in 2009 due both to demand reduction and a switch in generation away from coal towards (already existing) less carbon-intensive plant.
- Modest ambition reflected in our indicators for 2009 was generally achieved. However, in order to meet more ambitious indicators going forward, a much faster pace of progress will be required in future years (e.g. the rate of installation of new wind capacity should increase from around 0.7 GW in 2009 to over 3 GW annually in the third budget period). Key underpinning actions needed in the near term include:
  - Getting agreement between Ofgem and the transmission owners on regulatory treatment of the investments recommended by the Electricity Networks Strategy Group (ENSG) to ease bottlenecks in the power transmission network. The date for full agreement on investments has slipped from early 2010 to April 2011. Agreement by no later than this new date is needed, in order that investments proceed as required to support increased levels of wind generation on the system.
  - Ensuring that the proposed replacement of the Infrastructure Planning Commission does not prevent projects – renewables, or low-carbon infrastructure more generally – progressing in a timely manner through the planning process. Planning has historically been a barrier for low-carbon investments (e.g. nuclear) and continues to be in some cases (e.g. the planning period and approval rates for onshore wind generation are potentially problematic).
  - Progressing the enabling framework for new nuclear investment in a timely manner (e.g. through agreeing a National Policy Statement by the end of 2010 and Regulatory Justification by 2011).
- On CCS, the new Government has committed to support four demonstration plants by 2020. It is important now to conclude the first competition for CCS demonstration, and to commence the second competition for the other demonstration plants. In order to support both competitions, more details on the financing framework for retrofit of CCS should be provided, together with a stronger signal about the limited role for conventional coal generation in the 2020s (e.g. through introducing an emissions performance standard as proposed by the new Government). As part of a coherent approach to fossil fuel generation, the possibility of at least one gas CCS demonstration plant, together with an accompanying emissions performance standard (e.g. for new gas plant added beyond 2020) should

be seriously considered given the potentially important role of this technology in providing a flexible low-carbon generation option.

- The Energy Market Assessment is an important step forward in developing a framework to support investment in low-carbon generation. There is a short window for reform to occur if key investments required for decarbonisation in the 2020s are to go ahead in time. Given the new Government's objective to reform electricity markets, the full range of options available should now be considered in detail, including instruments to provide more certainty over the price paid for, and to require investment in, low-carbon capacity. In light of the continuing low carbon price, the Government's proposed carbon price floor would be useful as a transitional measure to help secure early investments in low-carbon generation, subject to its detailed design.

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

1. Progress reducing emissions
2. Opportunities for reducing emissions – the Committee's power sector indicators
3. Progress investing in renewables generation
4. Progress developing an enabling framework for new nuclear
5. Demonstration of CCS generation technologies
6. Next steps in the Energy Market Assessment
7. The case for a carbon price floor
8. The role for a green investment bank
9. DECC's carbon reduction delivery plan.

1. Progress reducing emissions

Emissions from 1990 to 2008

Power sector emissions fell from 1990 to 1999 due to the dash for gas then increased in the period from 2000 to 2008 as a result of rising electricity demand (Figure 2.1):

- Emissions fell by 28% from 1990 to 1999. Key drivers of emissions were: investment in around 9.5 GW of new gas-fired capacity in the early 1990s which substituted for coal-fired generation (the "dash for gas"); and demand growth averaging around 1.5% annually, partially offsetting the emissions impact of increased gas-fired generation.
- From 2000 to 2008 emissions increased by 9%, as demand continued to rise but the rate of substitution of gas-fired capacity for coal-fired capacity slowed.

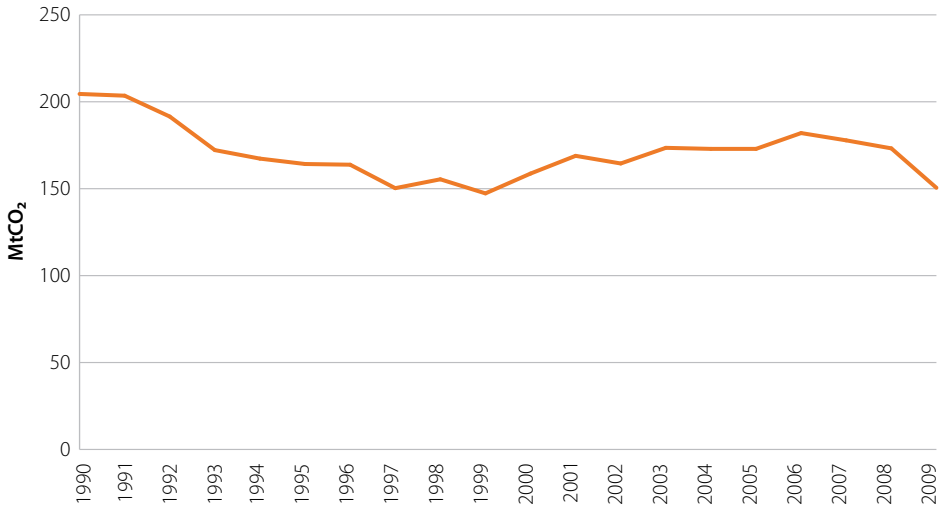
Emissions in 2009

In 2009, emissions fell by 13% due to both a demand reduction and a fall in carbon intensity:

- Electricity demand fell by 7% in 2009, having remained constant in 2008 (Figure 2.2). The 2009 demand reduction appears to be a result of the recession rather than implementation of policies to improve energy efficiency (Box 2.1).
- Carbon intensity of power generation fell from 545 gCO_2/kWh in 2008 to 496 gCO_2/kWh in 2009 (Figure 2.3). This reflects an increase in nuclear generation and a reduction in coal-fired generation, along with a small increase in renewable generation:
  - The share of nuclear generation increased from 13% in 2008 to 19% in 2009 as two plants (at Hartlepool and Heysham 1) which had outages throughout 2008 returned to operation.
  - Due to low gas prices in 2009 and despite a low carbon price, much of the additional nuclear generation displaced coal rather than gas. The share of coal-fired generation fell from 32% in 2008 to 28% in 2009, whilst the share of gas-fired generation remained constant at around 45%.
  - Generation from renewables continued to follow a gradual upward trajectory, increasing its share of total generation from 6.1% to 7.3%.

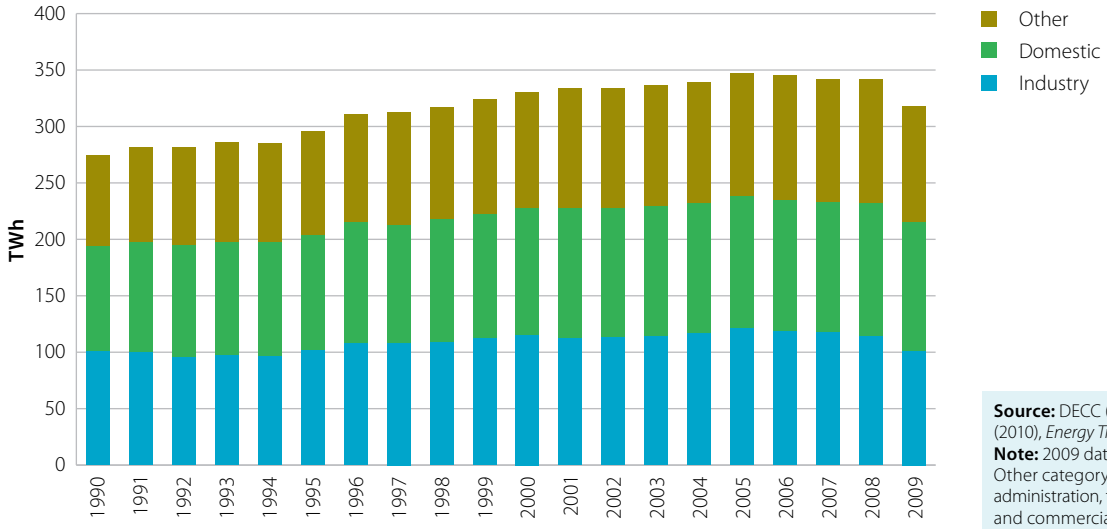
Data on emissions and demand for the first half of 2010 are not yet available. There have been some unplanned nuclear outages since March. However the gas price has remained low relative to the coal price, and investment in renewables has continued to follow a gradual upward trajectory. Overall, emissions intensity is unlikely to have changed significantly in the first months of 2010.

Figure 2.1 CO_2 emissions from power stations (1990-2009)



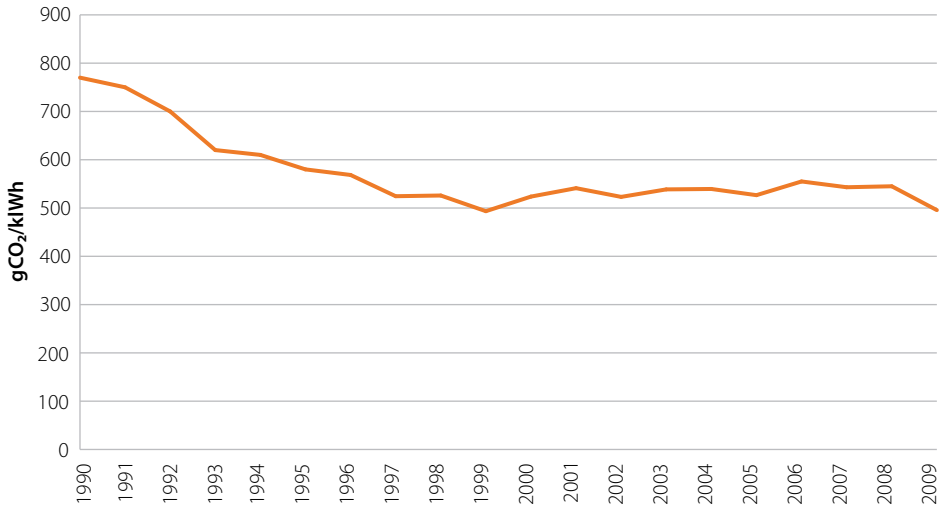
Source: DECC (2010) *Energy Trends March 2010.*
Note: 2009 data are provisional.

Figure 2.2 Electricity consumption (1990-2009)



Source: DECC (2009) *DUKES*; DECC (2010), *Energy Trends March 2010.*
Note: 2009 data are provisional. Other category includes public administration, transport, agriculture and commercial sectors. Electricity consumption is net of energy industry electricity use, and transmission and distribution losses.

Figure 2.3 Carbon intensity of electricity generation (1990-2009)



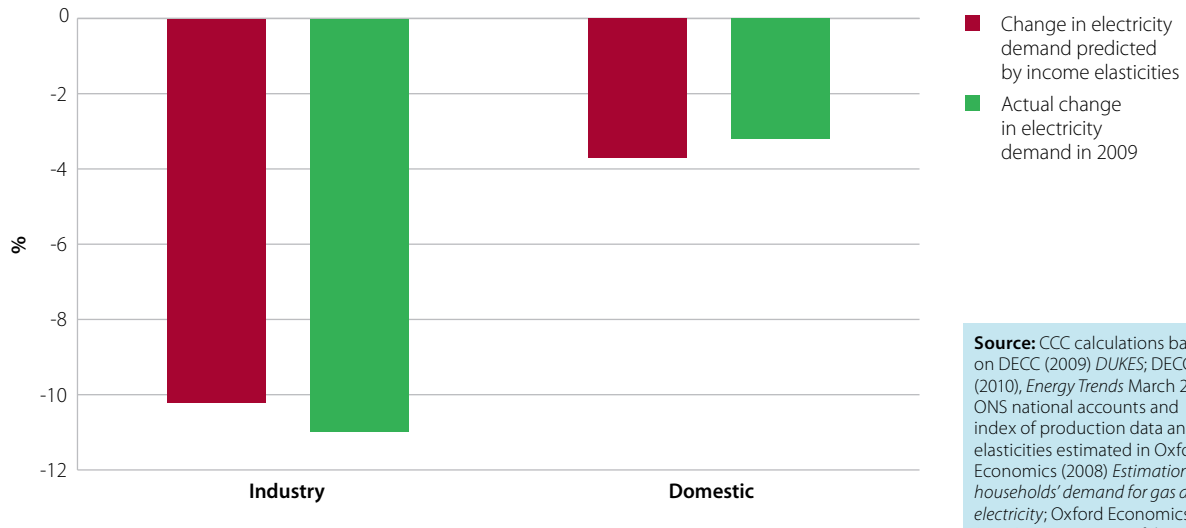
Source: CCC calculations based on: DEFRA (2009) *GHG Conversion Factors*; DECC (2010) *Energy Trends March 2010.*
Note: 2009 data are provisional. Intensity is based on energy supplied from major power producers and all renewable generators and is net of transmission and distribution losses.

Box 2.1 Is the demand reduction due to the recession?

The evidence strongly suggests that the 7% fall in electricity demand in 2009 was primarily due to the recession:

- As set out in Chapters 1 and 3, policies to increase energy efficiency and reduce electricity demand have not yet had a significant impact in the domestic and industrial sectors.
- Elasticities estimating the relationship between income and demand for electricity predict the outturn fall in demand relatively well (Figure B2.1).

Figure B2.1 Estimated change in emissions due to the recession compared to actual change (2008- 2009)



Source: CCC calculations based on DECC (2009) *DUKES*; DECC (2010), *Energy Trends* March 2010; ONS national accounts and index of production data and elasticities estimated in Oxford Economics (2008) *Estimation of households' demand for gas and electricity*; Oxford Economics (2008) *Re-estimation of the BERR Energy Demand Model.*

Achievable emissions intensity

Given that carbon intensity fluctuates year-on-year depending on carbon prices, fossil fuel prices and plant outages, it is useful also to consider underlying progress towards sector decarbonisation as indicated by achievable emissions intensity (the least-emissions dispatch to meet demand based on the current capacity mix).

Achievable emissions intensity improved by 13% (to 336 gCO_2/kWh from 383 gCO_2/kWh in 2008). However, only a very small part of this reduction (around 2 gCO_2/kWh) was due to addition of new low-carbon capacity, with the bulk of the reduction due to a fall in demand (meaning that existing low-carbon capacity can service a greater proportion of demand), and construction of new gas-fired capacity (which can substitute for coal) (Figure 2.4).

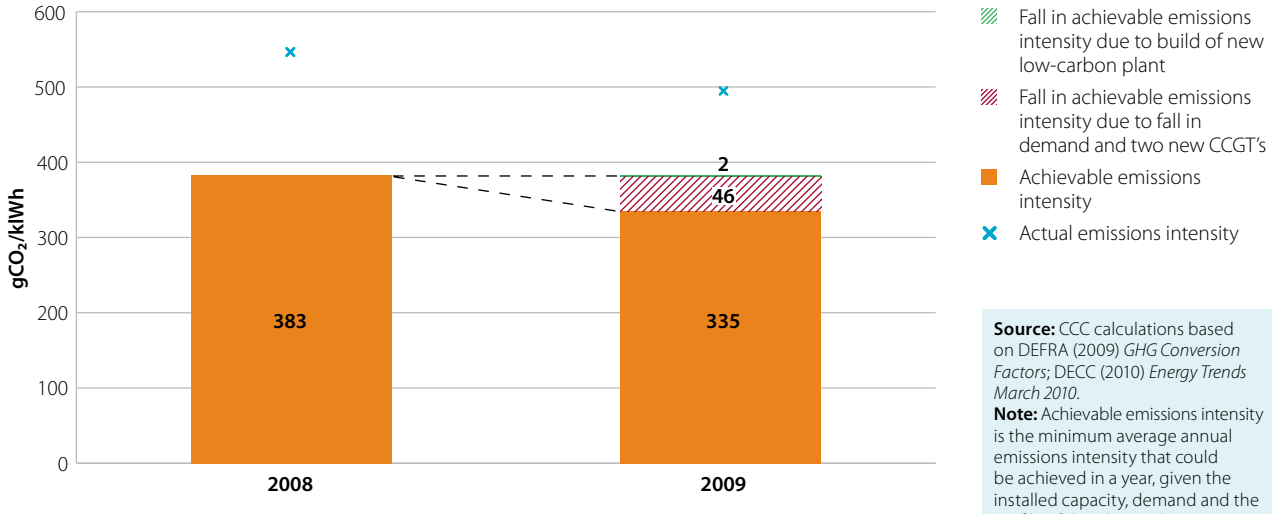
Going forward, it is crucial that low-carbon generating capacity is rolled out, so that electricity sector emissions are put quickly on a sustained downward path and so that the power sector is almost fully decarbonised by 2030 with low-carbon generation extended to transport and heat sectors.

2. Opportunities for reducing emissions – the Committee's power sector indicators

The Committee's power sector indicators are anchored in a high-level trajectory designed to put the UK on a path to substantially decarbonise the power sector by 2030, as required to meet the UK's 2050 emissions target to reduce economy-wide emissions by 80% relative to 1990 (Box 2.2). While it is just one of a number of possible scenarios for meeting carbon budgets, this scenario is based on technical and economic analysis of what is feasible and desirable in the period to 2020 in the context of longer-term objectives. It reflects falling levels of conventional coal-fired generation, with new investment in renewables, nuclear and CCS generation, and includes (Figure 2.5 and Figure 2.6):

- 23 GW of new **wind** capacity between 2008 and 2020: wind generation offers the best opportunity for early decarbonisation of the power sector because it is the only low-carbon technology that is ready for large scale deployment now.
- Up to three new **nuclear** plants by 2022: nuclear new build is a cost-effective form of low-carbon generation.
- Four **CCS** demonstration plants by 2020: CCS is likely to be a crucial technology for deployment in the 2020s, both in the UK and internationally.

Figure 2.4 Achievable emissions intensity (2008-2009)



Source: CCC calculations based on DEFRA (2009) *GHG Conversion Factors*; DECC (2010) *Energy Trends March 2010.*
Note: Achievable emissions intensity is the minimum average annual 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).

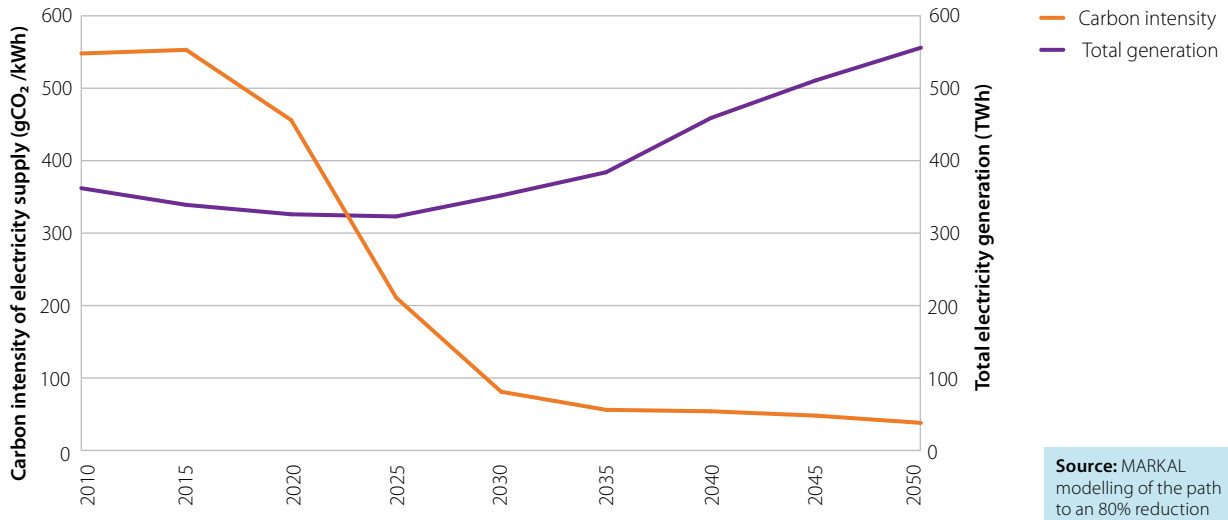
Box 2.2 Why invest in low-carbon generation capacity in the first three budget periods?

MARKAL analysis carried out for our 2008 report suggests that the most cost-effective way to meet our 2050 reduction target involves significant decarbonisation of the power sector by 2030 alongside electrification of heat and transport (Figure B2.2).

Electricity generation capacity has long lifetimes. Plants built in the next decade will be on the system for the next two or three decades. Failure to begin investing in low-carbon plant now risks making the sharp cuts required in the 2020s much more difficult or expensive.

While in theory the first three budgets could be met by investing in gas-fired generation alone during the 2010s, by 2020 this would result in a power system dominated by gas-fired generation – with up to around 40 GW of gas generation on the system alongside around 8 GW of renewables and around 5 GW of old nuclear. The system would be left highly exposed to the risk that fitting CCS to gas plant is more difficult or costly than expected (and to the risk of a higher than currently expected gas price). Our scenarios for the first three budget periods therefore include significant investment in low-carbon plant.

Figure B2.2 Indicative scenario for declining carbon intensity and increasing generation of electricity to 2050

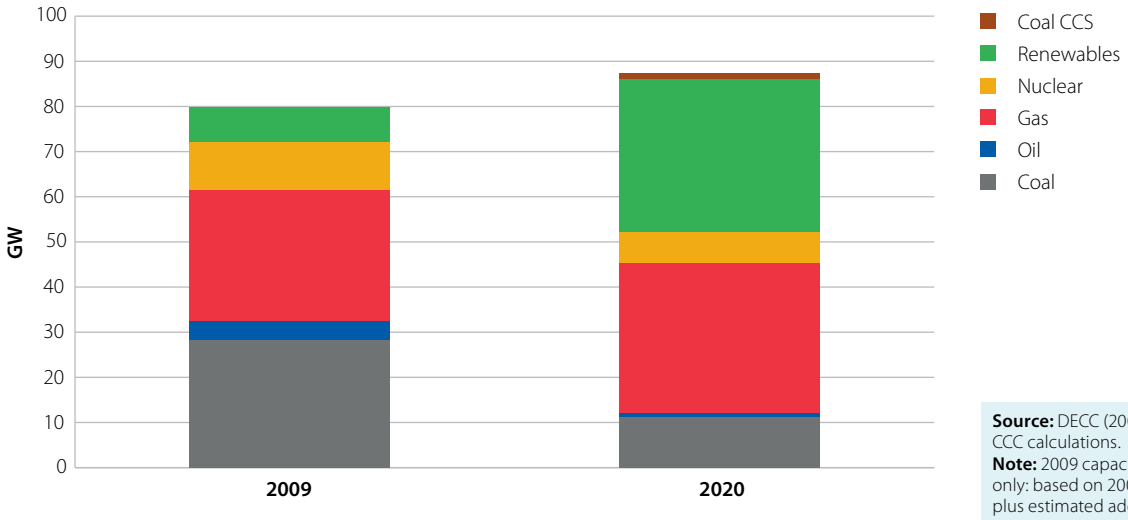


Source: MARKAL modelling of the path to an 80% reduction in UK domestic energy CO_2 emissions, for the CCC by AEA, 2008.

Our indicators underpin the emissions trajectory by setting out timings for key stages of the project cycle for these investments, and for enabling investments in the power transmission network, and policy milestones:

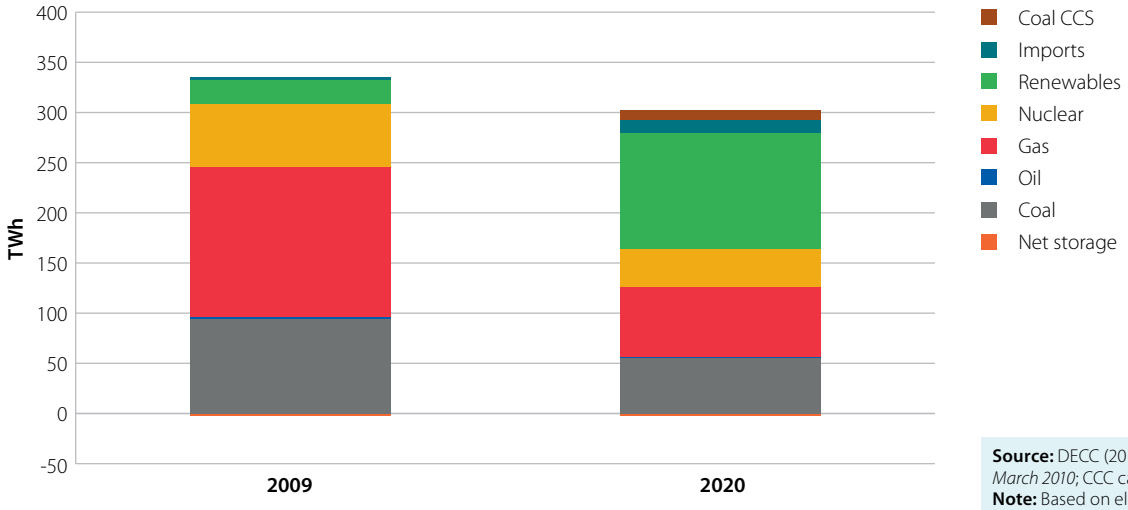
- **Renewables:** Our renewables indicators involve timelines for projects entering planning and construction and new capacity coming onto the system.
- **Transmission:** For transmission, indicators include agreement on key aspects of the regulatory regime (e.g. agreement of a new transmission access regime), and indicators relating to the project cycle for investment in onshore and offshore grids.
- **Nuclear:** Indicators for nuclear relate to the planning and regulatory framework, and to commencement and completion of construction for the first new plant to come on the system.

Figure 2.5 Indicative CCC scenario for capacity mix in 2020 compared to actual capacity mix in 2009



Source: DECC (2009) *DUKES*; CCC calculations.
Note: 2009 capacity is approximate only: based on 2008 DUKES data, plus estimated additions of new CCGT and renewables. Capacity is on nameplate basis. Renewables in 2020 are made up of 27 GW of wind and 7 GW of other renewables.

Figure 2.6 Indicative CCC scenario for generation mix in 2020 compared to actual generation mix in 2009



Source: DECC (2010) *Energy Trends March 2010*; CCC calculations.
Note: Based on electricity supplied. Based on gross supply of electricity (generation net of own use) from all major power producers and all renewable generators.

- **CCS:** Indicators for CCS cover development of an enabling framework and milestones for the CCS demonstration projects, covering both the first competition under which one demonstration plant will be financed, and the second competition under which a further three plants will be financed.

We now apply the indicator framework to understand whether this important programme of investment is on track, or if there is any evidence of slippage which could then be remedied before it undermines necessary sector decarbonisation. The Committee's indicator framework and outturn data for 2009 are summarised in Table 4.1 at the end of the chapter.

3. Progress investing in renewables generation

Adding capacity

Key actions in our indicator framework for renewable electricity in 2009 were:

- Addition of around 0.7 GW new wind capacity, of which 0.4 GW would be onshore and 0.3 GW offshore wind.
- Around 1.4 GW wind capacity entering construction, of which 0.9 GW would be onshore and 0.5 GW offshore.

Progress for adding new capacity has been largely as expected:

- 0.4 GW onshore wind and 0.1 GW offshore wind entered full operation in 2009; wind generation rose from 2.0% to 2.6% of total generation.
- There was a small delay in delivering Robin Rigg, a 0.2 GW offshore wind project, but this has come on to the system in the early months of 2010. The delay was due to difficulties accessing effective installation vessels and worse than expected weather conditions.

It is not clear whether the indicator for capacity entering construction has been achieved, because reliable data are not available. This is a particular problem given that we have previously identified a bottleneck as projects are given planning approval but do not proceed into construction (e.g. at the time of our 2009 progress report, 7 GW of capacity had planning approval but had not entered construction). Therefore DECC – as part of its wider monitoring framework (see Section 9 below) – should collect data on projects entering construction in order to be able to identify any issues at this stage of the project cycle.

Progress also been made at an earlier stage of the project cycle, in tendering offshore sites with the announcement in January 2010 of the winning bids from the Crown Estate's Round 3 which aims to deliver up to 32 GW of offshore wind capacity in addition to the 16.4 GW already licensed to date (10 GW in Rounds 1 and 2 including recent extensions, 6.4 GW in Scottish Territorial Waters).

Whilst our indicators focus on the project cycle for wind generation we also include up to 4 GW of new non-wind renewables by 2020 in our scenario. There are signs that there has been some progress towards this level:

- Generation from non-wind renewables increased from 4.1% of generation in 2008 to 4.7% of generation in 2009.
- Data on the new build capacity contributing to this increase will be available in July 2010[1].
- A joint DECC/industry Marine Action Plan was published in March 2010 and 1.2 GW of sites in the Pentland Firth were licensed for wave and tidal energy for delivery by 2020.

1 DECC, *Digest of UK Energy Statistics*, available at http://www.decc.gov.uk/en/content/cms/statistics/publications/dukes/dukes.aspx

Planning

Our indicator framework recognises the central role of the planning regime supporting investment in renewable generation, and focuses on three key areas:

- **Capacity entering planning**: the stock of projects in planning at the beginning of 2009 was around 6.8 GW (5.8 GW onshore and 1.0 GW offshore). Our indicator framework is based on an assumption that this stock should be maintained, with new applications balancing approvals. In 2009, a further 3.2 GW onshore and 1.4 GW offshore wind capacity entered the planning process, and 1.4 GW onshore were determined, raising the stock of projects awaiting planning consent to 10.0 GW (7.6 GW onshore and 2.4 GW offshore).
- **Planning period:** Planning approval has historically been and is currently slow, and should be accelerated if ambitious targets for investment in wind generation are to be achieved:
  - In 2009 the average planning approval period across on and offshore wind remained at 15 months – above the 12 months in our indicators, and well above the statutory target (16 weeks for onshore).
  - The average planning period for larger projects (over 50MW) has increased to 41 months.
- **Capacity receiving approval:** Evidence from RenewableUK suggests that approval rates for projects at the Local Planning Authority level fell to 53% by MW in 2009, relative to 68% in 2008[2].

Progress has therefore been mixed, particularly as regards approvals and the planning period. Going forward, Government should ensure that the planning process is fully aligned with objectives to significantly increase the level of renewable generation, particularly as regards onshore wind, where there have been difficulties to date in achieving timely planning approval. In particular, the proposed abolition of the Infrastructure Planning Commission in its current form should not adversely impact the efficiency of the planning system.[3]

Transmission

Our indicators highlighted the need for progress developing the regime for transmission network access and investment in 2009 and 2010. Specifically:

- Investments to reinforce the onshore transmission network (Stage 1 as set out in the 2009 ENSG report) should be agreed early in 2010[4].
- An enduring access regime for onshore transmission should be in place by mid-2010.
- A transitional offshore regime should be in place from mid-2009, and operational from 2010.
- The first offshore connections under an enduring regime should take place in 2010.

There has been progress against these indicators, with a need for more to ensure transmission is not a barrier to roll-out:

- Ofgem has approved pre-construction costs for all of the Stage 1 improvements identified by the ENSG, but is awaiting further information before it will approve the full construction costs for all of these projects. The earliest that incentives will be agreed for these is now April 2011.
- The current transitional access regime ("Connect and Manage") is to be made permanent in June 2010. This should allow new generators to connect to the grid in the interim before the network is fully upgraded.

2 BWEA (now RenewableUK), (2009) *Wind Energy in the UK: State of the Industry Report*, available at http://www.bwea.com/ref/reports-and-studies.html

3 The Government aims to bring forward legislation next year to replace the IPC with a unit within the Department for Communities and Local Government. The processes of the IPC will be retained but final decisions on nationally significant infrastructure projects will be made by the relevant Secretary of State.

4 ENSG (2009) *Our Electricity Transmission Network, A Vision for the Future*, http://www.ensg.gov.uk/assets/ensg_transmission_pwg_full_report_final_issue_1.pdf

- A transitional offshore transmission regime was put in place in 2009, with an enduring regime due to follow in summer 2010 (subject to resolution of current disagreements on specific design). Given progress with the offshore enduring regime, it seems likely that the first connections under that regime could take place later in 2010.

The main potential area of concern on transmission is slippage in full approval for Stage 1 investments in the transmission network recommended by the ENSG. This poses a risk to investment in renewables, given current network bottlenecks. Therefore it is a priority that early agreement is reached on these investments in order that they proceed and become operational from 2015, to support increased levels of wind generation.

Supply chain

Whilst we did not set out indicators for development of the renewable supply chain, we highlighted this as a risk to investment and committed to track progress in this area. There have been at least four notable advances in this area:

- GE, Mitsubishi and Siemens have announced plans to manufacture offshore wind turbines in the UK.
- There are some indications of expanded production facilities within the UK for blades, towers, and service vessels, for example, in February 2010, work to construct Clipper's new blade factory in Tyneside began.
- Additional installation vessels for offshore turbines are now under construction – according to recent announcements, at least nine have been ordered by companies active in the UK.
- £60m of funding was allocated in the March 2010 Budget for the development of port sites to meet the needs of offshore wind turbine manufacturers looking to locate new facilities in the UK.

Overview

Progress in 2009 towards adding new renewables capacity has been largely in line with the modest ambition in our indicators, but with some possible concerns for the future:

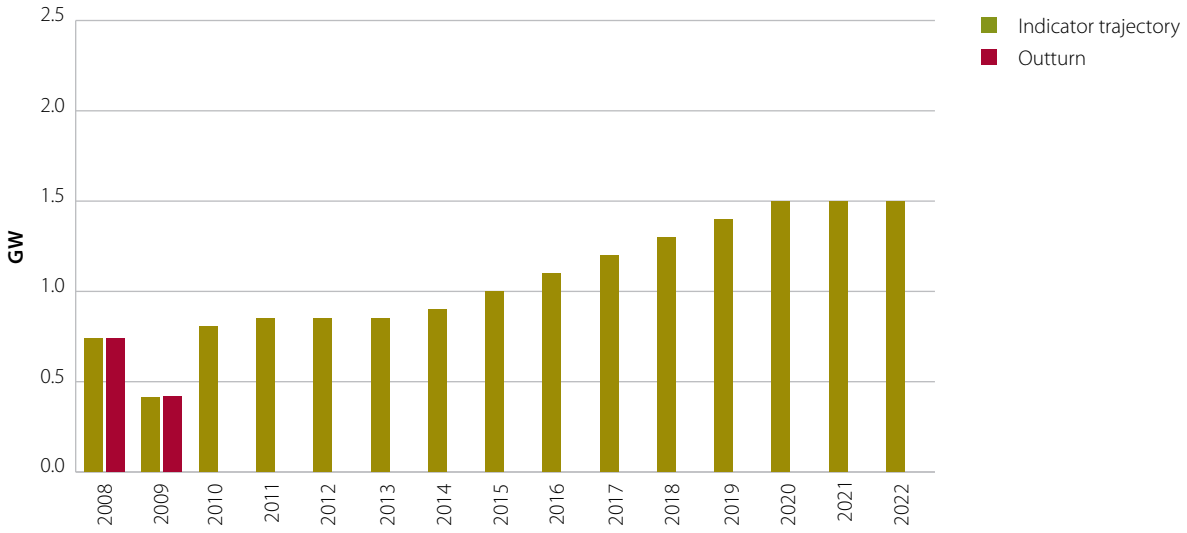
- Delivery of projects is broadly in line with our assumptions. This is expected, given that we set our indicators in October 2009 when the progress of projects for that year was already fairly well known, and given that levels of assumed investment were relatively low in the context of what is required to 2020.
- The large number of projects entering planning and the increases in supply chain capacity appear positive for the longer-term. However, reduction of the planning period and increased approval rates are required to provide more confidence that there will be a sufficient flow of projects moving into construction.
- The enabling framework on transmission and planning has developed largely in line with the requirements we identified. However, there is an issue around approval of investments in the transmission network recommended by the ENSG , which should be addressed promptly to ensure that this does not pose risks for investment in renewable generation.

Going forward, the required scale of delivery will increase rapidly (over 3 GW of new wind capacity will be required annually in the third budget period) and the risk of slippage may increase (Figure 2.7 and Figure 2.8). The priority now is to prove the effectiveness of the new frameworks in practice to ensure projects in development reach operation and to increase the pace of delivery in line with our indicator trajectories.

Devolved Administrations

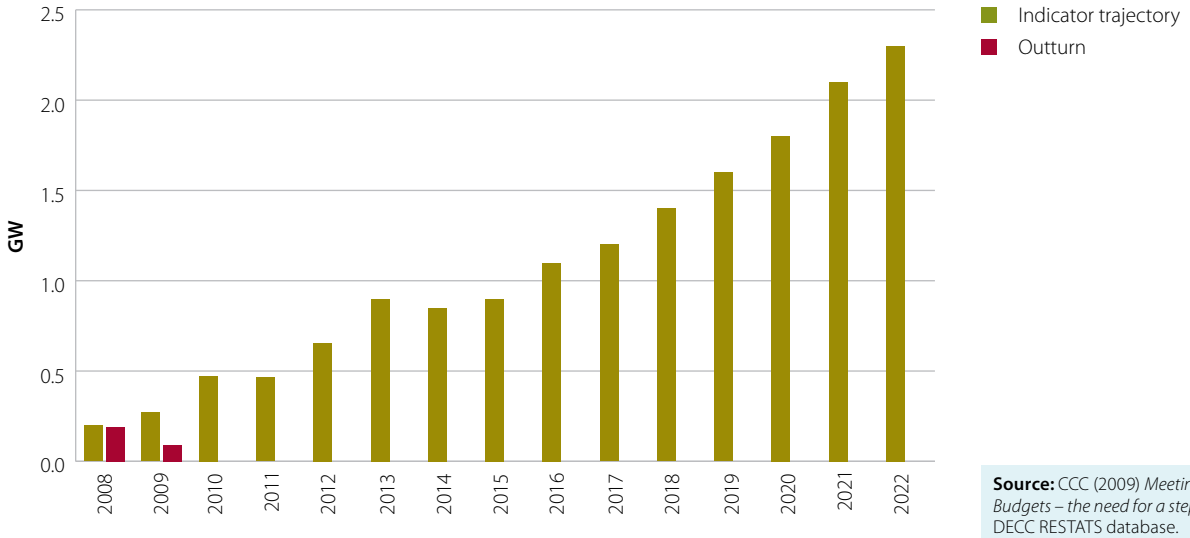
Our indicator set relates to the UK as a whole, but we note that targets and progress across the Devolved Administrations differ. Box 2.3 highlights some of the key developments.

Figure 2.7 Additional operational onshore wind capacity installed per year (2008-2020)



Source: CCC (2009) *Meeting Carbon Budgets – the need for a step change*, DECC RESTATS database.

Figure 2.8 Additional operational offshore wind capacity installed per year (2008-2020)



Source: CCC (2009) *Meeting Carbon Budgets – the need for a step change*, DECC RESTATS database.
Note: An additional 0.2 GW became operational in the early months of 2010.

Box 2.3 Progress and targets across Devolved Administrations

Renewable targets

The Devolved Administrations have set ambitious targets for renewables including:

- **Scotland** – 50% of electricity demand to be met from renewables by 2020 and interim target of 31% by 2011.
- **Wales** – To generate around 48 TWh per annum (more than twice the amount of electricity consumed in Wales in 2008) from renewables by 2025.
- **Northern Ireland** – 12% of electricity consumption to be met from indigenous renewable sources by 2012 and 15% of that to be from non-wind sources. The latest Strategic Energy Framework proposes that 40% of electricity is generated from renewables by 2020.

Current renewable capacity

In 2008, 22% of gross electricity consumption in **Scotland** was generated from renewables. There are sufficient approved projects to increase capacity from the current 4 GW to around 7 GW, which would meet the 2011 target of 31% renewable generation if all are built and connected in time.

As at October 2009 renewable capacity either operational or consented amounted to around 2 GW of capacity in **Wales**, primarily from on and offshore wind.

As of December 2009, renewable electricity represented 8.5% of electricity consumption in **Northern Ireland**. The Department of Enterprise, Trade and Investment (DETI) expects the 2012 target to be achieved, primarily from onshore wind.

Future prospects

While onshore wind is expected to account for the majority of capacity to meet near-term targets, offshore renewables are set to play a greater role in the Devolved Administrations in future:

Scotland – Agreements announced by the Crown Estate over 2009 and 2010 could lead to 11 GW of offshore wind capacity in Scottish waters. The construction phase of Round 3 agreements (which account for 5 GW of installed capacity in waters off Scotland's coastline) is scheduled to begin in 2014, with the first sites operational in 2018. Full construction leases for the additional 6 GW within Scottish Territorial Waters (STW) can be awarded once developers have carried out site-specific environmental assessments and a Strategic Environment Assessment (SEA) by the Scottish Government is complete. Following an environmental and technical assessment the Scottish Government is proposing to progress the STW sites and launched a public consultation on the SEA in May 2010.

In March 2010, The Crown Estate announced leasing agreements for ten marine sites (for six wave and four tidal projects) with potential installed capacity of over 1 GW in Scotland's Pentland Firth and Orkney waters, marking one of the world's largest planned developments of wave and tidal energy.

Wales – In March 2010, in its Energy Policy Statement, the Welsh Assembly Government set out its aim to increase capacity to 23 GW by 2025 largely through investment in offshore wind (to 2015-17) and marine (tidal range, tidal stream and wave, through the early 2020s).

A cross-government project investigating options for tidal range power in the Severn continues. An initial phase, completed in 2009, produced a shortlist of five options following public consultation. Phase 2 assesses these in more detail, taking into account economic, social and environmental impacts, with a further public consultation to take place later in 2010 before a decision on whether or not to take forward one or more of these schemes.

Northern Ireland – In March 2010 DETI completed a consultation on its Offshore Renewable Energy Strategic Action Plan for 2009-2020. It sets the framework for future rounds of commercial leasing by the Crown Estate and proposes that at least 600 MW of offshore wind and 300 MW tidal resources are developed in Northern Ireland waters by 2020.

An experimental turbine in the waters of Strangford Lough is currently demonstrating tidal technology with success. The 1.2MW prototype tidal energy convertor has so far achieved a capacity factor of 66% and delivered 800 MWh into the grid, making it the world's first commercial scale project of its kind to generate to a national grid.

Transmission

The Beauly to Denny transmission line upgrade was approved in January 2010. This is an important milestone in providing greater and more reliable capacity for the transmission of Scotland's renewable potential. The consent requires that construction of the line must begin within four years, and that electricity transmission should begin within six years of the start of construction.

4. Progress developing an enabling framework for new nuclear

Key near-term actions in our indicator framework for new nuclear capacity include the following actions to facilitate investment:

- Completion of the Regulatory Justification process (early 2010),
- Agreement of a nuclear National Policy Statement (2010),
- Agreement on regulations for a Funded Decommissioning Programme covering back-end waste and decommissioning costs (2010),
- First application for planning approval (2010),
- Progress on regulatory approval of new reactor designs (2011).

Good progress has been made against these milestones to date. Delivery of each of the enabling actions to the timescales set out in our indicator framework will now depend largely on the decisions of Ministers and Parliament:

- **Regulatory Justification:** DECC consulted between November 2009 and February 2010 on their findings that the AP1000 and EPR nuclear reactor designs are justified under UK radiation regulations. A final decision is expected later in 2010, subject to the approval of new Ministers and Parliament.
- **National Policy Statement:** A draft National Policy Statement was released in November 2009 and a final document is expected in 2010, subject to the approval of new Ministers and Parliament.
- **Funded Decommissioning Programme:** Following two years of consultation, guidance on the funding arrangements for decommissioning and waste is expected from DECC in the summer of 2010, alongside a fixed price for the disposal of waste and spent fuel. This should ensure that operators cover the full costs of decommissioning and their full share of waste disposal costs.
- **Approval of new reactor designs:** The two proposed reactor designs are currently being assessed by the Nuclear Installations Inspectorate and the Environment Agency. Subject to the resolution of one design safety issue on each reactor design, it is likely that Design Acceptance Certificates will be issued in 2011.

The first planning application for the construction of a new nuclear plant could be submitted by the end of 2010, though this will depend on progress developing the enabling framework, as well as the extent to which the financial risks to nuclear investors under the current market arrangements are addressed (Sections 6 and 7 below). Government has a key role in creating certainty in the investment climate which could bring forward up to three new nuclear plants to the system in the third budget, and thereby unlock the path to deep decarbonisation through the 2020s.

5. Demonstration of CCS generation technologies

The framework for support of CCS

The final framework for support of CCS demonstration, published in November 2009, largely addresses issues raised in our 2009 progress report:

- **Early review:** There will be a rolling review of CCS viability, reporting by 2018 and setting out the regulatory and financial framework to drive further CCS roll-out. Investment decisions supported by a new framework established in 2018 would result in new CCS capacity added to the system from around 2024.
- **Economic versus commercial viability:** The framework acknowledges that the carbon price may not be sufficient to support retrofit of CCS on partially fitted demonstration plants, and provides scope for additional funding through a levy, as set out in the Energy Act 2010.
- **Limited operation of conventional plant:** the framework states that, subject to CCS being proven, it is envisaged any conventional coal plant will be retrofitted with CCS by 2025, with all new plant fully fitted with CCS from 2020. In the event that CCS is not proven, the review would set out how emissions from any remaining conventional coal plant would be regulated.

The framework therefore provides a good basis for development of CCS technology. However, there are three areas where further strengthening may be required in order both to provide confidence to investors and to facilitate early roll-out of CCS:

- The framework for roll-out of CCS should be developed in tandem with the rolling review in order to support early investment. There should also be scope for early reporting and decision-making in the event that the evidence base – both domestically and internationally – allows this.
- Although there is the possibility that additional support may be available for retrofit of demonstration plants, a clearer commitment may be required in order to provide investor confidence.
- The signal on limited operation of conventional plant beyond the early 2020s could be strengthened in order that the limited future for these plants is fully transparent (e.g. through an emissions performance standard as proposed by the new Government, subject to detailed design questions such as whether the emissions performance standard would allow generation at the level of a CCGT plant, or would be more restrictive).

CCS demonstration projects

Beyond any further strengthening to the framework, there is a need for near-term progress on CCS demonstration projects:

- The first competition awarded funding in March 2010 to the Longannet and Kingsnorth projects for Front End Engineering and Design (FEED) studies, which are expected to be completed within 12 months.
- The second competition will provide funding for three CCS plants and is scheduled to be launched in the second half of 2010.
- The second competition must be started this year and the first competition concluded in early 2011 in order that demonstration plants are on the system by 2016/17, facilitating possible roll-out as required from the early 2020s.

CCS infrastructure

Recognising the possibility of scale economies in the provision of CCS infrastructure, we suggested in our 2009 progress report:

- That bids for oversized pipes be allowed in the first and second demonstration competitions.
- That an infrastructure strategy should be in place prior to roll-out of CCS following demonstration.

The new framework states that developers of new CO_2 infrastructure will be required to consider the opportunity for joint investments prior to seeking approval for construction, and that the Secretary of State will have fallback powers to require such modification. However, it is not clear how this requirement will interface with the bid process (e.g. whether a more expensive bid might be selected on the basis of its location near another project).

The process for developing a strategy for infrastructure development is ongoing, and important steps taken at UK level so far include:

- Publication of DECC's CCS Industrial Strategy,
- Launching of the Office for CCS, which will lead the development of a CCS roadmap for the UK to 2030,
- The start of an Energy Technologies Institute project, which aims to quantify UK CO_2 storage capacity, due to deliver in 2011.

Further work has taken place within Scotland and the English regions (Box 2.4).

The competitive bidding process for the CCS demonstrations will need to make clear how proximity to other sources of CO_2 and the oversizing of CO_2 pipelines will affect a project's chance of selection.

Gas CCS demonstration

For the second competition, there is a question, which the Committee has not considered in detail in previous reports, of whether the demonstration programme should include gas CCS. Although application of CCS to gas plant has been the subject of less focus, it is likely that this will be an important option for at least three reasons (Box 2.5):

- It is economically attractive relative to other low-carbon forms of generation, particularly at low load factors (reflecting a lower capital intensity).
- There is the possibility of low gas prices based on new supply sources (i.e. shale gas, although we note that there are significant uncertainties and outstanding environmental questions here).
- By 2020 there is likely to be at least 30 GW of gas-fired capacity on the system, most of which will be suitable for retrofit with CCS.

Furthermore, there is currently very limited activity to develop gas CCS in other countries (e.g. the planned Norwegian gas CCS demonstration has recently been delayed).

Therefore inclusion of gas CCS within the second CCS demonstration competition should be seriously considered, with the aim to deliver at least one gas CCS demonstration, and possibly more depending on bids received.

Extending an emissions performance standard to cover gas generation (e.g. requiring that CCS is fitted to any new plant built from 2020) would provide a coherent approach to fossil fuel generation. It would be consistent with the path for power sector decarbonisation through the 2020s which requires that the vast majority of investment at this time is in low-carbon generation, and should therefore be considered seriously.

We will include a full assessment of the future role of gas CCS in our advice on the fourth carbon budget, to be published before the end of 2010.

Box 2.4 Developments on CO_2 infrastructure in Scotland and the English regions

Scotland

Opportunities for CO_2 Storage around Scotland, an integrated strategic research study, was published by the Scottish Centre for Carbon Storage in 2009. This study undertook high-level screening and quantification of CO_2 storage sites around Scotland and evaluated transportation and infrastructure options. A key finding of the report was that there is potentially a very significant long-term storage resource (4,600-46,000 $MtCO_2$), particularly in the Central North Sea. A second phase is currently examining North Sea storage potential in more detail.

In March 2010 the Scottish Government and Scottish Enterprise published a *CCS – A Roadmap for Scotland*, which built on this integrated study and set out proposed actions and milestones on CCS in Scotland out to 2030.

English regions

As part of the development of the Hatfield CCS demonstration project, Powerfuel Power Ltd is working with National Grid on the design of a CO_2 pipeline and storage infrastructure for the Yorkshire and Humber region, which was designated a Low Carbon Economic Area in DECC's CCS Industrial Strategy.

In February 2010, One North East published a prospectus for the development of a CCS cluster in North-East England. This identifies the potential for a cluster in the region, with a pipeline taking CO_2 from power stations and industrial plants.

Box 2.5 Application of CCS to natural gas CCGT plant

We have previously set out that carbon capture and storage (CCS) is a set of technologies that are likely to be crucially important at a global level and that the UK can contribute to global mitigation efforts by being at the forefront of CCS demonstration.

In our December 2008 report, we made three key recommendations relevant to CCS:

- Electricity generation should be largely decarbonised by 2030,
- Due to its high carbon intensity, there can be no role for coal-fired power generation without CCS beyond the early 2020s,
- CCS is a globally important set of technologies, and demonstration of a range of CCS options should be undertaken with considerable urgency.

DECC's subsequent strategy increased the number of planned demonstrations to four CCS projects, all of which would be on coal-fired plants, and required any new coal plant to demonstrate CCS on a significant proportion of its capacity.

At the time, there were three key arguments in favour of focusing on coal for CCS demonstration:

- The importance of fitting CCS to the large amount of unabated coal capacity being built globally,
- The high carbon intensity, long life and capital-intensity of coal-fired plant,
- Coal CCS was seen as having considerable advantages over gas CCS both in terms of long-term security of fuel supply and because expected gas price rises would lead to coal CCS being more cost-effective.

While the first two of these arguments remain strong, the emergence of unconventional gas supplies, particularly shale gas in North America, has called into question the previous view that coal is inherently more secure and lower cost than gas for the longer-term.

There are several further reasons why demonstration of CCS on natural gas CCGT plant in the UK is worthy of consideration, outlined below.

Relative costs of CCS applied to gas- and coal-fired plant

While applying CCS to coal-fired generation is often said to be lower cost than its application to gas plant, it is important to understand what is meant by this. It is the metric of 'cost per tonne of CO_2 captured' on which CCS applied to coal appears to be lower cost than that for gas. But this finding is driven by the high carbon intensity of unabated coal-fired plants (i.e. the greater the emissions of the baseline plant used for this calculation, the lower the resultant figure for the cost per tonne abated). But an unabated coal plant is not a valid baseline from which to make this calculation for new generating capacity, as such a plant is incompatible with the UK's emissions targets and would not be allowed to operate unabated even in the near term.

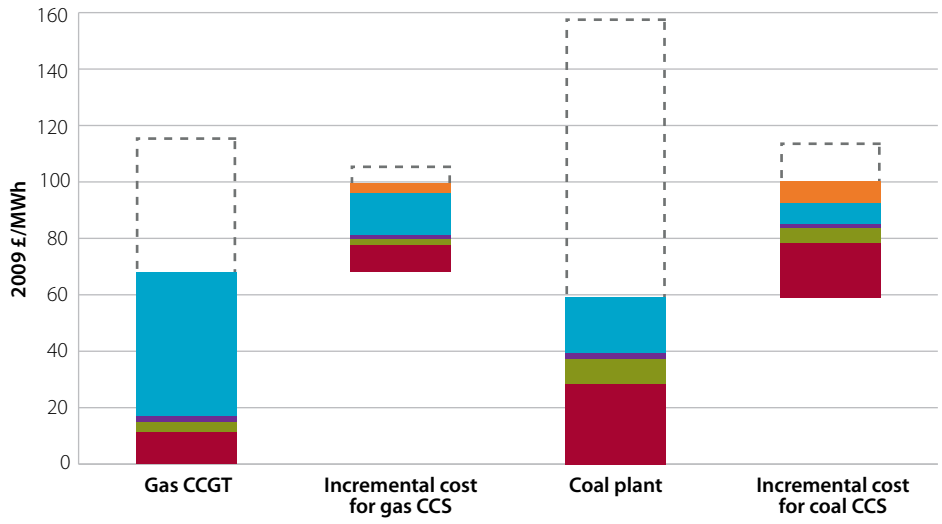
Instead, the appropriate comparison between coal CCS and gas CCS – and indeed any other generating option – is the cost per MWh generated, taking into account the carbon costs of any CO_2 emitted. As the chart shows, the incremental cost of adding CCS to a gas plant is less, per MWh generated, than that for coal (Figure B.2.5). Indeed in terms of total cost per MWh, gas CCS appears to be lower cost than coal CCS once the carbon costs of the residual emissions are included, although it is important to note that technology cost and fuel price estimates are inherently uncertain.

The relative cost advantage of gas CCS improves at lower load factors, as it is less capital-intensive than coal CCS. This is likely to make gas CCS well-suited to a more flexible role in a power system that includes high proportions of intermittent renewables and in which the electrification of heat means that electricity demand has a significant seasonal component. The emergence of unconventional gas may also limit future rises in the price of gas (e.g. the UK wholesale price may not increase from today's level of around 40p per therm to the DECC central scenario of 74p by 2030), further improving the attractiveness of gas CCS. We will set out these issues in more detail in our report on the fourth carbon budget, at the end of 2010.

Gas CCGT capacity on the UK power system

There is already around 24 GW of gas CCGT capacity on the UK power system, the vast majority of which is likely to still be running after 2020. Much of this

Figure B2.5 Incremental costs of adding CCS to gas- and coal-fired plants



Source: CCC runs of the DECC levelised costs model, based on data from Mott Macdonald (2010) *UK Electricity Generation Costs Update.*
Note: Costs presented for new-build 'nth of a kind' plants commencing operation in 2030. Central DECC fossil fuel prices and technology costs assumed; operation at baseload (90% load factor); 10% discount rate.

capacity is potentially suitable for retrofit with CCS[5], despite not being covered by the recent carbon capture readiness requirements.

Even with success in reducing electricity demand via energy efficiency and with new-build of renewables and nuclear, we would expect some further gas CCGT capacity to be added during the 2010s (e.g. the 8 GW of new gas plant indicated in the scenario in our October 2009 report) to maintain security of supply in a period in which a large amount of capacity will retire[6]. It is reasonable to expect the capacity of gas CCGT to exceed 30 GW in 2020, which presents a considerable opportunity to increase the amount of low-carbon capacity by retrofitting CCS.

Technical differences between CCS demonstration on coal- and gas-fired plant

The challenges of applying post-combustion CCS to gas-fired plant are different to those for a coal plant. While the flue gas from a coal-fired plant would be likely to contain more acid gas, the flue gas from a natural gas CCGT plant would have a lower concentration of CO_2 – increasing the difficulty of its capture – and also a higher concentration of oxygen, which can degrade the solvent used to capture the CO_2.

It is therefore important that post-combustion CCS technologies for both coal and gas are demonstrated, as well as other CCS options. We note that CCS demonstration activity globally is focused on coal-fired plant and that planned gas CCS demonstrations in Norway have recently been delayed, so there is a particular need to initiate gas CCS demonstration projects.

Signal that fitting CCS to gas-fired capacity will be important

To date, requirements for CCS demonstration and constraints on future unabated operation have applied only to coal plant and not to gas. These regulations, combined with the electricity market arrangements that favour investment in CCGT capacity, have created a structural bias towards investment in gas-fired plant. In addition to the essential reform of the electricity market arrangements, demonstrating CCS on gas and possibly extending the emissions performance standard to cover gas (e.g. for new plant added from 2020) would provide an indication that CCS will eventually be needed on CCGT capacity, helping to rebalance the relative risks.

5 Analysis for the CCC by Element Energy, Amec and Carbon Counts suggests that around 85% of existing CCGT capacity would be potentially suitable for retrofit of CCS, despite not having been required to be capture-ready. This work will be published on the CCC website.

6 A considerable amount of existing capacity is expected to be retired by 2020, either due to age (mainly nuclear and coal-fired plants) or specific regulations such as the Large Combustion Plant Directive or Industrial Emissions Directive (mainly coal and oil-fired plants).

6. Next steps in the Energy Market Assessment

In our 2009 progress report we set out analysis suggesting that, given the various risks for low-carbon investments under current electricity market arrangements (uncertainties over carbon price, fossil fuel price, electricity price, etc.), there are plausible scenarios where required investment in low-carbon generation to meet carbon budgets through the 2020s does not ensue, with investment flowing instead to gas-fired generation (Box 2.6).

There is a need to decarbonise electricity as part of broader economy-wide decarbonisation, both due to direct emissions reduction in the electricity sector and through extension of low-carbon electricity to transport and heat.

We therefore proposed that current arrangements should be reviewed and a new approach introduced to deliver low-carbon generation at least cost (e.g. through improving the investment climate and therefore reducing the cost of capital) and to enhance security of supply (e.g. by securing investment in new capacity and by reducing reliance on imported gas).

We argued that this review should take place in the near term given the need for early decisions on investments in projects with long lead times. We recommended three sets of options for consideration:

- **Measures to strengthen the carbon price signal** – for example, an extension of the exemption from the Climate Change Levy (CCL) to all new low-carbon generators or a carbon price floor.
- **Measures to provide confidence over the price received by low-carbon generation** – for example feed-in tariffs or tenders for low-carbon capacity.
- **Measures to ensure investment in low-carbon capacity** – for example an emissions performance standard or a low-carbon obligation.

In response to this, the Energy Market Assessment (EMA) was launched in December 2009 and reported back alongside the March 2010 Budget. The EMA concludes that current market arrangements are not fit for purpose to deliver required low-carbon investments, and considers at a high level five possible interventions:

- Minimum carbon price guarantee (e.g. through contracts for difference on the carbon price).
- Additional incentives for low-carbon generators above the carbon price (e.g. a low-carbon obligation, premium feed-in tariffs or contracts for difference on the electricity price).
- Regulation to directly limit high-carbon generation (e.g. legislation to directly limit investment in unabated fossil fuelled plant, or a requirement to accompany each GW of investment in unabated fossil fuelled plant with a certain amount of low-carbon investment).
- Long-term payments to low-carbon generators to provide revenue certainty (e.g. fixed feed-in tariffs, competitive tendering for low-carbon generation or regulation of an appropriate return).
- Establishment of a single agency to purchase all electricity generation and to sell to retailers.

The EMA concludes that carbon price strengthening alone and the single buyer model are unlikely to provide an appropriate enduring solution, and commits to consider other options in more detail as part of a review towards a White Paper in Spring 2011. Additional options and variants of the above options may need consideration. Proceeding with this process to the planned timescale will be crucial if low-carbon investment is to be delivered on a timely basis.

7 Redpoint (2009) *Decarbonising the GB power sector,* http://hmccc.s3.amazonaws.com/docs/FINAL%20Decarbonising%20the%20GB%20power%20sector_v1.pdf

Box 2.6 Problems with the current market arrangements

Current market arrangements were designed for a system with excess capacity and where most new investment was expected to be in gas-fired generation. However, in order to meet the 2050 80% emissions reduction target, large amounts of investment in intermittent, inflexible and capital-intensive low-carbon generation capacity will be required.

Under current arrangements, going forward, the electricity price would continue to be driven by the volatile gas and EU ETS allowance prices, and would become increasingly peaky as the proportion of inflexible and intermittent plants increased.

Low-carbon technologies have higher capital costs and lower marginal costs than conventional technologies. Exposure to a volatile price makes high-capital cost investments more risky to investors, (particularly in comparison with gas-fired generation whose fuel costs tend to be well correlated with the wholesale electricity price).

Increased price volatility would therefore disproportionately increase the risks for investors in high-capital plant. However, given the commitment to decarbonise, the only risks relevant to society are those associated with the costs of the alternative low-carbon technologies (i.e. risks associated with capital and fuel costs and operational characteristics of that technology). This mismatch between risks to private investors and society means that investors may invest more in gas-fired generation than is appropriate on a path to decarbonisation.

We commissioned Redpoint in 2009 to investigate this issue further.[7] Their modelling suggested that under current market arrangements, if investors perceive the market to be risky, or if they do not expect high carbon prices to materialise in the future, failure to reduce emissions, and very high electricity prices to consumers are likely to result.

Moving to a low-carbon power sector may thus stretch the current market arrangements to the limit, putting progress to decarbonisation at risk, and exposing consumers to higher costs than necessary.

The EMA concurs with Ofgem's Project Discovery, which concluded that changes to current arrangements will be required both to support investment in low-carbon generation and to maintain security of supply (Box 2.7).

It is also consistent with the new Government's objective to reform electricity markets to bring on investment in low-carbon power (Box 2.8).

The Committee will present new analysis of the path for electricity investment through the 2020s, and high-level implications for levers to drive required investments, as part of advice on the fourth carbon budget, to be published before the end of 2010 and to feed into the new Government's work on electricity market reform.

Box 2.7 Summary of Project Discovery

Project Discovery (Ofgem, 2010) identifies a number of serious challenges associated with providing secure, sustainable energy to 2020 and beyond:

- Huge levels of investment are needed (up to £200bn in the electricity and gas sectors by 2020) under a climate of risk and difficult financial conditions.
- Uncertainty in future carbon prices is likely to delay or deter investment in low-carbon technology increasing future costs of decarbonisation.
- Short-run prices in the market do not reflect the value consumers place on security of supply.
- Interdependence with international markets exposes the system to a range of additional security of supply risks.
- Increasing costs of gas and electricity could adversely impact on consumers and competitiveness.

The project concludes that leaving current arrangements unaltered would not be in the interest of consumers, and is likely to lead to a failure to deliver required renewables investment, and could put security of supply in jeopardy (either by increasing the UK's dependence on imported gas, or by failing to delivery any capacity to fill the post-2015 gap).

The project sets out five packages of interventions for consultation. These packages cover similar ground to those later set out in the EMA, ranging from supporting the carbon price to a more interventionist approach similar to the single-buyer model. No options are explicitly ruled out.

Box 2.8 Key points on electricity market reform in the Coalition Agreement and party policy papers

The new Government's Coalition Agreement announced the intention to carry out the following reforms:

- Establishment of an **emissions performance standard** that will prevent coal-fired power stations being built unless they are equipped with sufficient CCS.
- Introduction of a **floor price for carbon**.
- **Reform of energy markets to deliver security of supply and investment in low-carbon energy.**

This complements the stated objective in the Conservative energy policy Green Paper (published before the election) to substantially decarbonise the power sector by 2030.

7. The case for a carbon price floor

In Chapter 1 we discussed the impact of the recession on the traded sector and concluded that the carbon price is likely to remain low for the foreseeable future. This is reflected in low prices since our 2009 progress report and latest market estimates of the carbon price in the period to 2020 (see Chapter 1).

The Energy Market Assessment suggested that strengthening the carbon price alone would not be an appropriate solution to mitigating the various risks associated with current electricity market arrangements (see Section 6 above).

However, there is a useful transitional role for the new Government's proposal to strengthen the carbon price, to support investment decisions to be taken over coming months (e.g. for new nuclear to come on stream during the third carbon budget period), and before a market review is completed.

Whilst ideally a price floor would be set at EU level, it is unlikely to be practical to introduce an EU instrument on the timeframe required to support low-carbon investments in the UK.

Effectiveness of a national policy instrument will depend on detailed design. In particular, this should deliver a target carbon price well into the future, which together with the EU ETS will be sufficient to support investment in low-carbon power generation.

Factors to be considered in setting the precise level of the carbon price floor should include:

- The projected carbon price under an EU 30% GHG emissions reduction target for 2020.
- The level of support required for *new* low-carbon generation (as opposed to existing generation, which should not benefit from windfall profits) under various assumptions about fossil fuel prices.
- The present value of the marginal abatement cost associated with meeting the 2050 target in the Climate Change Act to reduce emissions by 80%.

The Government announced in the June 2010 Budget that it will consult on the design of a carbon price floor in the autumn.

8. The role for a green investment bank

In our 2009 progress report we highlighted the possible risks for meeting carbon budgets due to the credit crunch and the impact that this could have on financing of investments in renewable electricity. We suggested that this was an area that required monitoring with possible intervention (e.g. a Green Infrastructure Bank could be established to raise finance and lend to low-carbon investments) if it were shown to be the case that adequate financing was not forthcoming.

More generally, it will be important to remove barriers to investment and reform electricity markets in order to make projects bankable (set out in Sections 3-7 above). For example, it is important that any changes to the current renewables incentive regime are made in a way which minimise uncertainty for investors.

However, even with a very favourable policy environment, the availability of capital may also be an issue given the large scale of investments required over the next two decades:

- A large step up in investment in highly capital-intensive renewables, especially offshore wind, is needed before 2020. Total investments required to 2020 are estimated in the HM Treasury/DECC's Energy Market Assessment to be of the order of £110-120 billion.
- Beyond 2020, significant increases in capacity will be required in order to ensure the sector is largely decarbonised in the period to 2030. In order that investments proceed as required, and given long project lead times (e.g. for new nuclear plant), investment decisions will be required from the beginning of the second carbon budget period (i.e. from 2013).

Since our 2009 progress report, a number of steps have been made towards the establishment of a Green Investment Bank:

- In March 2010 a Strategy for National Infrastructure was published by the Treasury and Infrastructure UK. This included an assessment of financing needs, which concluded that there was a risk of insufficient equity finance for large, complex infrastructure projects, including renewable electricity investments. In response to the identified finance gap, the intention to establish a Green Infrastructure Investment Bank was announced, with an initial aim to participate in equity financing of offshore wind projects.
- In February 2010, the Conservatives set up a Green Investment Bank Commission, with the aim of advising on the set up of a Green Investment Bank which could both consolidate public funds currently divided across disparate Government initiatives and leverage private sector capital to invest in low-carbon technologies. The Commission's recommendations are due to be published in summer 2010.

- The Coalition Agreement of the new Government sets out the intention to set up a Green Investment Bank and to develop green financial products to provide individuals with opportunities to invest in the infrastructure needed to support the new green economy.

Given the scale of the investment required to 2020 and beyond, and the urgency in getting investment on track now, it is important that the full range of financing options are considered, and that there is close monitoring of commercial appetite for financing low-carbon projects. As announced in the June 2010 Budget, the aims and activities of the proposed Green Investment Bank will be considered further by Government and detailed proposals will be put forward after the Spending Review in autumn 2010.

As part of our advice on the fourth carbon budget to be published before the end of 2010, the Committee will set out our analysis of the required path for emissions reduction in power generation. Together with a high-level assessment of options for power market reform, this would provide evidence which could be used to identify any possible role for the Green Investment Bank in financing structures of investments to come on stream in the 2020s (e.g. to the extent that risks are not fully mitigated by market design, or that there are other structural barriers to financing).

9. DECC's carbon reduction delivery plan

DECC have published an indicator framework covering the decarbonisation of the power sector, which sets out the investments required to drive emissions reduction, and the policies and milestones which are required to facilitate them (Box 2.9).

The focus in DECC's framework is consistent with our indicators, covering the range of promising technologies for power sector decarbonisation (i.e. nuclear, renewable and CCS), with a broadly similar level of ambition for 2020. The framework also covers a full range of enabling actions, such as reform of planning and transmission.

However, the DECC framework lacks trajectories for investment in specific technologies, and therefore does not provide a basis for identifying delivery risks ahead of time. We recommend that this is addressed through inclusion of indicative trajectories against which progress can be assessed and remedial action taken as appropriate.

On policy milestones, we recommend the following additions to the DECC framework:

- **Power transmission:** Further detail on actions and timelines to support onshore and offshore grid reinforcement should be included.
- **CCS:** The current indicator framework could be improved by including indicators for development of an infrastructure strategy, and for gas CCS demonstration.
- **Energy Market Assessment:** Clear timelines for the next stages of this assessment should be set out, including a timeframe for legislation and implementation of new arrangements.

We will continue to report on progress against these milestones together with the full set of power sector indicators in our annual reports to Parliament.

Box 2.9 DECC's indicator framework for power

DECC's Climate Change Action Plan sets out the framework of indicators and milestones which will be used to assess progress in reducing power sector emissions:

Tier 1 indicators: Overall sector GHG emissions

- Absolute level and % change in total and projected CO_2e emissions from the power sector.

Tier 2 indicators: Disaggregated sector GHG emissions

- Absolute level and % change in total CO_2e emissions from generation of electricity by major power producers.

Tier 3 indicators: Main drivers of sector emissions

- Absolute change in final electricity consumption in UK, broken down by sector,
- Absolute change in carbon intensity of UK electricity generation,
- Total existing capacity and generation of UK MPP and absolute change, broken down by source.

Tier 4 indicators: Policy milestones and policy outcome indicators

- Various milestones and policy indicators relating to the Energy Market Assessment, renewables investment, the renewable obligation, feed-in tariffs, new nuclear, CCS, CHP, conventional fossil fuels, energy planning, and grid development.

Contextual indicators

- Security of supply, peak demand, efficiency ratio, gas, carbon and electricity prices, investment climate, temperature and GDP.

Traded sector specific indicators

- Milestones and policy indicators on the EU ETS.

Table 2.1 The Committee's Power sector indicators

POWER		Budget 1	Budget 2	Budget 3	2009 trajectory	2009 outturn
Headline indicators						
Emissions intensity (g/kWh)		509	390	236	526	496
Total emissions (% change from 2007)		-15%	-39%	-64%	-9.4%	-15.1%
Generation (TWh)	Wind	21	50	98	9.7	8.5
	Nuclear	58	30	48	58.3	62.9
	CCS	0	5	11	0	0
Supporting indicators						
Transmission						
Agreement on incentives for anticipatory investment for Stage 1 reinforcements		2010			n/a for 2009	
Implementation of enduring regime for accessing grid		2010			n/a for 2009	
Transitional OFTO regime in place		2009			in place	in place
Enduring OFTO regime in place		2010			n/a for 2009	
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		n/a for 2009	
Grid reinforcemement 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 for 2009	
Grid reinforcemements 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 for 2009	
Tendering for first offshore connections under enduring OFTO regime		2010			n/a for 2009	
Construction of first offshore connections under enduring OFTO regime begins		2011			n/a for 2009	

Table 2.1 The Committee's Power sector indicators

POWER		Budget 1	Budget 2	Budget 3	2009 trajectory	2009 outturn
First offshore connections under enduring OFTO regime operational		2012			n/a for 2009	
Planning						
IPC set up and ready to receive applications		2010				intention to replace IPC announced.
Market						
Review of current market arrangements and interventions that will help deliver low-cost, low-carbon generation investment		to begin in first budget period			to begin in first budget period	review started
Wind						
Generation (TWh)	Onshore	13	26	44	7.0	data not yet available
	Offshore	8	24	54	2.7	data not yet available
Total capacity (GW)	Onshore	5.7	10.8	18.0	3.2	3.2
	Offshore	2.5	7.4	16.6	0.9	0.7
Capacity entering construction (GW)	Onshore	0.9	1.3	1.5	0.4	data not yet available
	Offshore	0.8	1.6	2.6	0.3	data not yet available

*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.

Notes:

1. Numbers indicate amount in last year of budget period i.e. 2012, 2017, 2022.
2. While we present outturn vs. trajectory figures for 2009, it is not our expectation that our trajectories will be achieved precisely for every indicator in every year. There may be some year to year variation, which is acceptable. Similarly it may be the case that some indicators are not met while others are over-achieved; this may still on average constitute sufficient progress. A problem will be signalled however if under-achievement persists, if a large number of indicators are off-track or if specific indicators or milestones which are key to unlocking abatement in the longer term are not met.

Key: Headline indicators Implementation indicators Forward indicators Milestones Other drivers

Table 2.1 The Committee's Power sector indicators

POWER		Budget 1	Budget 2	Budget 3	2009 trajectory	2009 outturn
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	3.2
	Offshore	New planning applications will be expected in line with site leasing			No trajectory	1.4
Average planning period (months)		<12	<12	<12	<12	15
Nuclear						
Regulatory Justification process		2010				on track - consultation carried out
Generic Design Assessment		2011				on track - expected in 2011
National Policy Statement for nuclear (including Strategic Siting Assessment)		2010				on track- draft NPS published
Regulations for a Funded Decommissioning Programme in place		2010				on track - expected in late 2010
Entering planning		first planning application in 2010	subsequent applications at 18 month intervals		n/a for 2009	
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		n/a for 2009	
Construction begins			first plant in 2013, subsequent plants at 18 month intervals		n/a for 2009	
Plant begins operation				first plant in 2018, with subsequent plants at 18 month intervals*	n/a for 2009	
CCS						
Front-End Engineering and Design (FEED) studies for competition contenders initiated		end 2009			initiated	Initiated early 2010

Table 2.1 The Committee's Power sector indicators

POWER	Budget 1	Budget 2	Budget 3	2009 trajectory	2009 outturn
FEED studies for competition contenders completed	2010			n/a for 2009	
Announce competition winner	2010			n/a for 2009	
Second demonstration competition	launch 2010, announce winners 2011			n/a for 2009	
Quantification of saline aquifer CO_2 storage potential		no later than 2015		n/a for 2009	
Review of technology and decision on framework for future support		no later than 2016**		n/a for 2009	
Strategic plan for infrastructure development		no later than 2016		n/a for 2009	
Planning and authorisation approval, land acquisition, and storage site testing completed, construction commences	first demo in 2011	subsequent demos 2012/13		n/a for 2009	
Demonstrations operational		first demo in 2014, subsequent demos 2015/16***		n/a for 2009	
First new full CCS plants supported via the post-demonstration mechanism			2022		
Other drivers					
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					

* 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.

Notes:

1. Numbers indicate amount in last year of budget period i.e. 2012, 2017, 2022.
2. While we present outturn vs. trajectory figures for 2009, it is not our expectation that our trajectories will be achieved precisely for every indicator in every year. There may be some year to year variation, which is acceptable. Similarly it may be the case that some indicators are not met while others are over-achieved; this may still on average constitute sufficient progress. A problem will be signalled however if under-achievement persists, if a large number of indicators are off-track or if specific indicators or milestones which are key to unlocking abatement in the longer term are not met.

Key: Headline indicators Implementation indicators Forward indicators Milestones Other drivers

Chapter 3: Progress reducing emissions from buildings and industry

Introduction and key messages

In our previous reports we identified major opportunities for reducing emissions from buildings and industry through a range of energy efficiency measures. Improving energy efficiency will make a significant contribution to meeting carbon budgets and to offseting energy price impacts from other measures to meet budgets.

In addition, our analysis has suggested scope for significantly increasing the level of renewable heat from current very low levels. Progress on renewable and low-carbon heat can usefully contribute to the first three carbon budgets, and help to prepare for further heat decarbonisation that will be required to meet carbon budgets through the 2020s.

Our indicator framework for buildings and industry, set out in our 2009 progress report, included trajectories for key measures (e.g. lofts and cavity wall insulation, penetration of efficient appliances) and policy milestones (e.g. introduction of new incentives for residential and commercial energy efficiency improvement). In this chapter we consider latest emissions data for buildings and industry and we apply the indicator framework. We conclude that:

- While there have been recent emissions reductions in the buildings and industry sectors, the main driver is likely to have been the recession rather than policy strengthening.
- In industry, emissions remain closely coupled to economic activity, and some emissions bounceback is likely as the economy recovers.
- There has been some progress implementing measures, most notably loft and cavity wall insulation, and boiler replacement. However, overall the pace of progress remains slow relative to what is required to meet the first three carbon budgets.

There have been some positive policy proposals and announcements but further development is required:

- In the context of the new Government's commitment to a 'Green Deal' and early legislation to deliver a National Energy Efficiency Programme, it is important to develop detailed implementing arrangements (e.g. financing arrangements, including the balance between 'Pay As You Save' and other funding arrangements to support the implementation of more expensive measures and energy efficiency improvement for the fuel poor; how homeowners will be encouraged to participate through marketing, pro-active provision of energy audits and financial incentives/standards; the specific roles of local authorities, energy companies and other players; and standards for the private rented sector).
- The Renewable Heat Incentive (RHI) proposals suggest a level of ambition for deployment that is broadly consistent with our analysis, although further consideration of tariff levels for specific technologies may be required. The RHI should be better integrated with the framework for energy efficiency (so as to encourage renewable heat in the context of improved energy efficiency).
- Proposals for the wider roll-out of EPCs and DECs in non-residential buildings would underpin the proposed 'Pay As You Save' scheme for the non-residential sector, and should be taken forward to help unlock significant emission reduction opportunities in this sector. Consideration should also be given to strengthening the compliance framework.

The analysis that underpins these messages is set out in seven sections:

1. Progress reducing emissions
2. Opportunities for reducing emissions – the Committee's buildings and industry indicator framework
3. Residential buildings
4. Non-residential buildings
5. Emissions from industry
6. Low carbon and renewable heat
7. Departmental carbon reduction delivery plans

1. Progress reducing emissions

Emissions from buildings and industry

Emissions from buildings and industry account for around two-thirds of total CO_2 emissions in the UK. They comprise direct (i.e. due to burning of fossil fuels for heating and industrial processes) and indirect emissions (i.e. due to electricity consumption and other indirect fuel use), with direct emissions accounting for around half of total buildings and industry emissions. On a sectoral basis, residential emissions account for the largest share of the total in 2008 (41%), followed by industry (38%), commercial (15%) and public sector (6%) emissions.

Our 2009 progress report showed that emissions from buildings and industry fell by 3% in the five years preceding the first budget (2003 – 2007), with the residential sector accounting for 68% of this reduction.

Our analysis suggesting that emissions would fall further during the recession has been borne out by data for 2008 and 2009:

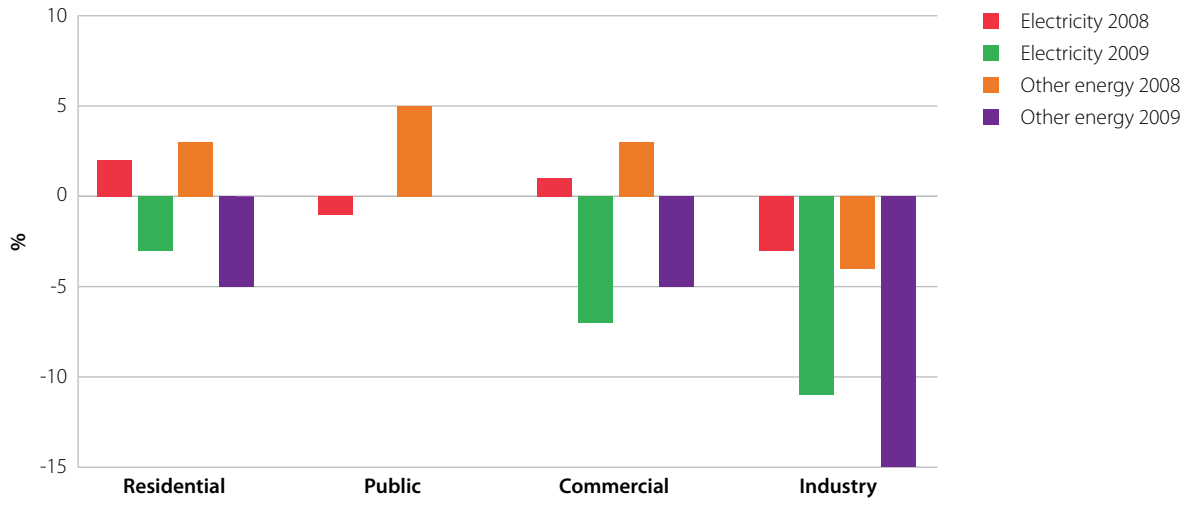
- In 2008 (i.e. before more significant GDP reductions), buildings and industry emissions continued the trend of the previous five years, falling by around 1% year-on-year.
- Provisional 2009 emissions data suggests that significant reductions have occurred over the past year. Specifically, direct emissions fell by 11% and indirect emissions (i.e. from electricity consumption) fell by 13%, due to reduced energy demand during the recession (Figure 3.1) and a 9% reduction in the CO_2 intensity of electricity.

Emissions from residential buildings

Emissions from residential buildings grew by 2% in 2008 and fell by 7% in 2009, with reductions in both direct and indirect emissions (Figure 3.2), due mainly to rising fuel prices and the recession:

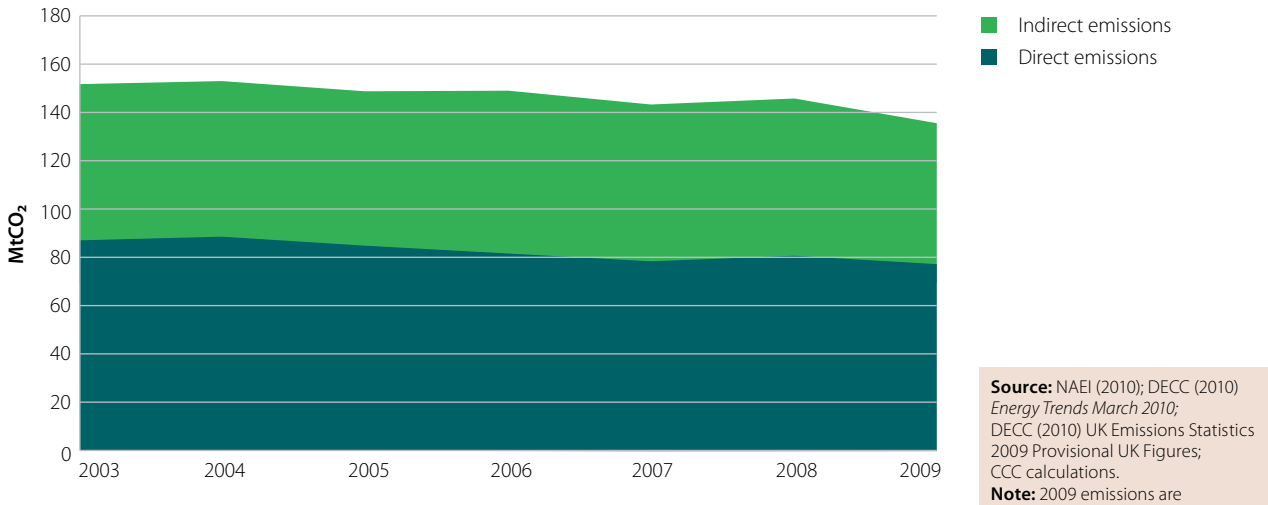
- Direct emissions rose by 3% in 2008 while indirect emissions stayed broadly flat.
- In 2009 direct emissions fell by 5%, while electricity emissions fell by 10%.
- Some savings are attributable to the installation of energy efficiency measures (see section 3). However, this explains only a small part of the observed emissions reduction.

Figure 3.1 Change in energy consumption (2008 and 2009)



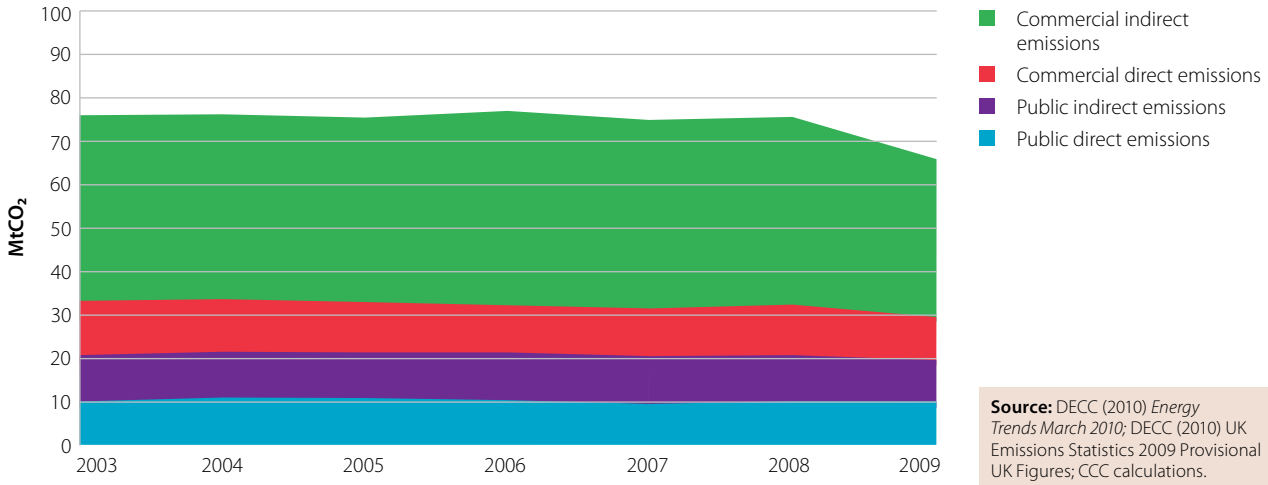
Source: DECC (2010) *Energy Trends March 2010;* CCC calculations.

Figure 3.2 Residential CO_2 emissions (2003-2009)



Source: NAEI (2010); DECC (2010) *Energy Trends March 2010;* DECC (2010) UK Emissions Statistics 2009 Provisional UK Figures; CCC calculations.
Note: 2009 emissions are provisional and based on CCC estimates. Indirect emissions are based on consumption of electricity from power stations only.

Figure 3.3 Non-residential CO_2 emissions (2003-2009)



Source: DECC (2010) *Energy Trends March 2010;* DECC (2010) UK Emissions Statistics 2009 Provisional UK Figures; CCC calculations.
Note: 2009 emissions are provisional and based on CCC estimates. Indirect emissions are based on consumption of electricity from power stations only.

- Therefore it is likely that the 2009 reductions are primarily a result of rising fuel prices (residential gas and electricity prices rose 12% and 3% respectively in real terms) and the recession. While generally residential energy demand is relatively inelastic to income and price, there is evidence that the recession and high fuel prices have resulted in some behaviour change to reduce energy consumption[1].

Emissions from the public sector

In our 2009 progress report, we highlighted the importance of the public sector leading by example. This has been accepted, and reflected in ambitious emissions reduction targets for the public sector. However, and notwithstanding this ambition, there has been little change in public sector emissions in recent years (Figure 3.3).

- Total CO_2 emissions in 2008 were broadly constant.
- A reduction in indirect emissions of around 7% occurred in 2009 as a result of a reduction in the emissions intensity of power generation but direct emissions were broadly unchanged.
- In the period 2003-07, CO_2 emissions fell by 1% with a 5% reduction in direct emissions partially offset by a rise in indirect emissions.

Emissions from commercial buildings

Around 80% of commercial sector emissions are indirect. Prior to the recession, commercial emissions were broadly flat.

In 2008, direct emissions increased by 6%, with indirect emissions remaining flat, and average emissions increasing by 1% (Figure 3.3).

Initial estimates for 2009 suggest significant reductions in 2009, with a reduction of 14% in indirect emissions and 10% in direct emissions. Commercial sector energy consumption fell by around 6%, reflecting reduced GVA of 5%.

Emissions from industry

Industrial emissions fell significantly between 1990 and 2008 (by around 20%) due to fuel switching and industry restructuring, with large reductions in the mid to late 1990s.

Further reductions have occurred since the onset of the recession (Figure 3.4):

- Industry CO_2 emissions fell 4% in 2008, with similar reductions in direct and indirect emissions.
- Provisional estimates suggest that direct and indirect emissions have fallen further in 2009, by 18 and 19% respectively.

Attributing these falls in emissions to specific causes, for example the EU ETS and the recession, is complex and requires further systematic analysis. However, the conjunction of reductions in output and emissions in key UK EU ETS sectors during 2009 suggests that the recession played a key role:

- Output from the manufacture of basic metals (including steel) fell by 19% and emissions from pig iron and steel fell by approximately 14%.
- Output from manufacturing of mineral products (including cement) fell by 13% and emissions from cement, clinker and lime production fell by nearly 30%.

Large reductions in emissions have also occurred across the EU in 2009, compared with flat or rising emissions previously (e.g. 28% fall in emissions from pig iron and steel, and 20% fall in cement, clinker and lime in 2009).

To the extent that emissions reductions have resulted from the recession, there is the potential for some bounceback in emissions as the economy recovers. This will depend on the extent to which there is long-term income reduction, any permanent closure of businesses, lasting fuel switching, energy efficiency improvement, etc.

1 uSwitch (2010) 13 million households go without heating to save on energy bills. *http://www.uswitch.com/news/utilities/13-million-households-go-without-heating-to-save-on-energy-bills-1022/*

However, through the combination of these factors, it is likely that there will be some persistent emissions reductions in some key sectors:

- In the cement sector there have been closures of inefficient plant. Some of the production has been rationalised and moved to other, more efficient cement plants in the UK, which could lead to a persistent emissions reduction.
- In the steel sector, the extent to which closures or mothballing of plant beyond 2010 lead to a persistent reduction in emissions depends upon whether production is moved to other plant, or if plant re-opens in the longer term.

Required emission reductions to 2022

Emission reductions in 2008 and 2009 will contribute towards meeting the first carbon budget. Going forward, our analysis suggests that emissions reductions of around 3% annually will be required across buildings and industry in the period to 2022. Given that emissions reductions in 2008 and 2009 have been largely due to the recession rather than outperformance on measures, a step change in the implementation of measures, especially in residential and non-residential sectors (Figure 3.5, Figure 3.6 and Figure 3.7) will be required if the second and third budgets are to be achieved.

2. Opportunities for reducing emissions – the Committee's buildings and industry indicator framework

In our 2009 progress report we identified a range of opportunities for emission reductions. Based on these and existing government policy commitments, we set out a framework of indicators to help assess progress towards meeting carbon budgets. For buildings and industry these include high level emissions trajectories, with underpinning trajectories for the implementation of measures (in the residential sector), policy milestones for energy efficiency and the penetration of renewable heat (see Table 3.1 at the end of the chapter).

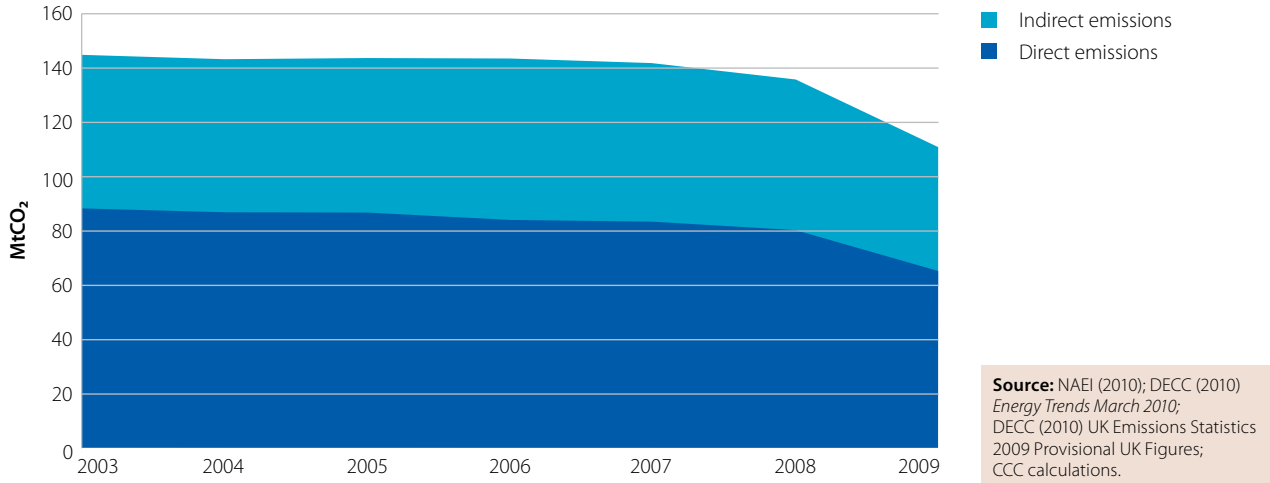
The trajectories were set based on 2007 emissions levels, prior to the recession (Figure 3.5, Figure 3.6 and Figure 3.7). The recession has meant that emissions have fallen by more than we had anticipated. However, the extent to which these emissions reductions will persist over time is not yet clear (discussed further in Chapter 1, Box 1.2).

- **Residential sector:** our analysis suggests that there is scope for emission reductions of 4% annually in the period to 2022, primarily through insulation of lofts, cavity and solid walls, boiler replacement, and increased penetration of efficient appliances.
- **Non-residential buildings:** we estimate that there is scope for emissions reductions of 4% annually in the period to 2022 through the uptake of energy efficiency measures, efficient lighting and less energy-intensive appliances. We are currently reviewing these estimates in the context of the Committee's advice on the Carbon Reduction Commitment (see section 4), to be published in autumn 2010.
- **Industry:** our analysis suggests that there is potential to reduce industry emissions by 2% each year in the period to 2022. This could be achieved through a range of measures such as improvements in the efficiency of electrical machinery, renewable heat applications and heat recovery. However, there are limitations with the current evidence base (see section 5) and we noted in our 2009 progress report that there may be additional abatement available in industry. The Committee will conduct a review of further abatement potential in industry as part of its work for the fourth budget period.
- **Renewable heat:** our analysis suggests that there is realistic scope for emission reductions of 20$MtCO_2$ in 2022 across all sectors through increased penetration of renewable heat technologies such as heat pumps and biomass boilers. This is broadly consistent with the ambition in the Renewable Energy Strategy to achieve renewable heat penetration of 12% by 2020, which would save around 17 $MtCO_2$.

Implementation of all the identified measures, including renewable heat, would result in around 3% annual emissions reduction from buildings and industry. Together with appropriate contributions from other sectors this would deliver carbon budgets.

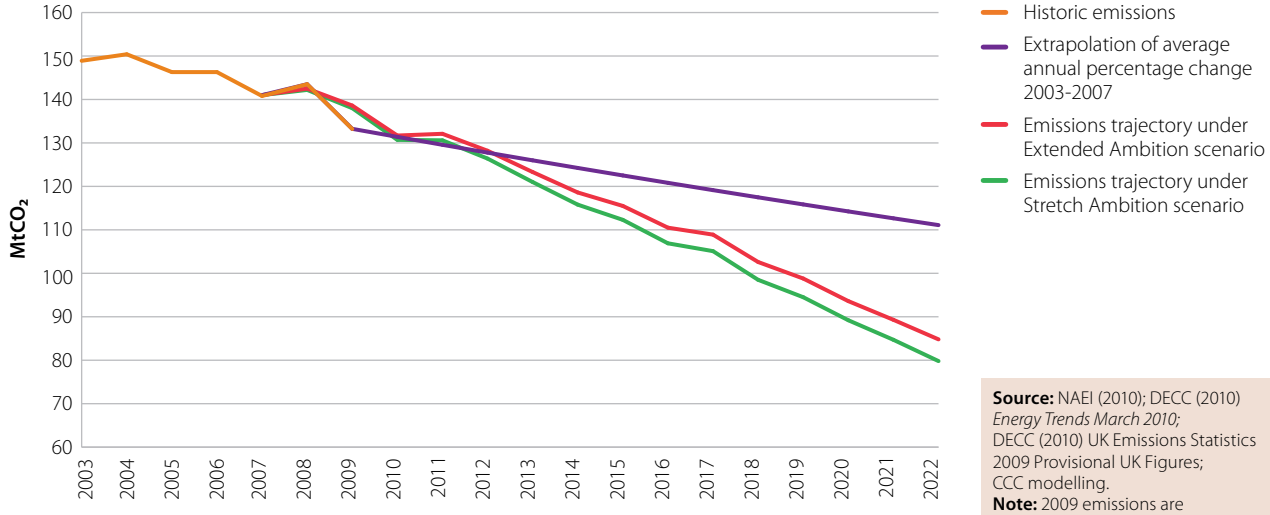
We now consider the extent to which the implementation of key measures and policy developments in 2008 and 2009 are consistent with the required trajectories.

Figure 3.4 Industrial CO_2 emissions (2003-2009)



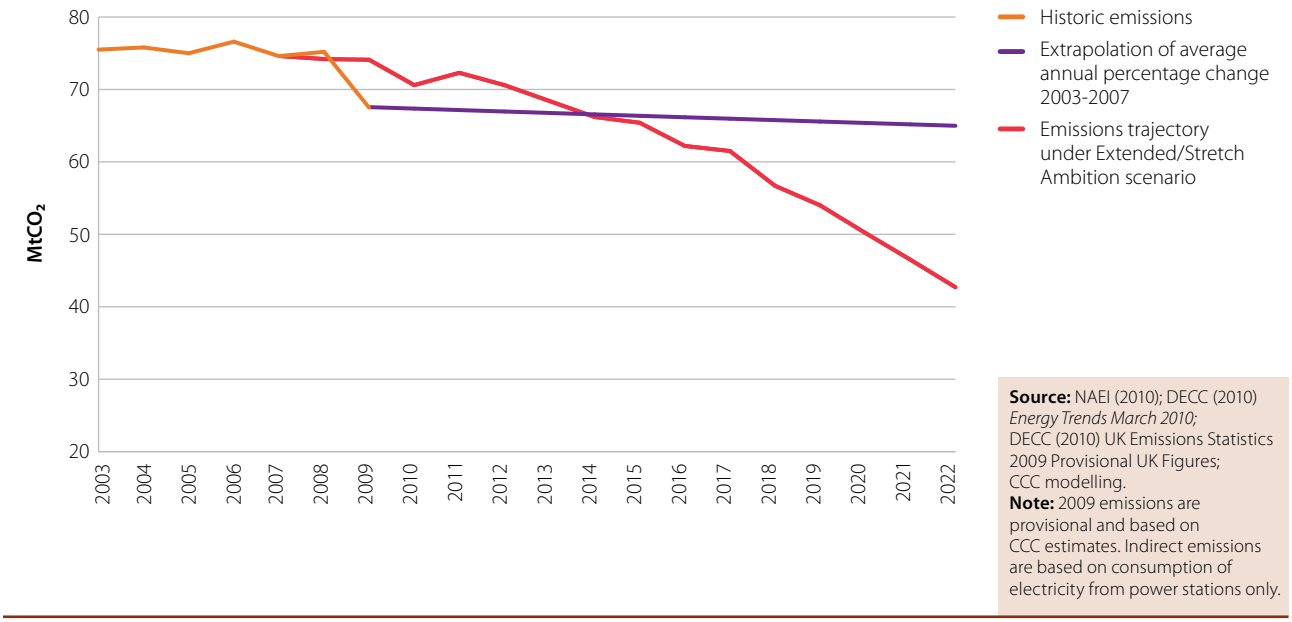
Source: NAEI (2010); DECC (2010) *Energy Trends March 2010;* DECC (2010) UK Emissions Statistics 2009 Provisional UK Figures; CCC calculations.
Note: 2009 emissions are provisional and based on CCC estimates. Indirect emissions are based on consumption of electricity from power stations only.

Figure 3.5 Recent residential CO_2 emissions and reductions required under CCC scenarios (2003-2022)



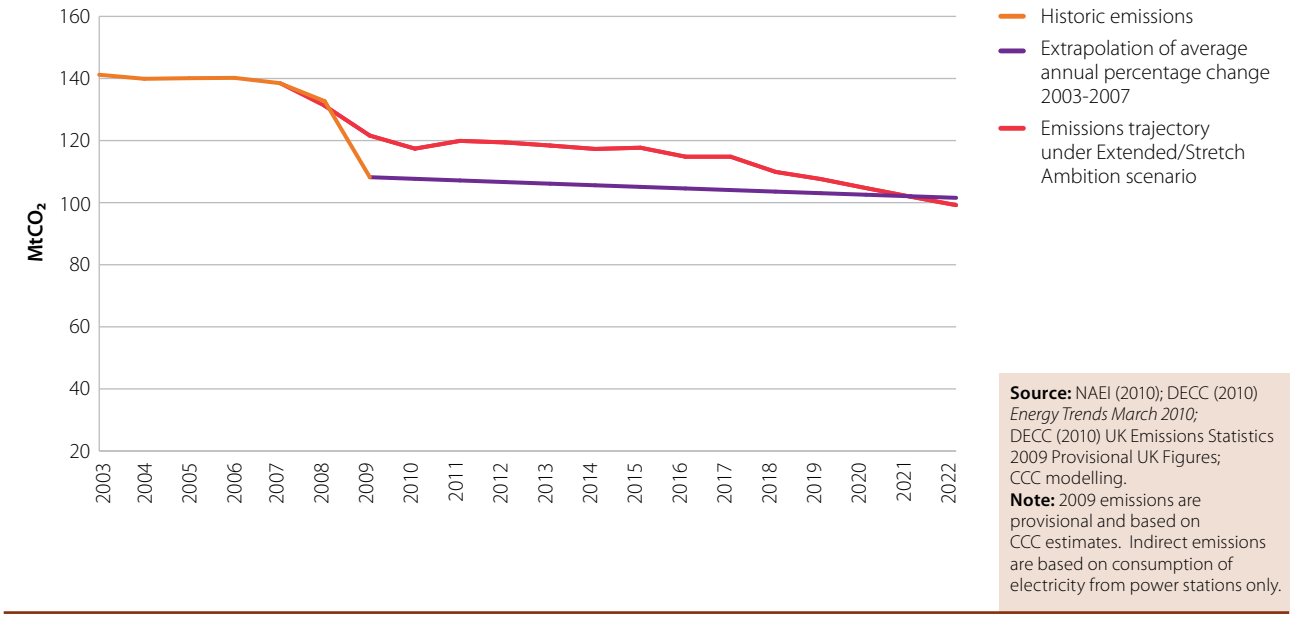
Source: NAEI (2010); DECC (2010) *Energy Trends March 2010;* DECC (2010) UK Emissions Statistics 2009 Provisional UK Figures; CCC modelling.
Note: 2009 emissions are provisional and based on CCC estimates. Indirect emissions are based on consumption of electricity from power stations only.

Figure 3.6 Recent non-residential CO_2 emissions and reductions required under CCC scenarios (2003-2022)



Source: NAEI (2010); DECC (2010) *Energy Trends March 2010;* DECC (2010) UK Emissions Statistics 2009 Provisional UK Figures; CCC modelling.
Note: 2009 emissions are provisional and based on CCC estimates. Indirect emissions are based on consumption of electricity from power stations only.

Figure 3.7 Recent industrial CO_2 emissions and reductions required under CCC scenarios (2003-2022)



Source: NAEI (2010); DECC (2010) *Energy Trends March 2010;* DECC (2010) UK Emissions Statistics 2009 Provisional UK Figures; CCC modelling.
Note: 2009 emissions are provisional and based on CCC estimates. Indirect emissions are based on consumption of electricity from power stations only.

3. Residential buildings

Implementation of energy efficiency measures

The uptake of energy efficiency measures is a key part of meeting the first three carbon budgets. The Carbon Emission Reduction Target (CERT) remains the main delivery instrument, with some additional delivery from fuel poverty schemes (primarily Warmfront), the Community Energy Saving Programme (CESP) and Devolved Administration schemes (Box 3.1).

Box 3.1 Devolved Administration residential energy efficiency schemes

Scotland

The Scottish Government provides £45.9 million in 2010-11 for the Energy Assistance Package to improve energy efficiency in fuel poor households. It has also increased funding for the Home Insulation Scheme's second year of operation. An additional £10m will take funding for 2010/11 to £25m and support a new universal access scheme offering free insulation measures to around 90,000 homes. In addition, a recent pilot offered energy efficiency loans for householders worth over £2 million. The Scottish Government's consultation on its Energy Efficiency Action Plan was launched in late 2009 and the Plan is due to be finalised in 2010.

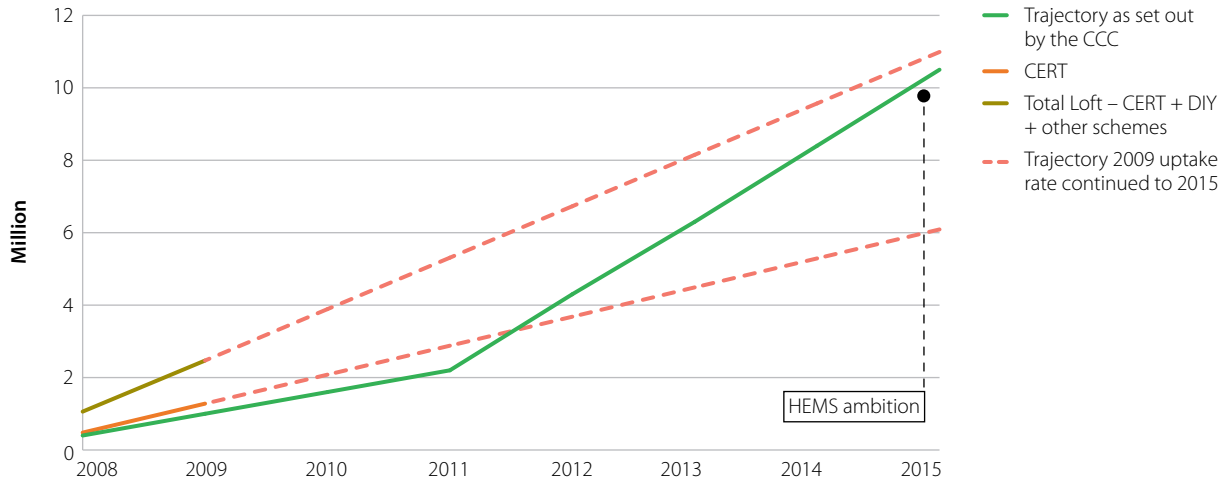
Wales

In May 2010, the Welsh Assembly Government launched the £30 million 'arbed' scheme aimed at reducing fuel bills and emissions in 6000 homes by March 2011. The first phase will see an average of £2.5 million spent every month to retrofit exterior wall insulation, solar panels and heat pumps in at least 21 schemes across Wales' regeneration areas. The project also aims to create new green jobs and boost the energy efficiency and renewable energy industry in Wales. Following a consultation, the Government is due to publish its Energy Efficiency Action Plan later in 2010.

Northern Ireland

The revised Northern Ireland Sustainable Energy Programme commenced in April 2010. Whilst the scheme is primarily focused on alleviating fuel poverty (including 34% of total funding ring fenced for whole house measures, including solar water heating and biomass boilers), the scheme is also available to business customers. The scheme's predecessor, the Energy Efficiency Levy, provided funding of just under £6m in 2008/09 which supported 21 projects resulting in carbon savings of around 149,000 tonnes.

Figure 3.8 Loft insulation cumulative installations (2008-2015)



Source: OFGEM CERT data; DECC estimates; CCC calculations.

Insulation measures

There has been some progress insulating lofts and cavity walls in 2009, and very limited progress insulating solid walls:

- Between 2008 and 2009, the rate of professional loft installation measures under CERT increased by 68% to 0.8 million, while cavity wall installations increased by 15% to 0.6 million.
- According to DECC figures, loft insulation (including DIY and other schemes such as Warmfront) totalled 1.4 million installations in 2009, an increase of one-third over 2008. However, there is considerable uncertainty around the number of DIY installations and to what extent there has been double-counting of loft insulation material subsidised under CERT.
- If loft insulation continues at the 2009 rate of installations (and provided there is no double-counting), it will meet the required trajectory for the period to the end of 2015 (Figure 3.8). However, as a progressively larger proportion of lofts has been insulated and there are fewer 'low hanging fruit', it will become increasingly challenging to maintain such a high number of installations.
- For cavity walls, while the current annual installation rates are broadly on track, they would have to more than double from 2012 to meet our trajectory of 8 million installations between 2008 and the end of 2015 (Figure 3.9). However, DECC has to date only committed to insulating 75% of the cavity-walled homes (see below) which translates to a much lower ambition of around 4 million.
- The pace of solid wall insulation under CERT has picked up a little, although installation rates were still only around 15,000 in 2009. Installation rates need to increase rapidly to achieve the required 2.3 million by 2020 (Figure 3.10).

Therefore, to meet the first three carbon budgets, acceleration is required in the pace of cavity wall insulation and particularly solid wall insulation. For lofts, the current pace needs to be sustained at a minimum, with acceleration required depending on the extent to which there is double counting between professional and DIY installations.

We note that since the publication of our insulation indicators in the October 2009 progress report, DECC has clarified its ambition to insulate all lofts and cavities 'where practicable' by 2015. While we interpreted 'where practicable' as 90% of 2005 remaining potential, DECC is currently aiming at 85% and 75% of all lofts and cavities respectively.

Given the uncertainty over evidence underpinning these potentials, we will continue to measure progress against our (more ambitious) indicators. We will also work with DECC to better understand their lower level of ambition, and what implications this might have for the level of ambition of other measures (e.g. does this imply that a larger number of homes need solid wall insulation in order to achieve carbon budgets).

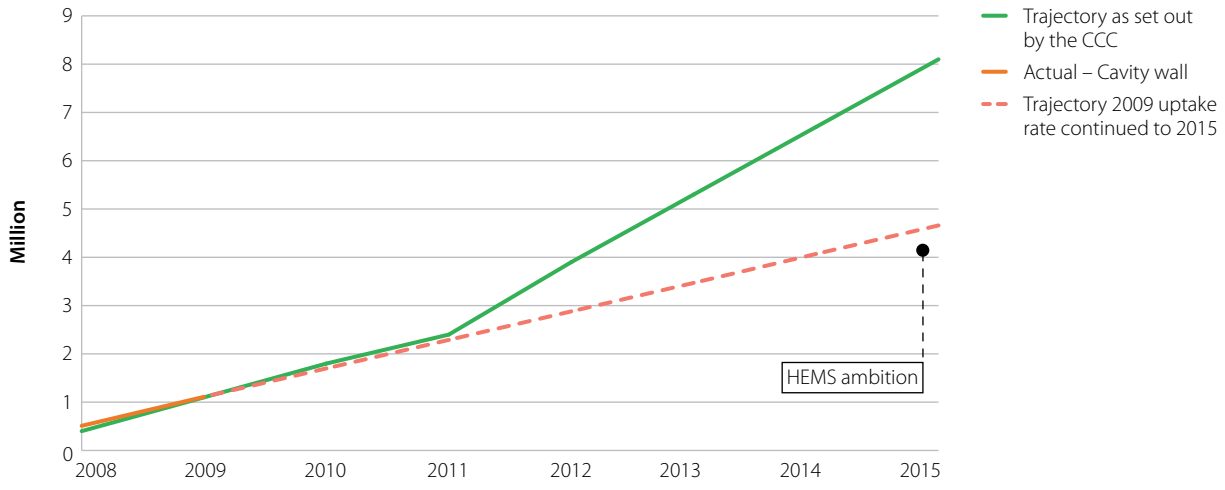
Boiler replacement

Sales of A rated energy efficient boilers in 2008 and 2009 were around 1.2 million per annum. This is ahead of our trajectory set out in October 2009. If uptake continues at these rates, there could be scope for replacement of an additional 4 million boilers by 2022 (i.e. over and above the 12 million that we assumed, (Figure 3.11). Since early 2010, boiler replacement has benefited from several boiler scrappage schemes (Box 3.2) which may accelerate replacement rates.

Box 3.2 Boiler scrappage schemes

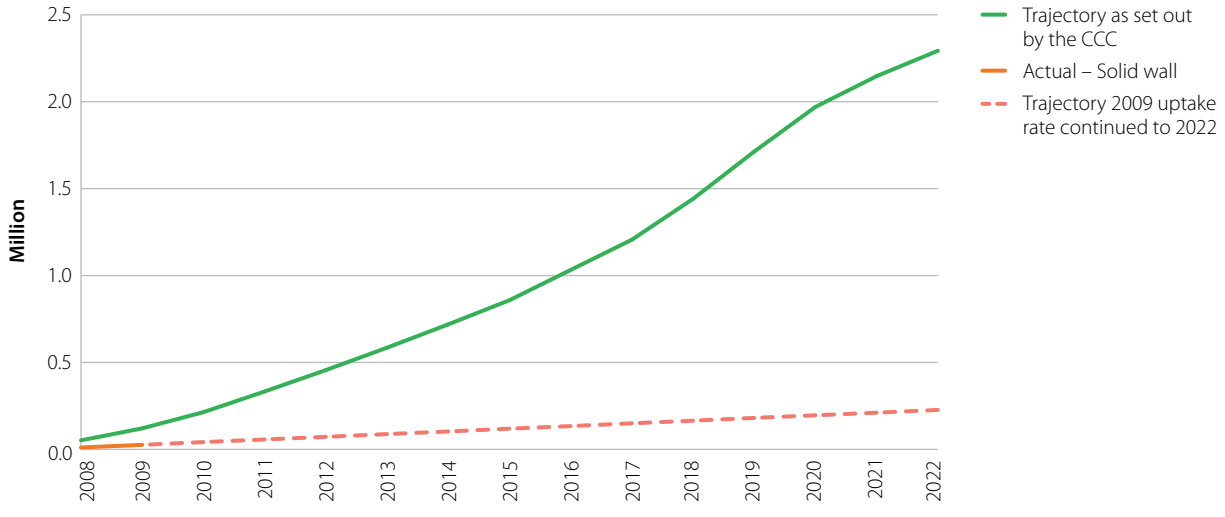
The UK Government's boiler scrappage scheme was launched in January 2010 with funding of £50 million to upgrade up to 125,000 household heating systems in England only. The scheme offered a £400 voucher to help offset the costs of upgrading from an inefficient 'G' rated boiler to an 'A' rated boiler. The scheme was so successful that the scrappage funds were exhausted at the end of March 2010. A similar Welsh scheme started in April 2010 offering a £500 discount, whilst a Scottish Government scrappage scheme, aiming to replace 5,000 boilers through £400 grants, allocated all funds within two days of its launch in May 2010.

Figure 3.9 Cavity wall insulation cumulative installations (2008-2015)



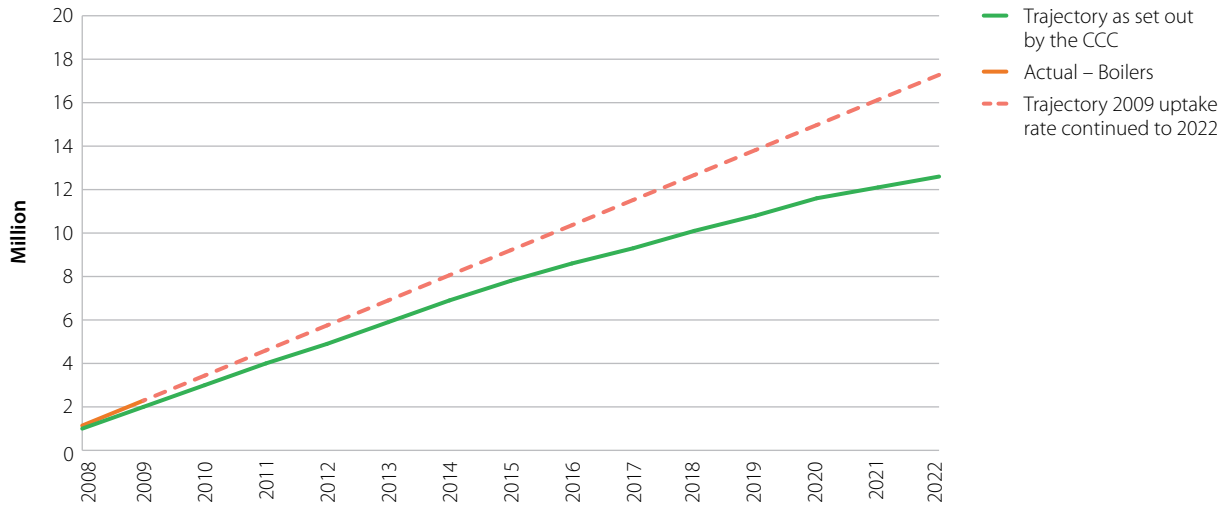
Source: OFGEM CERT data; CCC calculations.

Figure 3.10 Solid wall cumulative installations (2008-2022)



Source: OFGEM CERT data; CCC calculations.

Figure 3.11 A rated boilers cumulative installations (2008-2022)



Source: Heating and Hotwater Industry Council (2010); CLG; CCC calculations.

Energy efficient appliances

2009 sales data suggests that stock penetration of energy efficient cold and wet appliances remains very low, especially for cold appliances:

- Total cold and wet appliance sales have declined by 8% from 2008 to 2009 due to the recession, thus resulting in lower stock replacement levels and slower penetration of efficient appliances.
- While sales of A++ cold appliances increased by 73% between 2008 and 2009, they still account for only 0.2% of total cold appliance sales. To achieve a stock penetration of 45% by 2022, our trajectory suggests sales of A++ appliances should have reached 4% of the total in 2009.
- A+ wet appliances accounted for around 22% of total wet appliance sales in both 2008 and 2009, with total A+ sales declining by 3.5% in 2009. Sales in 2009 are 20% below our trajectory to achieve a 82% stock penetration of A+ (or better) appliances by 2022.

Due to a lack of robust sales data we have not set trajectories for other appliance classes (lighting, consumer electronics, home computing and cooking appliances). However, we note the significant scope for emissions reductions from these appliances.

Whilst general requirements for appliance efficiency are set at the EU level, the UK has gone further in certain cases (e.g. for phasing out of inefficient incandescent light bulbs through a voluntary agreement). Similar initiatives to improve standards could usefully be applied to other appliances.

Policy milestones

In our 2009 progress report, we stressed the need for a new policy framework to deliver a much higher level of ambition on energy efficiency. We outlined that the key features of the new policy should include:

- **Whole house packages** covering the range of cost effective measures to reduce residential emissions, with an energy audit and follow up to be offered to every household.
- **Neighbourhood/area based approach** with Government showing leadership and establishing energy efficiency improvement as a national priority; local authorities to have a key role in implementation in partnership with energy companies and other organisations.

- **New financing mechanisms** with a mix of individual charging of beneficiaries through schemes like 'Pay As You Save', and continued financing through the socialisation of costs, subsidies and other incentives.
- **Standards** which in the first instance should focus on the private rented sector to address the landlord-tenant split.

In March 2010, DECC and CLG published a new Household Energy Management Strategy (HEMS), which is broadly consistent with our recommendations (Box 3.3).

Box 3.3 HEMS key features

- An obligation on energy companies working in partnership with local authorities and other organisations to deliver up to 7 million 'eco-upgrades', including as many as 2.3 million solid walls insulation measures.
- Total cost of insulation measures 2013-2020 to come to £18.6 billion (£2.3 billion per annum).
- Two-thirds of the finance required to be delivered through the obligation but with no additional impact on fuel bills. Spending under the new obligation will be more transparent than CERT.
- Recognition that smart meter roll-out is a major opportunity to provide advice.
- Legislation to enable 'Pay As You Save' financing as a charge on the property. Finance to be provided by the private sector.
- Warm Homes standard for social housing and proposals for regulation for the private rented sector – standards in these two sectors are particularly important for addressing fuel poverty.
- Universal advice service and accreditation for installers.

The HEMS framework is a positive high-level step to encourage home energy efficiency improvement, but detailed implementing arrangements should now be developed to deliver the new Government's commitment to a 'Green Deal' and a National Energy Efficiency Programme. In particular, the following key areas need to be elaborated to provide confidence that the proposed approach will deliver:

- **'Eco-upgrades'/Green Deal Measures.** These should include a wide range of potential options to allow significant carbon reductions, including solid-wall insulation, 'A' rated energy efficient glazing, floor insulation and heating controls. The role of energy audits should be spelt out, especially in relation to the smart meter roll-out to ensure a pro-active approach to providing information to households to trigger action.
- **Partnership approach.** The roles and responsibilities of various organisations (national government, local government, energy companies, and other organisations) in the proposed partnerships to deliver area-based programmes should be clearly set out. The introduction of a statutory instrument underpinning the approach should be considered.
- **Financing mechanisms.** More details are required on the balance of funding between 'Pay As You Save', the socialisation of costs (e.g. spreading costs across the consumer base to provide free measures for the fuel poor and to subsidise some of the less cost-effective measures) and other financing mechanisms (e.g. a possible role for a Green Infrastructure Bank, as discussed in Chapter 2).

- **Role for standards/fiscal incentives.** In 'Hard-to-treat-homes' an effective energy efficiency package is likely to cost in excess of £10,000, with long payback periods of 20 years or more. A 'Pay As You Save' scheme alone is unlikely to persuade sufficiently large numbers of households to undertake the full range of measures. Therefore, standards for levels of energy performance and the provision of additional incentives (e.g. subsidised loans, council tax and other rebates for the less cost-effective options) should be considered.
- **Level of ambition.** A justification of the proposed ambition to insulate only 75% of cavity walls should be provided (see above), together with a consideration of possible alternatives for emission reductions in those homes deemed unsuitable. A credible strategy is needed for the proposed transition from insulation of solid walls in the social housing sector to the owner occupied sector, noting the significant delivery differences between these two market segments.

Given the importance of energy efficiency improvement, early clarification through setting out a detailed implementing framework is necessary if these measures are to contribute appropriately to meeting carbon budgets.

Zero carbon homes

With regard to reducing emissions from new residential buildings, progress has been made during the last year towards meeting the commitment that all new homes in England will be zero carbon from 2016 (e.g. proposing a definition for zero carbon and consulting on what the energy efficiency standard for new homes should be), with positive developments also in the Devolved Administrations (Box 3.4). The timing of this policy and the slow build rate for new properties means that this will be of more relevance for future carbon budgets as we move towards the fourth budget period and beyond.

Box 3.4 Zero carbon buildings and the Devolved Administrations

Scotland

New building regulations for Scotland will come into force in October 2010. These will enhance energy standards for both homes and non-residential buildings, including a reduction in emissions from new buildings of 30% compared to 2007 standards. A sustainability standard is under development that aims to set optional higher levels of carbon and energy targets, include wider aspects of sustainability, and clearly recognise developments that meet or exceed the 2010 standards. With the ambition of net zero carbon buildings by 2016/17 if practical, a further review of energy standards is planned for 2013 and 2016.

Wales

The Welsh Assembly Government is seeking to achieve a zero carbon buildings standard by 2011. Unlike for England, the 2011 ambition in Wales applies to all new buildings (residential and non-residential) from the outset. In moving towards this, there is a requirement, over certain thresholds, that new homes must meet the Code for Sustainable Homes Level 3 and non-residential buildings the 'BREEAM' 'very good' rating. Transfer of building regulations to Welsh Ministers will be effective as of the end of 2011.

Northern Ireland

Northern Ireland requires that new social housing meets the Code for Sustainable Homes Level 3, and as of April 2010 also offers rate relief on low and zero carbon new build homes. All new public sector buildings have to be zero carbon by 2018.

4. Non-residential buildings

Roll out of energy certificates to improve transparency

In developing an indicator framework for the non-residential sector, we noted that the evidence base about emissions abatement potential is highly uncertain. Therefore we did not attempt to set out trajectories for specific measures (e.g. to improve energy efficiency, and better manage energy). Rather, we recommended that the evidence base should be improved by rolling out Energy Performance Certificates (EPCs) and Display Energy Certificates (DECs), which would also enable firms and organisations to act on new information about abatement opportunities, and would provide scope for Government to introduce appropriate policy levers (e.g. regulation for SMEs based on achieving minimum ratings).

CLG has since published new proposals which are in line with the Committee's recommendations:

- CLG has consulted on extending DECs to cover commercial buildings, initially those with a floor space of 1,000m^2 and over, which is expected to cover 30,000 buildings. The eventual target is to include all commercial buildings of over 250m^2. This goes beyond the recast of the EU Energy Performance of Buildings Directive (EPBD2), which restricts the roll-out to buildings occupied by a public authority and frequently visited by the public. Member states have to implement the EPBD2 by 2012-13.
- CLG is planning to publish an impact assessment to calculate the relative costs and benefits of rolling out EPCs to all non residential buildings later this year.
- Work is ongoing to improve the quality of the EPC and DEC assessment and accreditation schemes, which will include improving the training that energy assessors receive and a possible withdrawal of accreditation for poor performers.

Once this work is concluded, early roll-out would provide increased transparency and facilitate possible new policies to unlock emissions reduction potential in the non-residential sector. These approaches would complement the proposed new 'Pay As You Save' policy for the non-residential sector.

Even before widespread roll-out, it is important to note that there is currently an implementation risk given evidence of a high level of non-compliance, with the majority of commercial buildings up for sale or re-let not having an EPC.[2] Proposed mandating that property advertisements carry the EPC rating will help to address this, but stricter enforcement by local trading standards or alternative compliance mechanisms should also be considered to ensure that existing and any future legislation is implemented.

Zero carbon non-residential buildings

There has been progress towards the target that new non-residential buildings in England should be zero carbon from 2019, with both schools and the public sector required to comply from 2016 and 2018 respectively. The earlier targets for public sector buildings reflect the Government's focus to lead emissions mitigation by example. The Devolved Administrations have set their own targets (Box 3.4).

CLG has proposed that zero carbon standards for the non-residential sector should, where possible, be consistent with zero carbon homes through the adoption of the same three tier hierarchy of energy efficiency, followed by on-site or linked low/zero carbon technologies and finally off-site measures. Due to the timescales involved, the carbon impact of this policy will be negligible during the first three carbon budgets but more important in the long term.

2 National Energy Services monitoring of commercial buildings recorded that 61% of commercial building sampled in February 2010 were marketed without an EPC rating.

New incentives for SME energy efficiency improvement

The Committee has highlighted the significant opportunity for emissions reduction from SMEs and suggested a number of high-level options to strengthen incentives in this area:

- Provision of more financial support,
- Extending the new residential sector delivery model to cover SMEs,
- Mandating implementation of measures.

A programme of work is underway in DECC to assess these alternative policies, with proposals due later this year. Their latest assessment suggests that SMEs and more broadly the sectors not covered by policy levers (EU ETS, CCA and CRC) currently account for 49 $MtCO_2$ emissions (30% of which is in industry, the rest in non-residential buildings), with the potential for cost-effective abatement of 2.7 $MtCO_2$ by 2020. Some of this potential will be accessed by policy measures already planned, notably the RHI.

We will provide a further assessment of opportunities in this area following the publication of proposals by DECC.

Carbon Reduction Commitment Energy Efficiency Scheme

A key lever for reducing emissions in non-residential buildings is the Carbon Reduction Commitment Energy Efficiency Scheme (CRC), which took effect in April 2010. The CRC caps the emissions of large non energy intensive companies and public sector buildings. The Committee has been asked by the Government to provide advice on the appropriate level of the second phase cap (2013-18) and other aspects of the CRC:

- The Committee will provide an indicative assessment of the cap, which will subsequently need to be firmed up based on further analysis of baseline emissions and the abatement potential in sectors covered by the CRC.
- Also as part of the review, the role of the safety valve – which allows participants to buy allowances from the EU ETS – beyond the introductory phase will be considered and complementary measures to support emissions reductions (e.g. information and financing).

The Committee will report its advice on the level of the CRC cap in September 2010.

Public sector buildings

There is a significant opportunity for emissions reduction in public sector buildings. It is important that the government and public authorities show leadership in addressing their own emissions and realise what can be significant monetary savings from energy efficiency improvements. For these reasons, we proposed that all cost-effective emissions reduction potential in public buildings covered by the CRC should be unlocked by 2018.

Recent progress includes:

- The commitment by the new Government to reduce emissions from central government by 10% over the next year.
- The ongoing low carbon review of the public sector is expected to identify energy efficiency improvements in order to deliver annual energy savings of £300m in 2012/13. This will support the take up of cost effective measures in the short and medium term.
- Under the Departmental Carbon Reduction Delivery Plans (CRDPs), all major central government departments have been given responsibility for reducing their share of emissions in the total carbon budget. This covers emissions from their own estates and operations, as well as emissions from relevant public sector bodies.
- The first stage of the BEEP (Building Energy Efficiency Programme) launched in 2009 by the London Development Agency saw the retrofit of 42 existing public sector buildings in London with energy efficiency measures. Average CO_2 reductions of 27% were achieved with annual energy savings totalling £1m. The scheme is designed to accelerate the pace of retrofit with a 2025 target to cover over 2,000 existing public sector buildings, and will be rolled out to other areas in the country.

Given this progress on commitments, as well as positive developments in the Devolved Administrations (Box 3.5), the challenge now is to move from setting ambitious targets to accelerated delivery.

Box 3.5 Devolved Administrations own emissions

Scotland

The Scottish Government's 2009 Carbon Management Plan is currently under review to take account of a substantial increase in the size and diversity of the Scottish Government estate. A revised plan will be available in the spring of 2011, whilst a progress report setting out achievements against the list of carbon reduction projects set out in the 2009 plan will be produced in September 2010.

Wales

The Welsh Assembly Government has developed a £2.1m investment plan for its own estate for the period 2008-11 covering energy efficiency measures and renewable technologies, new boiler plant, LED lighting and increased lighting control, double-glazing, high efficiency hand dryers and automatic metering. The Government is also working towards achieving the highest level of environmental management system certification. Across the built estate CO_2 emissions fell 5% in 2008/09 compared to the previous year. In Cathays Park, the largest office of the estate, emissions fell 11% over the same period.

Northern Ireland

Northern Ireland, as well as having a target to make the public sector estate carbon neutral by 2015, has set various energy efficiency and energy use targets for the public sector and reports against these each year. The latest annual report finds that while the target to source at least 10% of renewables has been overachieved (at 19%), progress on energy efficiency and total carbon emissions must accelerate in the next few years to meet targets.

5. Emissions from industry

Opportunities for emissions reduction

Currently iron and steel, offshore oil and gas production, cement and chemicals account for nearly half of industry emissions. Emissions in this sector include direct CO_2 and other GHGs produced from chemical reactions in industrial processes such as cement manufacture.

Our previous assessment noted that industrial sector abatement potential is difficult to characterise due to:

- Uncertainties surrounding the future shape of industry in the UK, including future demand for products and what proportion of this demand will be met by manufacturing located in the UK.
- Uncertainties surrounding the options for reducing industry emissions, such as future technologies and radical process changes.
- The evidence base on scope for emissions reduction in industry (primarily the "ENUSIM" model) had not been comprehensively updated for a number of years.

In order to address these challenges, we have recently worked with DECC to improve the evidence base through updating the ENUSIM model in some key sectors. This has resulted in some improvement in modelling capability and transparency.

However, the accuracy of data underpinning ENUSIM, including the recent update, is reliant on the often limited ability and/or willingness (given commercial considerations) of industry to provide information regarding abatement opportunities. Other shortcomings in the current form of the model include under-representation of fuel switching and future technological options for abatement.

Therefore further improvements to the evidence base are required to accurately assess the likely potential for abatement across industry.

Policies to encourage emissions reduction

There are three key policy instruments for reducing industry emissions:

- **Climate Change Agreements (CCAs).** These cover energy-intensive industries and set targets for emissions reduction (Box 3.6). It is not clear how much of the emissions reduction in industry can be attributed to CCAs, or the scope for future emissions reduction given problems with the current evidence base (see above).
- **EU ETS.** Approximately two-thirds of industry emissions are covered by the EU ETS, of which around half are also covered by CCAs. Our working assumption has been that the combination of energy-intensive production processes and a carbon price would provide sufficient incentives for energy efficiency improvement and investment in low-carbon process technology. While there is some evidence that the EU ETS has played a role in guiding investment decisions, the incentives are diluted by some aspects of its design (Box 3.7).
- **The Renewable Heat Incentive (RHI).** The RHI as currently proposed will incentivise renewable heat use in industry (see Section 6). Projected abatement for industry under the RHI scheme is 7.2.MtCO_2 by 2020, primarily from the use of biomass boilers.

Box 3.6 Climate Change Agreements

For energy-intensive industries, the CCAs are a key part of the policy framework for reducing emissions. Owing to the multiple influences on industry energy use, such as energy prices and the demand for products, measuring the effectiveness of CCAs is extremely complex, and different studies make conflicting estimates for emissions reductions in industry. The common message emerging from these reports is that there is a great deal of uncertainty surrounding any estimate of emissions savings.

CCAs were introduced in 2001 alongside the Climate Change Levy (CCL) in recognition of the need to maintain the competitiveness of energy-intensive sectors. They provide businesses in certain energy intensive sectors (including aluminium, cement, ceramics, chemicals, food and drink, foundries, glass, non-ferrous metals, paper, steel – approximately half of industrial sector emissions) with an 80% discount on the CCL in return for improving energy efficiency and/or reducing emissions. In the June 2010 budget, the Government confirmed plans to reduce the discount to 65%. Sector targets were set with a view to achieving 60% of the difference between 'business as usual' and a scenario in which all cost effective measures had been achieved.

The vast majority of sectors met their annual carbon reduction targets (36 of 52 sectors in the most recent review period), with many sectors over-complying particularly in the early stages of the scheme. A study by the National Audit Office (2007) argued that this early overachievement was as much a result of weak targets as it was of efficiency improvements. Subsequently the Environmental Audit Committee (2008) recommended that lax targets early in the scheme meant that CCA targets needed to be regularly reviewed, to ensure they were continually binding. DECC has responded to this concern through a tightening of the targets by 4.4% for 2010. The current CCAs expire in 2013 and in March 2010, the government published a consultation on draft agreements and scheme rules for new CCAs.

Box 3.7 EU ETS and industry

The EU ETS is now in the second phase (2008-2012) of operation. The first phase of the scheme (2005-2007) and to some extent the current phase have been viewed as a learning period in which the design of the scheme can be optimised to achieve emissions reductions most effectively.

Across the EU, verified emissions in the EU ETS have been consistently below the allocation. For example, in phase 1 annual verified emissions were lower than allocations by around 120 $MtCO_2$ (6%). The recession has exacerbated over-allocation (in 2009 verified emissions were 94$MtCO_2$ or 4.8% lower than allocation).

The resulting lower carbon price has dampened incentives for implementation of measures to reduce emissions, although some incentives may have been provided through non-financial levers (e.g. raising awareness at the board level).

Incentives may have diminished further for a number of reasons:

- **Free allocation:** A low level of auctioning in Phase 1 and 2 may have led to windfall profits for organisations (if the price of allowances is passed through to consumers). This can also dilute the incentives for industry to invest in lower-carbon technology.
- **Distribution of allowances:** The basis for allocation of allowances has been much disputed. Even for a scheme with an appropriate level of ambition overall, the basis for allocations may impact on incentives to reduce emissions.
- **New entrant reserve:** Free allocations given by one Member State can adversely affect the competitiveness of new entrants elsewhere, and so tends to be mirrored by others, with potential distortions to investment decisions.
- **Closure rules:** Retiring allowances following the closure of an installation may provide an incentive to keep outgoing and inefficient plant open longer.

- **Banking:** The banking of emissions from phase 2 to phase 3 was introduced to overcome price volatility such as that experienced at the end of phase 1. However, this can carry through the impact of over-allocation, reducing prices in the next phase.
- **Uncertain forward prices:** An uncertain longer-term framework for the scheme may reduce the impact of the scheme on investment decisions, particularly those investments involving longer pay back periods.

Phase 3 of the scheme (2013-2020) attempts to overcome some of these issues by making changes to the design of the scheme, including an overall EU cap on emissions that is progressively tightened, a move towards auctioning (up to 50% of allowances), benchmarking of allowances and a limit on the use of project credits from outside the EU (at most, 50% of the reductions required by the scheme).

The Committee's future approach to industry

Going forward, our approach to monitoring progress reducing industry emissions will be based on three pillars:

- We will work with DECC to continue to improve the existing evidence base. Depending on progress here, and available data, we may set out indicators for progress on specific measures.
- We will assess more fundamental options for reducing industry emissions as part of advice on the fourth budget to be published before the end of 2010. A number of important opportunities for the industrial sector are likely to develop in the 2020s, including the application of CCS in industry, low-carbon process and product innovations and further options for the provision of low-carbon heat through biomass and CHP.
- In future progress reports we will consider effectiveness of the main policy instruments in this sector, including CCAs, CCLs, and EU ETS.

6. Low carbon and renewable heat

We have previously presented analysis which showed the need for significantly increased penetration of renewable heat in the period to 2020 to meet carbon budgets, and to prepare for deeper cuts in heat emissions through the 2020s. In particular, the analysis suggested the Government's ambition to increase renewable heat penetration to 12% by 2020 would make a useful contribution to carbon budgets, notwithstanding that meeting this target would be expensive at the margin.

We highlighted financial and other incentives as being key areas to address in developing the policy framework for renewable heat:

- Given the cost characteristics of renewable heat together with the lack of a carbon price in most of the heat sector, a financial support mechanism will be required.
- Complementary measures are needed to address other barriers such as low awareness, supply chains and lack of adequately trained suppliers and installers.

The draft Renewable Heat Incentive (RHI) document published in February 2010 sets out proposals to support a range of renewable heat technologies such as heat pumps and biomass boilers (Box 3.8). The level of ambition for deployment in the proposals is broadly consistent with our analysis, although further consideration of the exact levels of support for specific technologies and delivery mechanisms (including the balance between capital grants and recurrent payments) may be required to ensure cost-effectiveness and to maximise carbon savings.

Box 3.8 Renewable Heat Incentive proposals

In order to incentivise the uptake of renewable options, the proposed RHI provides a tariff that aims to make investing in renewables financially attractive. The tariff levels have been set with a view to compensating renewable heat generators for the following:

- **Higher financial costs:** This is the difference in financial costs (capital and operating) associated with renewable technologies, compared with a `reference technology` of a gas boiler (except for small scale biomass, where the reference technology is oil heating).
- **Barriers costs:** This includes for example the disruption of digging up gardens to install a ground source heat pump.
- **The opportunity cost of capital and level of risk:** This is calculated as an investment return on the difference in capital costs between renewable heat and the reference technology annuitized at 12% for all technologies (except solar, which is 6%).

For example, an off-grid 3-bed semi-detached home installing a biomass boiler to replace an old oil fired boiler could get an RHI payment of around £1,000 a year, with additional fuel savings of up to £500 per year (depending on the cost of the pellets/wood chips). Pay-back could be as short as three or four years.

In the residential sector, heat demand will be deemed (as opposed to metered), based on the assumption that some basic energy efficiency measures will be taken up. However, this only assumes 125mm of loft insulation (as opposed to a standard of 270mm under CERT) and no evidence is required that minimum levels of energy efficiency have been achieved. There are no incentives for more difficult measures such as solid wall insulation and an inefficient solid walled property will get a much higher level of RHI payment than an energy efficient home. There is no link of RHI payments to energy efficiency in non-residential sectors.

By 2020, the annual cost of the RHI is expected to be between £0.8bn and £1.8 bn. The RHI did not commit to specific financing arrangements but if the costs were passed on to energy consumers, annual domestic fuel bills could increase by 14% (£104) and industrial bills by 20%.

Box 3.9 Renewable heat activities in the Devolved Administrations

Scotland

Scotland's Renewable Heat Action Plan outlines a target for 11% of heat to be met from renewable sources by 2020. It is envisaged that meeting this target will require 2.07 GW_{th} installed capacity by 2020. By March 2009 there was an estimated 233MW_{th} of renewable heat capacity in Scotland. To accelerate progress and help build the industry ahead of the introduction of the proposed RHI, the Plan outlines a number of supporting actions to be taken across a range of areas. These address labour/skills barriers in the workforce, the provision of advice and assistance to emerging and new-start supply chain companies, improving wood fuel supply forecasts and supporting investment in renewable heat (e.g. through the Scottish Biomass Heat Scheme which provides grants for the installation of biomass heating systems in business premises and district heating demonstrators). Energy-from-waste also has an important part to play. Scotland's Zero Waste Plan highlights that energy-from-waste could generate enough heat for 110,000 homes and make a significant contribution towards Scotland's renewable heat target.

Wales

The Welsh Assembly Government's Energy Policy Statement published in March 2010 outlines the aim for virtually all Wales' local energy needs, including heat, to be met from low carbon electricity generation by 2050. The Statement builds on earlier consultations on a Renewable Energy Route Map (2008) and Bioenergy Action Plan (2009). The latter outlines the aim to secure annual generation of 2.5 TWh of usable heat energy from renewable biomass by 2020 via a range of actions to stimulate demand for bioenergy. These include public awareness campaigns, the inclusion of biomass in demonstration zero carbon buildings, and providing a heat map to identify and highlight CHP opportunities. Financial support includes funding for local authorities to collect and treat food waste, funding for the establishment of anaerobic digestion plants and the Wood Energy Business Scheme, which aims to install 40MW of renewable heat capacity over its 4 year operation (2009-2013).

Northern Ireland

The proposed RHI does not apply to Northern Ireland and the utility regulator is planning to work with the Department of Trade, Enterprise and Investment (DETI) to develop its own policies in relation to renewable heat in 2010/11. The Draft Strategic Energy Framework for Northern Ireland consultation, published in July 2009 and due for approval in late summer 2010, proposes a 10% renewable heat target for 2020. It also outlines DETI's commitment to urgently consider how financial support for significantly increased levels of renewable heat can be provided, and whether support is needed at a variety of points along the supply chain.

The RHI includes proposals for certification and standards for suppliers and equipment to address non-financial barriers to renewable heat uptake, such as lack of trust and certainty in the market. However, it does not address in detail the current lack of awareness of renewable heat technologies, which will require promotion and marketing to ensure that potential customers are aware of their benefits. The Devolved Administrations have recently announced additional activities to address this and other issues such as training and skills (Box 3.9).

The RHI proposals provide only a limited incentive to improve energy efficiency. Given the important role of energy efficiency improvement for carbon budgets, and the fact that renewable heat is more cost-effective when installed in energy efficient buildings, it is desirable that stronger incentives for energy efficiency improvement should be introduced as part of the RHI. Amongst possible options are conditionality of the RHI on a certain level of energy performance (e.g. by mandating all cost-effective measures) and offering some RHI payments in the form of energy efficiency vouchers.

District heating and combined heat and power

The HEMS also identifies a clear role for district heating and Combined Heat and Power (CHP) in decarbonising heat supply:

- Up to 16 GW_e of conventional and biomass CHP could be operational by 2020.
- A heat market to be developed at a community scale (i.e. local district heating networks) as well as at a larger industrial/commercial scale.

A new enabling framework is to be established including a Heat Market Forum (focusing on consumer protection), a national heat map, and local authority partnerships.

In considering a potential role for CHP and district heating a number of factors are important:

- The timing of heat decarbonisation in the context of the path towards meeting the UK's 80% emissions reduction target, and the implied need to transition from conventional to low-carbon CHP.
- The proximity of heat loads to potential sites for low-carbon CHP (e.g. the extent to which nuclear and CCS power stations near to coasts could usefully be used to meet local heat demand).
- The availability of sustainable bioenergy (both locally and more generally) to support this transition.
- The costs and suitability of alternative forms of renewable heat (e.g. heat pumps).

The Committee will provide a full assessment of the role of CHP and district heating as part of its advice on the fourth budget to be published by the end of 2010.

7. Departmental carbon reduction delivery plans

In March 2010, a suite of departmental carbon reduction delivery plans (CRDPs) was published which set out how each government department will reduce emissions in the sectors where they have an influence. The buildings and industry sectors are covered by the CRDPs of CLG and DECC. The departmental plans also include a number of key indicators and policy milestones that Government will use to track progress towards carbon budgets.

The DECC and CLG plans are broadly consistent with the Committee's recommendation and indicator framework in terms of coverage and high-level ambition, although there is scope for strengthening in key areas (Box 3.10):

- **Defining indicators:** there are no trajectories in the plans for specific measures (the approach here is to simply list a desired direction of travel: upwards or downwards), with the only trajectory being the high-level emissions path set out in the Low Carbon Transition Plan. Therefore, it is difficult to assess the level of change that should be observed against each indicator to be consistent with carbon budgets. In order to address this, trajectories for some key indicators should be included, similar to the Committee's indicator framework (Table 3.1).
- **Ensuring sufficient ambition:** As noted in Section 3 above, DECC's level of ambition on cavity walls is substantially lower than the Committee's trajectory set out in 2009. While we understand that DECC is continuing to build the evidence base in this area, our analysis suggests that a higher level of ambition for improvements in this section of the housing stock is important for achieving carbon budgets.
- **Committing to new approaches and policies:** We have highlighted the need for new approaches to reducing emissions from buildings and industry (finalising the framework for residential energy efficiency improvement, roll-out of EPCs and DECs, new approaches to SMEs, finalising the RHI, etc.). Policy development is crucial to unlocking the emissions reduction potential that we have identified, and this should be reflected through including policy milestones in the departmental delivery plans.

We will continue to consider progress against our indicators for implementation of measures and policy milestones in our annual reports to Parliament.

Box 3.10 Departmental indicator framework

Residential

In terms of individual indicators the departmental indicator framework is broadly consistent with the indicators set out by the Committee in the 2009 progress report and in some areas more indicators are being tracked. Additional indicators include:

- All new homes to be zero carbon from 2016,
- All homes to have a smart meter by 2020.

The Committee recognises the importance of these policies but as their impact will be relatively small in the first three budget periods, we have not included these measures in our indicator set.

The Committee's framework includes additional indicators that are not being tracked by the government framework. These are:

- Every house offered a whole house energy audit by 2017,
- New financing mechanisms have been piloted, evaluated and legislated by 2011,
- A post CERT delivery framework legislation is in place by 2011.

In terms of indicators relating to insulation, the Government's policy milestone of 'all lofts and cavities to be filled where feasible by 2015' differs significantly from the Committee's. For cavities, 'where feasible' assumes a significantly lower level of ambition than the Committee's (4 million versus 8 million) but higher CO_2 savings per measure.

The LCTP set out a trajectory for a 29% reduction in non-traded sector emissions across the first three budget periods. The HEMS set out at a high-level how the trajectory would be met but as noted above, implementation details need to be developed before we can assess the potential effectiveness of the policy.

Non-residential buildings and industry

The departmental indicator framework combines non-traded non-residential buildings and industry indicators into one category called "workplaces" which encompasses non-traded energy use from commercial operations and industry. Other traded sector indicators are also highlighted.

For non-domestic buildings, the departmental framework is less specific than the Committee. For example:

- The Government's lists a future indicator of improvement in EPC ratings, with no date or indication of desired trend.
- The Committee's indicators include a minimum EPC of F or higher by 2017.

In its workplaces section, the departmental indicator set includes additional policy milestones such as CCAs and Feed in Tariffs (FITs).

- For industry, the Committee is currently carrying out further analysis and may add further indicators in the future, such as performance against CCAs.
- As FITs will only deliver a low level of traded sector abatement (around 1 $MtCO_2$ by 2020), we have not included them and focused on renewable measures with a larger abatement potential (such as the RHI).

Table 3.1 The Committee's buildings and industry indicators

		Budget 1	Budget 2	Budget 3	2009 trajectory	2009 outturn (compared to 2007)
All buildings and industry						
Headline indicators						
CO_2 emissions (% change on 2007)*	direct	-9%	-11%	-15%	-8%	-11%
	indirect**	-11%	-28%	-58%	-2%	-15%
Final energy consumption (% change on 2007)	non-electricity	-10%	-18%	-23%	-0%	-6%
	electricity (centrally produced)***	-8%	-7%	-5%	-4%	-6%
	electricity (autogen included)***	-4%	-9%	-13%	-5%	-7%
Residential buildings						
Headline indicators						
CO_2 emissions (indicative minimum % change on 2007)*	direct	-6%	-18%	-20%	3%	-2%
	indirect**	-11%	-23%	-53%	-6%	-10%
Final energy consumption (indicative minimum % change on 2007)	non-electricity	-6%	-18%	-19%	4%	-2%
	electricity (centrally produced)***	-5%	-4%	-3%	-3%	-1%
	electricity (autogen included)***	-5%	-4%	-3%	-3%	-1%
Supporting indicators						
Uptake of solid wall insulation (million homes, total additional installations compared to 2007 levels)		0.5	1.2	2.3	0.1	(approx 26,000)
Uptake of loft insulation (up to and including 100mm) (million homes, total additional installations compared to 2007 levels)		2.3	5.6	5.6	All lofts: 1.0	Professional: 1.6, DIY: 0.86
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	1.1	1.1
Uptake of energy efficient boilers (million homes, total additional installations compared to 2007 levels)		4.9	9.3	12.6	2.0	2.3
Uptake of energy efficient appliances - Cold A++ rated (% of stock)		3%	18%	45%	0%	0%

Table 3.1 The Committee's buildings and industry indicators

	Budget 1	Budget 2	Budget 3	2009 trajectory	2009 outturn (compared to 2007)
Uptake of energy efficient appliances – Wet A+ Rated (% of stock)	16%	40%	58%	7%	~6%
Every house offered whole-house energy audit		by 2017			n/a
Heat and Energy Saving Strategy finalised	2009				Household Energy Management Strategy published March 2010
New financing mechanism pilots operate and are evaluated	2011				PAYS pilots launched in 2010
New financing mechanism budgeted and legislation in place if necessary	2011				Commitment to Energy Bill by new government
Post CERT delivery framework legislation in place	2011				n/a
Other drivers					
Average SAP rating, Implementation of behavioural measures, Population (by age), Number of households (by type – building and occupants), Real Household disposable income, Real electricity prices, Real gas prices, Appliance ownership, Weather				See technical annex for these indicators	

*These indicators should be considered jointly. Reductions in total emissions from buildings and industry reflect savings from renewable heat. We do not however set out in advance the split of these savings across sectors. Therefore emissions changes for individual sectors do not assume any savings from renewable heat and reflect a minimum level of change.

**These changes are based on centrally produced electricity demand changes whose carbon intensity is assumed to be that of new build gas. Within our modelling of the power sector, emissions from electricity generation are lower than is represented here due to different assumptions about carbon intensity. The indirect emissions shown here are therefore conservative.

***Figures show percentage changes in total electricity consumption including auto generated electricity, and in centrally produced electricity only.

Notes:

1. Numbers indicate amount in last year of budget period i.e. 2012, 2017, 2022.
2. While we present outturn vs. trajectory figures for 2009, it is not our expectation that our trajectories will be achieved precisely for every indicator in every year. There may be some year to year variation, which is acceptable. Similarly it may be the case that some indicators are not met while others are over-achieved; this may still on average constitute sufficient progress. A problem will be signalled however if under-achievement persists, if a large number of indicators are off-track or if specific indicators or milestones which are key to unlocking abatement in the longer term are not met.
3. There have been revisions to the buildings and industry indicator table presented in CCC's 2009 progress report.

Key: Headline indicators Implementation indicators Milestones Other drivers

Table 3.1 The Committee's buildings and industry indicators

		Budget 1	Budget 2	Budget 3	2009 trajectory	2009 outturn (compared to 2007)
Non-residential buildings						
Headline indicators						
CO_2 emissions (indicative minimum % change on 2007)*	direct	6%	2%	-3%	10%	1%
	indirect**	-9%	-22%	-51%	-4%	-13%
Final energy consumption (indicative minimum % change on 2007)	non-electricity	-4%	-8%	-13%	-2%	1%
	electricity (centrally produced)***	-1%	-1%	-1%	0%	-5%
	electricity (autogen included)***	-1%	-1%	-1%	0%	-5%
Supporting indicators						
Develop policy on SMEs		by October 2010				Analysis of policy options underway, proposals due end 2010
Government decision on the following recommendations for EPCs and DECs:		by October 2010				
• All non-residential buildings to have an EPC			by 2017			Impact Assessment to be published Autumn 2010
• All non-residential buildings to have a minimum EPC rating of F or higher				by 2020		Impact Assessment to be published Autumn 2010
• Roll out of DECs to non-public buildings			by 2017			Consultation published March 2010
All public buildings covered by CRC to realise all cost-effective emissions change potential			by 2018	by 2018		n/a for 2009
Other drivers						
Emissions and fuel consumption by subsector, GVA vs. GVA for each sub-sector, Electricty and gas prices					See technical annex for these indicators	
Industry						
Headline indicators						
CO_2 emissions (indicative minimum % change on 2007)*	direct	-15%	-2%	8%	-10%	-21%
	indirect**	-12%	-35%	-66%	-15%	-23%

Table 3.1 The Committee's buildings and industry indicators

		Budget 1	Budget 2	Budget 3	2009 trajectory	2009 outturn (compared to 2007)
Final energy consumption (indicative minimum % change on 2007)	non-electricity	-20%	-21%	-19%	-6%	-18%
	electricity (centrally produced)***	-16%	-11%	-5%	-11%	-13%
	electricity (autogen included)***	-6%	-18%	-30%	-9%	-14%
Other drivers						
Emissions and fuel consumption by subsector, GVA vs. GVA for each sub-sector, electricty and gas prices					See technical annex for these indicators	
Renewable heat						
Headline indicators						
Renewable heat penetration		1%	5%	12% in 2020	n/a	n/a
Supporting indicators						
Renewable Heat Incentive in operation		from April 2011			n/a	RHI proposals published in February 2010.
Other drivers						
Uptake and costs of renewable heat technolgys: Biomass boilers, Solar thermal, Heat Pumps, District Heating					See technical annex for these indicators	

*These indicators should be considered jointly. Reductions in total emissions from buildings and industry reflect savings from renewable heat. We do not however set out in advance the split of these savings across sectors. Therefore emissions changes for individual sectors do not assume any savings from renewable heat and reflect a minimum level of change.

**These changes are based on centrally produced electricity demand changes whose carbon intensity is assumed to be that of new build gas. Within our modelling of the power sector, emissions from electricity generation are lower than is represented here due to different assumptions about carbon intensity. The indirect emissions shown here are therefore conservative.

***Figures show percentage changes in total electricity consumption including auto generated electricity, and in centrally produced electricity only.

Notes:

1. Numbers indicate amount in last year of budget period i.e. 2012, 2017, 2022.
2. While we present outturn vs. trajectory figures for 2009, it is not our expectation that our trajectories will be achieved precisely for every indicator in every year. There may be some year to year variation, which is acceptable. Similarly it may be the case that some indicators are not met while others are over-achieved; this may still on average constitute sufficient progress. A problem will be signalled however if under-achievement persists, if a large number of indicators are off-track or if specific indicators or milestones which are key to unlocking abatement in the longer term are not met.
3. There have been revisions to the buildings and industry indicator table presented in CCC's 2009 progress report.

Key: Headline indicators Implementation indicators Milestones Other drivers

Chapter 4: Progress cutting surface transport emissions through low-carbon vehicles and alternatives to car travel

Introduction and key messages

Surface transport emissions (i.e. excluding emissions from aviation and shipping, which are discussed in Chapter 1) currently account for around 22% of total UK CO_2 emissions and 18% of total GHG emissions. Before declining in 2008 and 2009, surface transport emissions increased by around 10.6% over the period 1990 to 2007, including 2.7% over the five-year period 2003-2007, with the emissions impacts of improvements in vehicle fuel efficiency more than offset by increased miles travelled.

In our previous reports we have highlighted significant potential for transport emissions reductions through a range of measures covering both technology innovation and consumer behaviour change including:

- **More efficient and low-carbon vehicles:** our analysis suggests that there is scope to reduce emissions by around 17 $MtCO_2$ in 2020 from cars, vans and HGVs through more fuel efficient conventional vehicles, through the introduction of electric/plug in hybrid vehicles, and through increased penetration of biofuels.
- **Smarter Choices:** evidence from the Sustainable Travel Town pilots suggests that there is scope for rationalisation of car journeys through a range of measures including working from home, car pooling, and switching to public transport. Our analysis suggests that rolling out of Smarter Choices could reduce emissions in 2020 by almost 3 $MtCO_2$.
- **Eco-driving:** gentle braking and accelerating, driving without excess weight and with tyres at the correct pressure would reduce emissions in 2020 by over 1 $MtCO_2$.
- **Integrated land use and transport planning:** we estimate that emissions reductions of up to 2 $MtCO_2$ are available in 2020 through designing new residential and commercial developments to minimise additional car miles.

Together these measures offer the potential to reduce transport emissions by around 25 $MtCO_2$ in 2020.

This level of emissions reductions is required both to meet the first three carbon budgets, and to lay the foundations for deep cuts in transport emissions required through the 2020s.

In this chapter, we consider transport emissions trends, and progress against the indicators set out in our first report to Parliament covering the key areas of emissions reduction potential above. The key messages in the chapter are:

- Road transport emissions fell by 3.4% in 2008 and around 3.9% in 2009 due to the purchase of more efficient vehicles and falling mileage during the recession, and increased penetration of biofuels.
- Going forward, it will be important to strengthen incentives and lock in to progress made on car purchase behaviour, to provide financial support for the purchase of electric cars and investment in a national electric vehicle charging network, and to work with the EU to introduce a new framework for reducing emissions from vans.
- In order to complement emissions reductions from more efficient vehicles, evidence suggests phased roll-out of Smarter Choices to cities and towns across the UK would result in reduced car miles and emissions, and wider economic benefits. The Coalition Agreement commitment to radically reform the planning system provides a good opportunity to achieve better integration of land use and transport planning, particularly as regards new developments.

We have also been asked to consider the DfT plan for meeting carbon budgets. This would benefit from setting out ambitious targets for new car and van efficiency, and penetration of electric vehicles:

- New car emissions in the UK should fall to 130 g/km in 2015 and 95 g/km in 2020 in line with EU targets.
- There is scope for the UK to reduce emissions from new vans from current levels of around 205gCO_2/km to around 135 g/km in 2020, in line with draft proposals from the EU.

- Cumulative penetration of up to 1.7 million electric and plug-in hybrid cars by 2020 is feasible and desirable. This would contribute both to achieving the 95 g/km target for 2020, and to building a critical mass for wider roll-out in the 2020s required to meet carbon budgets in this period.

The analysis that underpins these messages is set out in four sections:

1. Progress reducing emissions
2. Opportunities for reducing emissions – the Committee's transport indicators framework
3. Reducing emissions from road vehicles
4. DfT's departmental delivery plan

1. Progress reducing emissions

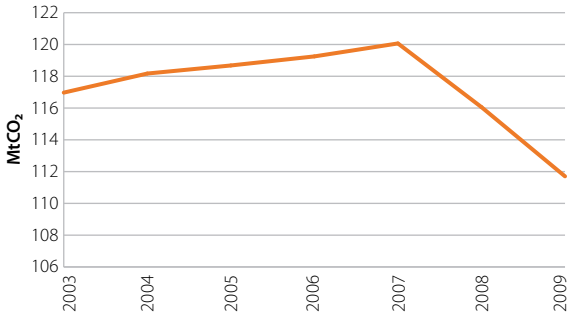
Total surface transport emissions

Total surface transport emissions increased by 10.6% in the period from 1990 to 2007, and 2.7% in the period from 2003-07. Surface transport emissions are dominated and have been driven by road transport (this accounts for 98% of total surface transport emissions), with increased emissions resulting from improvements in vehicle fuel efficiency more than offset by increased miles travelled (Figure 4.1).

In 2008, road transport emissions fell by 3.4% (Figure 4.2), with a preliminary estimate of a further 3.9% reduction in 2009[1]. Emissions reductions in 2008 and 2009 were due to purchase of more efficient vehicles, increased penetration of biofuels, and reduced miles/fuel consumption.

Going forward, we expect miles/fuel consumption to increase as GDP growth resumes. Significantly improved fuel efficiency/reduced carbon intensity of new vehicles and consumer behaviour change will therefore be required if the pace of recent emissions reductions is to be sustained such that a step change is realised and surface transport makes an appropriate contribution to meeting carbon budgets (Figure 4.3).

Figure 4.1 Road transport emissions (2003-2009)



Source: DECC (2009), UK emissions statistics: 2008 final UK figures.
Note: 2009 $MtCO_2$ is a CCC estimate.

Car emissions

Emissions from cars fell by 3.1% in 2008 and around 2.7% in 2009[2], reflecting improved fuel/carbon efficiency and reduced car miles (Figure 4.4):

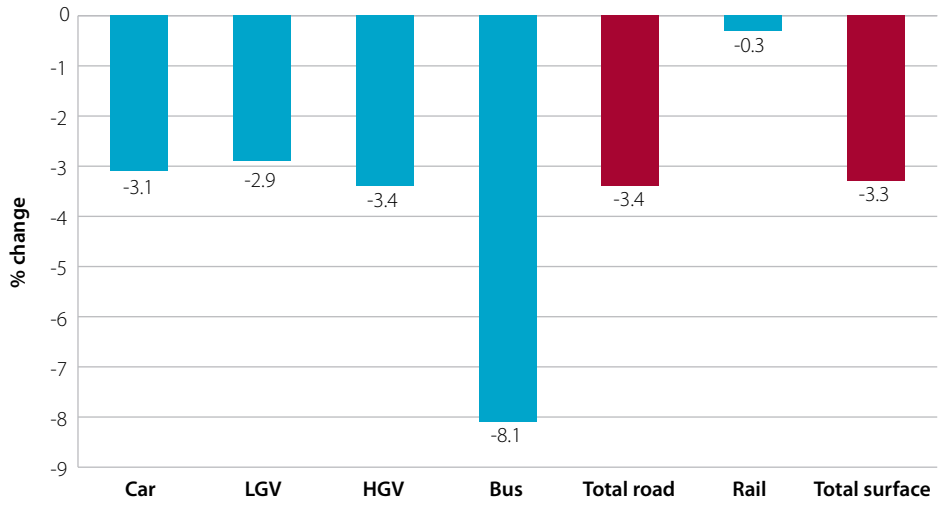
- Average car fleet emissions fell from 177 g/km in 2007 to 173 g/km in 2008 (a 2.5% reduction). This is accounted for both by improved fuel efficiency of new cars (around three-quarters of the 2.5%) and increased penetration of biofuels (around one-quarter).
- We estimate that the carbon intensity of the fleet reduced a further 1.6% in 2009, with improvement in fuel efficiency accounting for around two thirds of this reduction and the remainder from biofuels.
- Car miles fell from 420.2 billion vehicle km in 2007 to 417.7 billion (a 0.6% reduction) in 2008 and 412.8 billion (a 1.2% reduction) in 2009, reducing emissions by the same proportion.

Prior to the recession, emissions had declined slightly in the period 2003-07 as the impact of increasing car miles (around 2.8% over the five year period) was more than offset by improved car fuel efficiency (a 4.9% improvement from an average of 188 g/km in 2003 to 179 g/km in 2007).

1 CCC estimate from preliminary fuel consumption figures.

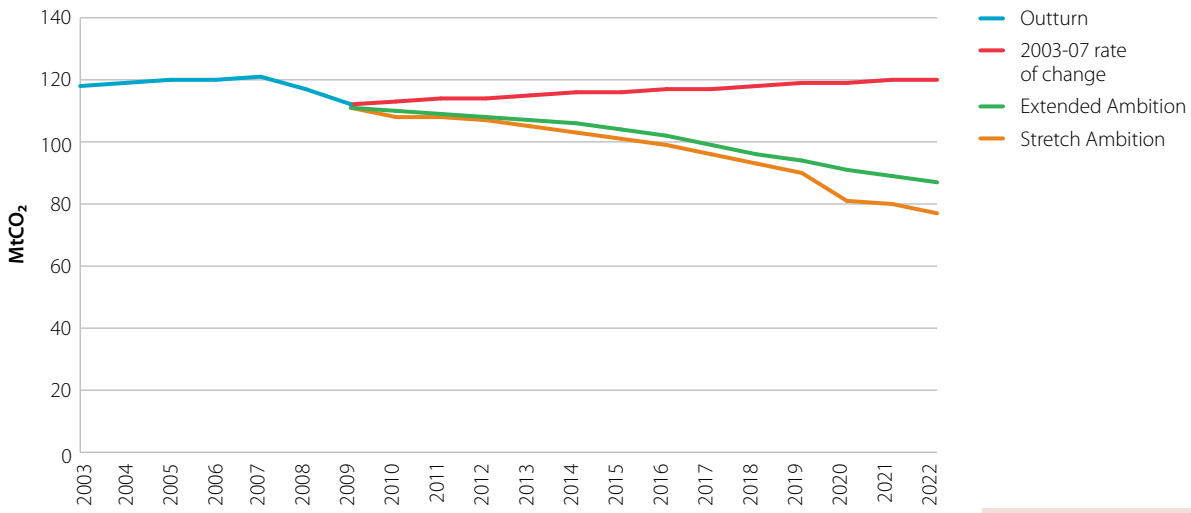
2 2009 emissions data has not yet been published; we have therefore estimated emissions based on data on 2009 petrol and diesel fuel sales, mileage and our own estimate of the reduction in CO_2 intensity of the vehicle fleet.

Figure 4.2 Surface transport emissions reduction (2007-2008)



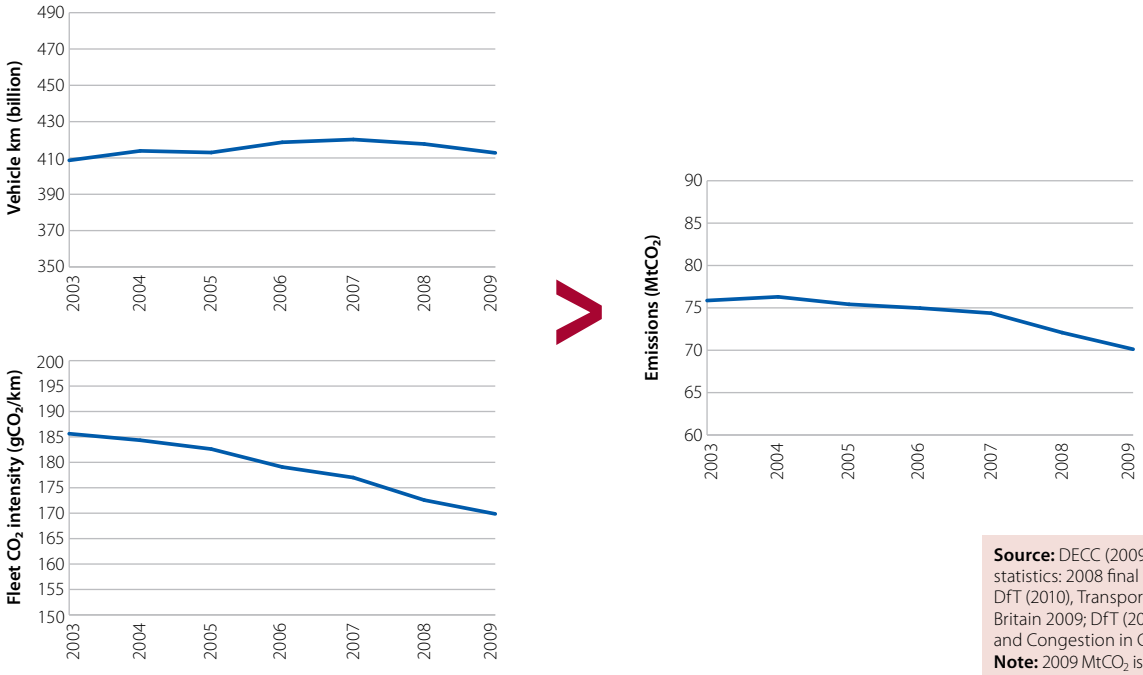
Source: DECC (2009), UK emissions statistics: 2008 final UK figures.

Figure 4.3 Trend surface transport emissions and reductions under Extended and Stretch Ambition scenarios



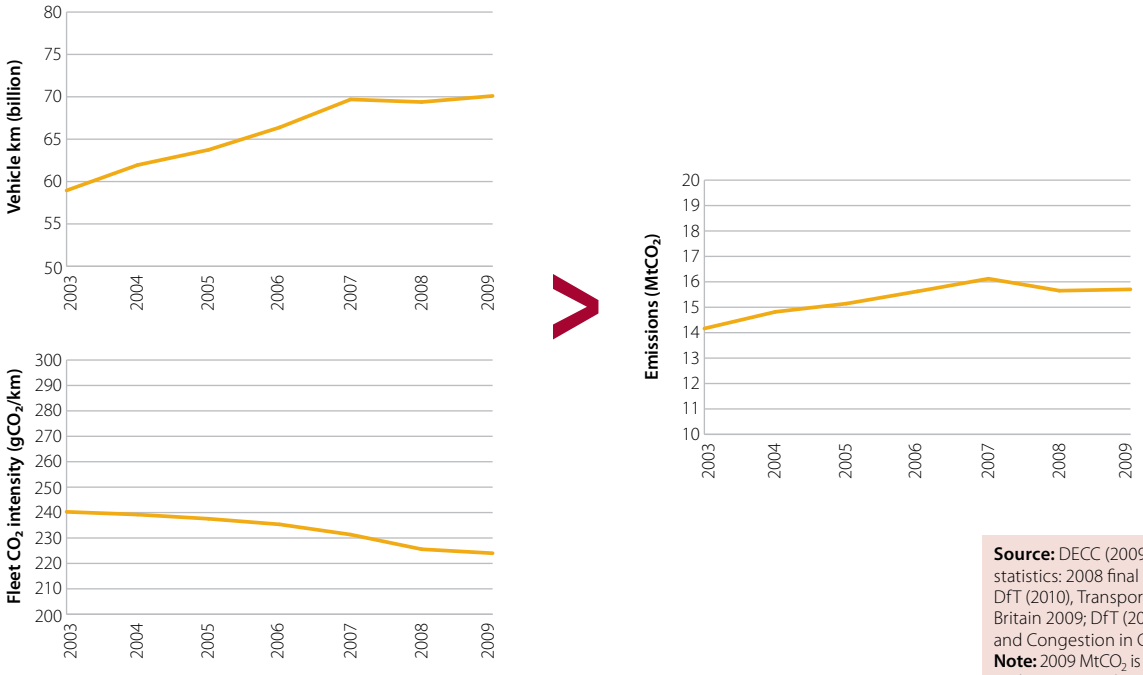
Source: CCC (2009), Meeting Carbon Budgets – the need for a step change.

Figure 4.4 Car mileage, carbon intensity of the car fleet and CO_2 emissions (2003-2009)



Source: DECC (2009), UK emissions statistics: 2008 final UK figures; DfT (2010), Transport Statistics Great Britain 2009; DfT (2010) Road Traffic and Congestion in Great Britain.
Note: 2009 $MtCO_2$ is a CCC estimate, and 2009 gCO_2/km is based on a CCC assumption.

Figure 4.5 Van mileage, CO_2 emissions and carbon intensity of the van fleet (2003-2009)



Source: DECC (2009), UK emissions statistics: 2008 final UK figures; DfT (2010), Transport Statistics Great Britain 2009; DfT (2010) Road Traffic and Congestion in Great Britain.
Note: 2009 $MtCO_2$ is a CCC estimate, and 2009 gCO_2/km is based on a CCC assumption.

There is a risk that emissions do not continue to fall beyond the recession:

- There is a question over whether changed car purchase behaviour during the recession will persist (see Section 3 below).
- We would expect car miles to increase as GDP returns to growth.

The challenge will be to lock in and leverage improvements in car purchase behaviour and to strengthen incentives for reduction of car miles in a context of rising GDP. We set out the path for car emissions required to meet carbon budgets, and consider options for delivering this path in sections 2 and 3 below.

Van emissions

Van emissions fell by 2.9% in 2008, mainly due to improved fuel/carbon efficiency. Van emissions are likely to have increased slightly (by around 0.3%) in 2009[3] (Figure 4.5):

- Average van emissions improved 2.5% from 231 g/km in 2007 to 226 g/km in 2008. We estimate that most of this improvement (around 2 percentage points) was due to use of biofuels, with the remainder (0.5 percentage points) due to improvement of the fuel efficiency of the van fleet.
- Van miles fell by 0.4% in 2008 but increased by 1% in 2009.

The longer-term trend for van emissions is a significant increase (69.9% over the period 1990 to 2007, including 13.8% over the five-year period 2003-2007) due to increased miles. Despite some progress improving fuel efficiency, the share of van emissions in total surface transport emissions increased from 8.5% in 1990 to 13.1% in 2008.

Given that reductions in future van emissions are required to meet carbon budgets, and unless the upward trend in van miles can be reversed, the implication is that fuel efficiency will have to improve over the period to 2020; we consider the evolving framework for reduction of van emissions and scope for delivering this framework in Section 4 below.

HGV emissions

HGV emissions fell by 3.4% in 2008 due mainly to reduced miles travelled, and are likely to have decreased further by around 9% in 2009 (Figure 4.6):

- HGV miles fell from 30.3 billion vehicle km in 2007 to 29.6 billion in 2008 and 27.2 billion in 2009, resulting in emissions reductions of 2.3% in 2008 and 8.4% in 2009.
- There was also some improvement in HGV fuel efficiency, from 801 g/km in 2007 to 792 g/km in 2008, resulting in emissions reductions of 1.1%.

As GDP returns to growth following the recession, we would expect emissions to resume the upward trend of the period before 2008, with the effect of increasing miles only partially offset by improved fuel efficiency (e.g. emissions increased by 7% over the period 2003-2007.

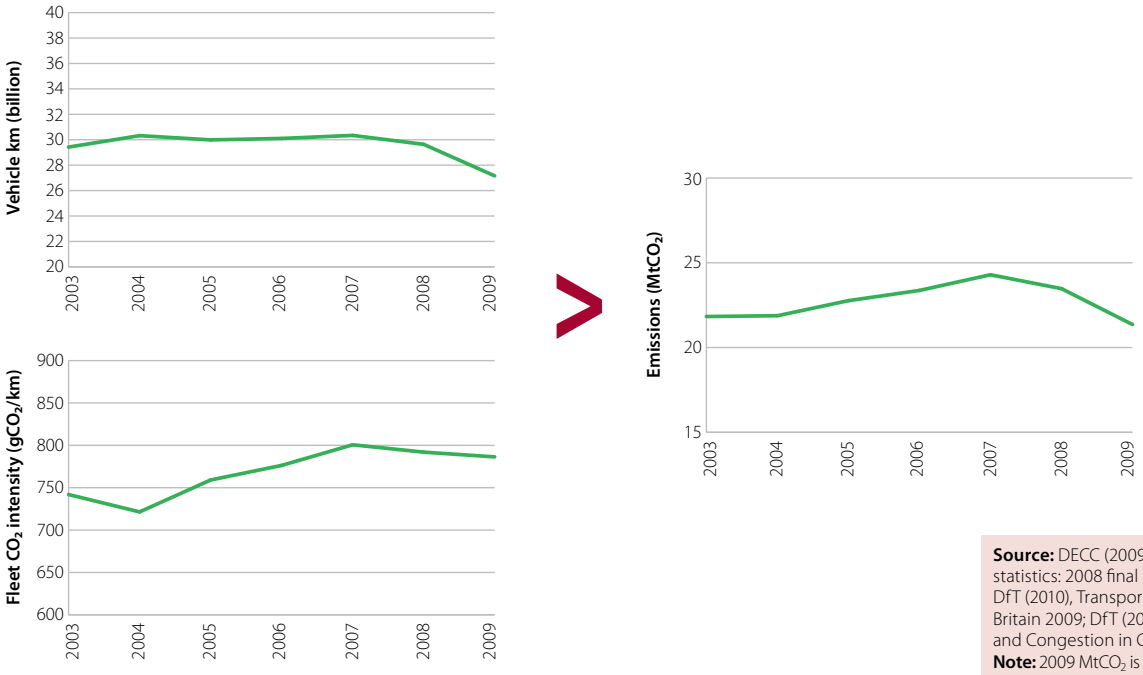
Emissions from public transport

Bus emissions fell by 8.1% in 2008 due mainly to a 5.7% reduction in bus vehicle km (Figure 4.7). We do not have estimates for bus passenger or vehicle km in 2009. Over the longer term, bus emissions increased by 40.7% over the period 1990 to 2007, including 3.2% over the five year period 2003-2007. At the same time there was an increase of bus km (20.2% over the period 1990 to 2007, including 2% over the five year period 2003-2007).

Rail emissions fell by 0.3% (Figure 4.8), as passenger km fell by 12.9% (Figure 4.9) in 2008. We do not have estimates for rail emissions and passenger km in 2009. The longer-term trend for rail emissions is a slight increase (1.3% over the period 1990 to 2007, including 7.7% over the five year period 2003-2007; the latter is exaggerated due to a sharp fall in emissions in 2003). At the same time there has been a significant increase in rail patronage (47.5% over the period 1990 to 2007, including 19% over the five year period 2003-2007).

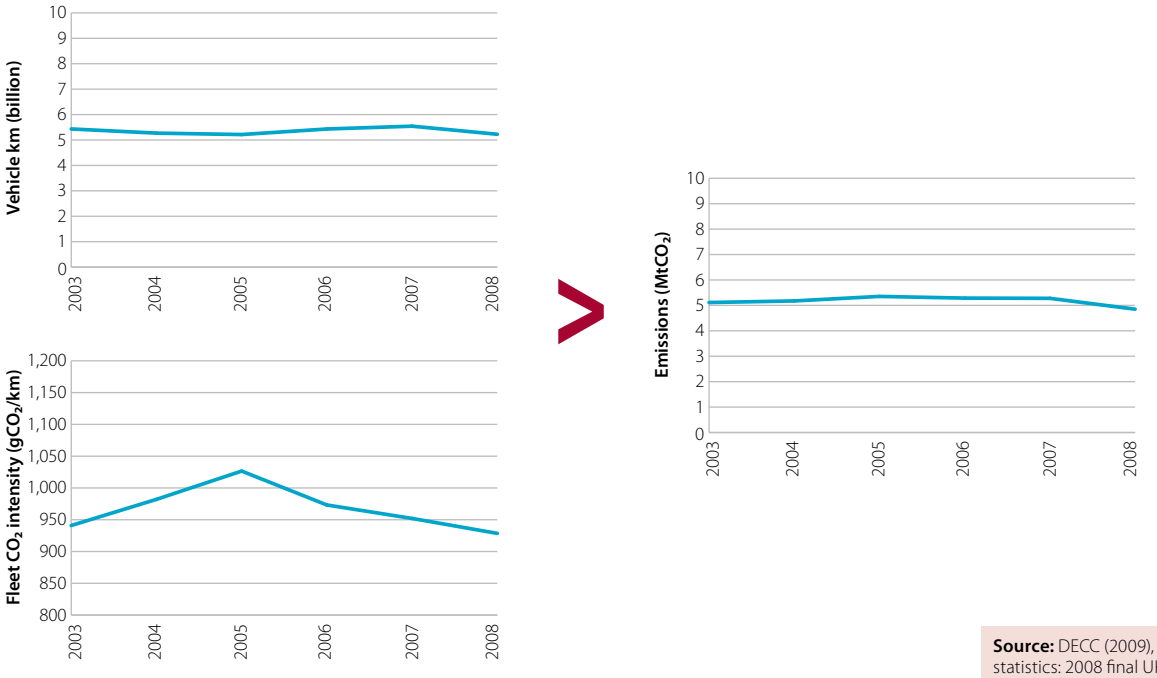
3 CCC estimate.

Figure 4.6 HGV mileage, CO_2 emissions and carbon intensity of the HGV fleet (2003-2009)



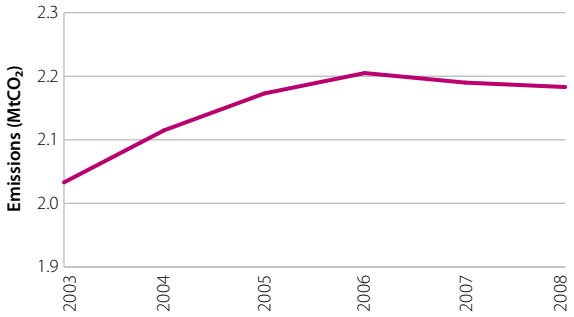
Source: DECC (2009), UK emissions statistics: 2008 final UK figures; DfT (2010), Transport Statistics Great Britain 2009; DfT (2010) Road Traffic and Congestion in Great Britain.
Note: 2009 $MtCO_2$ is a CCC estimate, and 2009 gCO_2/km is based on a CCC assumption.

Figure 4.7 Bus mileage, CO_2 emissions and carbon intensity of the bus fleet (2003-2008)



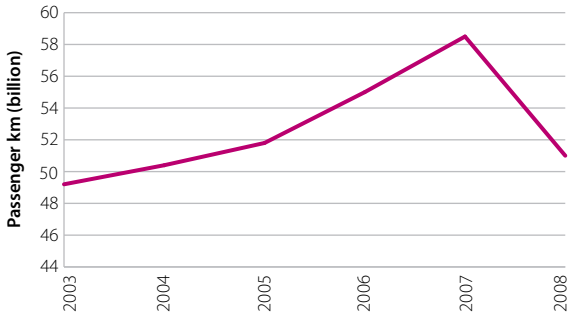
Source: DECC (2009), UK emissions statistics: 2008 final UK figures; DfT (2010), Transport Statistics Great Britain 2009.

Figure 4.8 Rail emissions (2003-2008)



Source: DfT (2010), Transport Statistics Great Britain 2009.

Figure 4.9 Rail passenger km (2003-2008)



Source: DfT (2010), Transport Statistics Great Britain 2009.

For the future, there is a specific opportunity to increase the carbon efficiency of bus travel through switching of journeys from cars and therefore increasing load factors under Smarter Choices policies; we discuss Smarter Choices in Section 3 below. There is also an opportunity for reducing rail emissions through electrification of that part of the network which currently operates on diesel; we will consider this opportunity in more detail in our advice on the fourth budget to be published by the end of 2010.

2. Opportunities for reducing emissions – the Committee's transport indicators framework

In our 2009 progress report we set out a framework of transport indicators to measure progress reducing emissions and meeting carbon budgets. The indicators were based on detailed technical and economic analysis to identify cost-effective opportunities for reducing transport emissions, together with measures required in order to lay foundations for later carbon budgets (e.g. developing electric car technology).

Our analysis suggested that surface transport emissions reductions of 11% from 2007 levels in the first budget, followed by 19% and 29% from 2007 levels in the second and third budgets are both feasible (given appropriate policies) and desirable in the context of meeting economy-wide carbon budgets. The indicators framework embodies these emissions reductions, and includes underpinning measures to deliver them (Table 4.1 – at the end of this chapter):

Fuel/carbon efficiency of cars

We identified three key areas where there is scope for progress on fuel/carbon efficiency of cars:

- **New car fuel efficiency:** given European legislation, there is an opportunity to reduce new car emissions from around 160 g/km in 2008 to 130 g/km in 2015 and 95 g/km in 2020; these emissions reductions would drive average fleet emissions from the current level of around 173 g/km to around 136 g/km in 2020.
- **Increased use of biofuels:** there is scope to increase the level of sustainable biofuels penetration from 2.7% by energy in 2009 progressively to 8% in 2020.
- **Development of electric car technology:** given new electric and plug-in hybrid car models due for launch in the near future, there is scope, with some transitional financial support from Government for car purchase and investment in a battery recharging network, to develop an electric car market. This is important given that electric cars are the most promising technology to deliver deep cuts in car emissions that will be required through the 2020s, and that will not be feasible through cars with conventional combustion engines. Given appropriate support, we suggested it would be feasible to have 240,000 electric cars on the road in the UK by 2015, rising to 1.7 million by 2020.

Consumer behaviour change:
Amongst areas we identified for progress in reducing emissions, we set out indicators for implementation of Smarter Choices, roll out of eco-driving, and alignment of land use/transport planning polices to climate change objectives:

- **Smarter Choices:** this is an approach under which local authorities work with employers and the public using a range of measures including travel planning and provision of travel related information to encourage reduced car travel (for example through including car pooling, home working, and switching to public transport). Acknowledging considerable uncertainty, we adopted a central estimate of emissions reduction in 2020 from nationwide roll out of Smarter Choices of 2.9 $MtCO_2$ consistent with a previous government estimate. We estimated that progressive roll out of Smarter Choices could result in a 4-8% reduction in national car miles and therefore car emissions by 2020.
- **Eco-driving:** there is scope for reduced fuel consumption/emissions through a range of eco-driving techniques including braking and accelerating gently, not driving with excess weight, and ensuring that tyres are at the correct pressure. Our indicators framework reflects scope for fuel consumption/emissions reductions of up to 0.3 $MtCO_2$ based on training of around 3.9 million car drivers by 2020.
- **Land use/transport planning:** there is an opportunity for emissions reduction through ensuring that new development is focused on existing urban areas, complemented by good quality public transport and supporting policies (Smarter Choices, network management measures, etc.). Our indicators framework included a review of land use planning policies to assess the extent of alignment with climate change objectives, to be carried out by 2011.

We now consider progress against our indicators based on latest data for 2009, and related Government announcements since publication of our 2009 progress report. The Committee's indicator framework and outturn data for 2009 are summarised in Table 4.1 at the end of the chapter.

3. Reducing emissions from road vehicles

New car fuel efficiency

New car emissions fell from 158.0 g/km in 2008 to 149.5 g/km in 2009, outperforming our indicator of 157.8gCO_2/km. This 5.4% improvement reflected relatively high purchase of more fuel efficient cars (Figure 4.10) in the context of reduced demand for cars:

- The Government introduced a car scrappage scheme in May 2009. Around 14% of new cars were purchased under the scrappage scheme. Whilst this was not targeted at fuel efficient cars, people buying within the scheme tended to buy more efficient cars (average emissions for cars covered by the scrappage scheme were around 133.3 g/km).
- For those cars not purchased under the scrappage scheme, average emissions in 2009 were 152.2 g/km.
- The total number of new cars purchased in 2009 was 1.97 million, compared with 2.11 million in 2008.

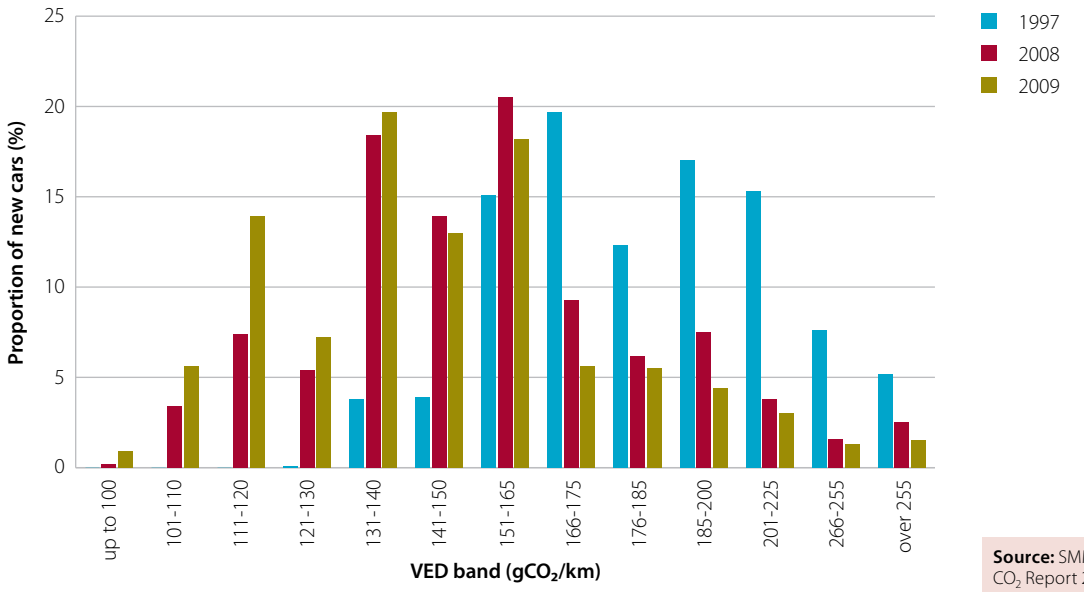
Our analysis suggests that improvement in new car fuel efficiency is likely to have resulted from both changing consumer preferences and technology innovation:

- Around 4.4 percentage points of the 5.4% reduction in new car CO_2 has arisen due to improvements in vehicle efficiency within a vehicle class (Figure 4.11).
- Of this, our analysis suggests at least 1 percentage point is attributable to technology innovation under the EU voluntary agreements (i.e. new efficient models coming to market replacing old inefficient models, without trading off performance characteristics)[4], with the remainder due to changing consumer preferences (i.e. people choosing best in class models).
- In addition, switching between class of car has accounted for around a 1 percentage point increase in average new car efficiency.

We have considered the extent to which new car emissions reductions have been driven by policies (e.g. scrappage, fuel labelling, VED differentiation, the company car regime) or have resulted from increasing fuel prices and the recession (Box 4.1).

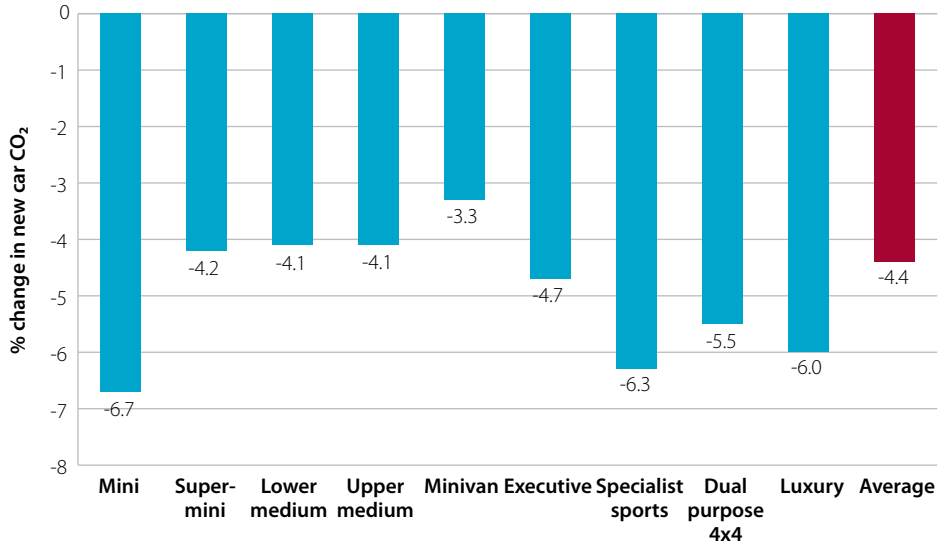
4 Based on AEA Transport Technology Model assumptions. SMMT estimate that the average CO_2 of all new models (not sales) declined by 3.8% in 2009; however the sales weighted effect of this is unclear.

Figure 4.10 New car sales by VED band (1997, 2008 and 2009)



Source: SMMT (2010), New Car CO_2 Report 2010.

Figure 4.11 Improvement in new car CO_2 of each vehicle segment due to technological improvements in vehicle efficiency and consumer shift towards best in class (2008-2009)



Source: SMMT (2010), New Car CO_2 Report 2010.

Our conclusion is that whilst there may have been positive policy impacts, these cannot fully explain the change in car purchase behaviour in 2009 (i.e. the expected impacts of the scrappage scheme, fuel labelling, and differentiated VED alone would be smaller than the observed fuel efficiency improvement).

Going forward, it will be important to create sustained demand for fuel efficient cars as the economy returns to growth and independent of variation in oil prices. In this respect, the changes in first year VED for 2010/11 (particularly the introduction of a more differentiated first year rate of VED up to £950) are important, and further strengthening of the fiscal framework (e.g. by further increasing VED differentiation in line with other EU countries such as France, and increasing the level of fuel duty to offset oil price reductions) to provide signals for consumers and vehicle manufacturers should be seriously considered[5].

A strengthened framework would help to lock in to gains made on new car fuel efficiency during the recession, and support further progress required to meet the EU-wide 95 g/km target in 2020. Meeting this target is necessary if transport is to make an appropriate contribution to meeting carbon budgets, and to prepare for deeper emissions cuts that will be required in the 2020s.

Development of electric car technology

A support package for electric cars and plug-in hybrids was confirmed in February 2010. This comprises total funding of up to £260 million, of which £230 million will cover up to £5,000 of upfront purchase costs per car, and up to £30 million will support investment in a battery charging network.

Our analysis suggests that this support is appropriate as a first step. In particular, the level of support per car proposed is probably sufficient to make electric cars competitive with conventional alternatives. The funding available for battery charging infrastructure is consistent with a largely home based network, which our analysis suggests is both feasible (given that most trips are within the range of an electric car battery) and desirable (given the relatively low cost of home versus fast charging in public places).

Our indicator framework included a near-term action to develop pilot projects in order to kick start the electric car market. Progress has been made in this respect through the Plugged in Places initiative under which three pilot projects have been awarded funding, with a further 3-6 pilots to be selected by end 2010 (Box 4.2).

Plugged in Places is a positive step, but covers only a relatively short time period. In order to underpin the pilots, and to provide more certainty about the long term development of the electric car industry, the Government should now set a level of ambition for the number of electric cars on the road in the period to 2020, and commit to required funding to cover both price support and battery charging infrastructure.

We have proposed that it is appropriate to aim to have 1.7 million electric cars by 2020 to unlock the option for widespread deployment in the 2020s, and will set out scenarios for electric car deployment in the 2020s as part of our advice on the fourth carbon budget, to be published before the end of 2010.

The Japanese Government recently adopted a 2020 target commensurate with this level of ambition (Box 4.3). Particularly given the new Government's objective to mandate a national charging network for electric cars, a similar commitment would be appropriate for the UK in the context of preparing to meet carbon budgets to 2020 and beyond.

Increased use of biofuels

Penetration of biofuels increased from 2.3% in 2008 to 2.9% in 2009 in line with our indicators framework. There remains scope to increase the level of sustainable biofuels to 8% by 2020 in line with the recommendations of the Gallagher Review. Beyond 2020 there is uncertainty around the level of sustainable second generation biofuels, as highlighted in our December 2009 aviation report. We will set out scenarios for second generation biofuels in surface transport through the 2020s as part of our advice on the fourth carbon budget, to be published before the end of the year, and will undertake a more detailed analysis of sustainable bioenergy (i.e. biofuels, biomass, etc.) in 2011.

5 The EC has recently suggested that a more coordinated approach to CO_2 emission based vehicle taxation schemes across member states is desirable in order to provide a consistent signal to manufacturers; see EC (2010), A European strategy on clean and energy efficient vehicles.

Box 4.1 Determinants of new car emissions reductions

- **Scrappage.** Average emissions for cars covered by the scrappage scheme were around 133.3 g/km, compared with 152.2 g/km for those cars not purchased under the scrappage scheme. It is possible that the scheme contributed to lowering average new car CO_2 to 149.5 g/km, through providing a greater subsidy as a proportion of total purchase price. However, it is also possible that the scheme brought forward future purchases of smaller cars to a greater extent than larger cars. The impact of the scrappage scheme is limited by the fact that this covered only around 14% of new car purchases.
- **Fuel efficiency labelling.** Colour coded fuel efficiency labels showing average fuel efficiency and expenditure on fuel over 12,000 miles of typical use were introduced in the UK in 2005. To the extent that fuel efficiency may have been an important consideration in car purchase decisions in 2009, fuel efficiency labelling has arguably encouraged purchase of vehicles with lower gCO_2/km. We note that used car labelling was introduced in November 2009; this is unlikely to have had significant impact in 2009, but it is plausible that this could in future increase the demand for lower emitting new cars in market segments (e.g. fleet buyers) that are sensitive to the price of used cars.
- **VED differentiation.** Differentiation of VED according to fuel efficiency of cars could in principle support changing purchase behaviour (for example, the share of more fuel efficient new cars increased by up to 50% following introduction of differentiated purchase taxes in France). There was some limited differentiation in UK VED in 2009 (up to around £400 annually according to fuel efficiency) which could have had some impact on car purchase behaviour, particularly in combination with rising fuel prices and the recession. However, the observed improvement in new car efficiency far exceeds any impacts from VED differentiation as projected by government.
- **Fuel prices.** Petrol and diesel pump prices have increased by around 25% in the five-year period 2004-2008, including a 14% increase in 2008 alone. Prices fell by 10% in 2009 but remained around 12% higher than 2004 levels. Although we would expect improved fuel efficiency as a result of increasing fuel prices, the scale of improvement in 2009 is well beyond what would be expected, in a year when fuel prices actually fell.
- **The company car regime.** We estimate that purchases of company cars accounted for around 14% of sales in 2009. Following the introduction of a new company car tax regime in 2002 it has been estimated that average emissions of new cars subject to company car tax in 2004 fell by around 15 gCO_2/km[6]. There is, therefore, some evidence of responsiveness to fiscal incentives and it is likely that this, reinforced by the impact of higher fuel prices and the recession, has encouraged continued purchase of more fuel efficient company cars.
- **The recession:** evidence on the relationship between income and fuel efficiency is limited. However, it is reasonable to assume that consumers with reduced current income, or with concerns about future reductions in income are more likely to seek to reduce both purchase and fuel costs when considering a new vehicle. Smaller cars tend to be both cheaper and more fuel efficient than larger cars, and it is therefore likely that the recession has motivated consumers to purchase smaller, cheaper vehicles with greater fuel efficiency and therefore reduced CO_2 emissions.

6 Compared to a no reform counterfactual. Source: HMRC (2006), Report on the Evaluation of the Company car tax reform: Stage 2.

Box 4.2 Plugged In Places

Plugged-In Places, launched on 19 November 2009, is a scheme to provide total seed funding of up to £30 million to consortia of local authorities, businesses, electricity distributors and suppliers and other organisations to support installation of battery charging infrastructure. The aim is to support the early market for electric vehicles, and to inform the future development of a national recharging infrastructure.

On the 25 February 2010, London, the North East region and Milton Keynes were selected as recipients of Plugged-In Places funding (Table B4.2).

Table B4.2 Plugged in Places winning bids

Region	Total project cost	PiP Funding request years 1-3 (allocated year 1)	Charge points	Technologies
London	£28.8m	£9.33m	7,400 public comprising: • 6000 at work places • 500 on-street • 330 public car parks • 50 London Underground stations • 140 supermarket car parks • 250 Olympics • 122 Car clubs rental	Standard, Rapid, Battery swap feasibility study for buses
North East	£7.78m	£2.98m	1050 public comprising: • 50 on-street • 250 public car park • 90 retail car park • 240 workplace • 50 leisure centre • 30 transport hubs • 26 rapid charge 240 domestic	Standard, Fast, Rapid, Inductive, Intelligent networks, Domestic
Milton Keynes	£4.94m	£2.24m	430 public comprising • 286 on street Milton Keynes • 24 on street other • 50 retail car parks • 62 work place • 8 bus rapid charge 2000 domestic	Standard, Fast, Rapid, Inductive, Grid interaction

Source: OLEV

Smarter Choices

Based on evidence from the Sustainable Travel Town pilots, we proposed that rolling out of Smarter Choices initiatives across all urban areas in the UK would result in cost effective emissions reductions and wider economic benefits (e.g. reduced congestion). Since publication of our 2009 report the Sustainable Travel Towns evaluation was completed and the results published (Box 4.4). The evidence continues to strongly support our recommendation that Smarter Choices should be rolled out to other towns and cities.

Box 4.3 Japanese government targets for car technology take up

The Japanese Government has set ambitious targets for take up of "next generation" cars (defined as hybrid, electric and plug in hybrid, fuel cell and clean diesel cars) for 2020 and 2030 (Table B4.3).

The objective is to achieve a 15-20 per cent market share of electric and plug-in hybrid cars by 2020, compared to the 16% market share assumed in our Extended Ambition scenario.

In 2030, it is envisaged that the market share of electric and plug-in hybrid cars in Japan will increase up to 30%, with a further market share of up to 5% for cars using fuel cells.

Table B4.3 Japanese government targets for car technology take up

		2020 target	2030 target
Conventional cars		50-80%	30-50%
Next-generation cars		20-50%	50-70%
	Of which:		
	Hybrid	Up to 30%	Up to 40%
	Electric and plug-in hybrid	Up to 20%	Up to 30%
	Fuel-cell	Up to 1%	Up to 5%
	Clean diesel	Up to 5%	Up to 10%

Box 4.4 Results of the Sustainable Travel Towns evaluation

The DfT funded three Sustainable Travel Towns in Peterborough, Darlington and Worcester to assess the intensive implementation of packages of Smarter Choices measures. The three towns shared £10 million of DfT funding over the five years of the project 2004/05 – 2008/09.

Preliminary results of the implementation of Smarter Choices measures in the Sustainable Travel Towns suggested that the number of car driver trips declined 7-9% over the study period; however, it was not clear to what extent the reduction in car driver trips translated into a reduction in car mileage.

The results of the completed evaluation indicate that residents' car driver trips of under 50km fell by 9% per person, and that car driver distance fell by 5-7%, indicating a greater reduction in shorter car trips than in longer trips. This is within the range we estimated in our 2009 progress report and consistent with our overall estimate of 2.9MtCO_2 for nationwide implementation.

The evaluation estimates a benefit-cost ratio of at least 4.5 (assuming benefits of reduced congestion alone) and possibly much greater if environmental, health and other benefits are also considered.

The evaluation report also notes that further potential could be achieved through targeting of medium and long-distance journeys and a more intensive focus on travel for work.

Source: Sloman et al (2010), The Effects of Smarter Choice Programmes in the Sustainable Travel Towns: Research Report.

However, this positive evidence is not reflected in current policy. Specifically, funding for the proposed Sustainable Travel City project was withdrawn in March 2010. Although it is possible that this could proceed in a revised form under the new Urban Challenge Fund, we cannot currently be confident about this given the lack of details over how this fund will work or the level of funding available.

More generally, there are currently no firm plans to support wider roll out (e.g. through provision of funding and/or other levers to encourage adoption by local authorities). Therefore there is currently a risk that the potential benefits from Smarter Choices remain unlocked. In order that more confidence is provided in this area and to ensure emissions reductions and wider economic benefits, the Government should set out firm details on how it will make good on its support for Smarter Choices and ensure roll out across the country.

Eco-driving

We previously estimated that eco-driving training had the potential to reduce CO_2 emissions in 2020 by up to 1.5 $MtCO_2$ with extensive training of car, van and HGV drivers. We also noted the difficulties involved in delivering eco-driving training at the required scale: in 2009 only 5,311 drivers were trained under the Energy Saving Trust's Smarter Driving programme and training of around 26,000 drivers is forecast for the financial year 2009/10, compared to a required 350,000 car drivers per year in the period to 2020 to achieve the emissions reductions we estimated.

Positive developments as regards eco-driving are:

- The Driving Standards Agency is reviewing the syllabus of Pass Plus (a post-test scheme completed by around 90,000 newly qualified drivers each year), with an emphasis on driver behaviour, including eco-driving. DfT and DSA aim to launch a trial of the new scheme by March 2011.
- DfT recently published a consultation on options to achieve 90% uptake of eco-driving in the HGV sector (Box 4.5).

The challenge now is to move from consultations and draft proposals in these specific areas to implementation, and to develop a credible plan for training the vast majority of car drivers in eco-driving techniques.

Box 4.5 DfT Consultation on eco-driving training for drivers of Large Goods Vehicles and Passenger Carrying Vehicles

The DfT is considering options to achieve at least a 90 percent uptake of eco-driving training for drivers of Large Goods Vehicles (LGVs).

The consultation document (March 2010) presents three options for achieving uptake of eco-driving for LGV drivers and (in the third of these options) for Passenger Carrying Vehicle (PCV) drivers:

- Option 1 (baseline): No change. Eco-driving training continues to be undertaken on a voluntary basis, and the commercial pressure to reduce fuel costs is the primary driver for change.
- Option 2: Maintain current regulations but increase promotion of the benefits of eco-driving training, for example through increased marketing or improved best practice programmes.
- Option 3: Regulatory change. Eco-driving training to become a mandatory part of Driver Certificate of Professional Competence (CPC) periodic training for both LGV and PCV drivers. Option three is projected to save around 3 million tonnes of carbon dioxide over an eight year period relative to baseline (option 1).

DfT favours Option 3 on the basis that this provides more confidence about emissions reductions, and, depending on the response to the consultation, is planning to bring forward specific proposals to implement this option.

Land use/transport planning

In our 2009 progress report to Parliament we suggested that land use planning provides a significant opportunity for reducing emissions. We highlighted the risk that under the current planning framework inappropriate siting of new housing development could lead to considerable additional car travel. We also argued that significant new retail development (in particular supermarkets and retail warehouses) continues to be located out of town and in edge-of-centre locations where they are likely to generate a greater volume of car travel than in town centre locations.

This conclusion is supported by the recent Commission for Integrated Transport (CfIT) study[7], which reviewed the evidence base on the influence of urban structure on travel patterns, and evaluated the adequacy of existing guidance on the ways in which transport issues should influence planning decisions. CfIT highlight a number of areas in which current planning guidance does not fully reflect current understanding of land use/transport relationships in a number of respects (Box 4.6):

CLG acknowledged the Committee's concerns and outlined a number of future changes to the current planning system, including:

- Introduction of the integrated Regional Strategy, reinforcing the integration of Regional Spatial Strategies and Regional Transport Strategies, with consideration of emissions to be given during the Sustainability Appraisal process.
- Publication of a revised Planning Policy Statement on climate change (now under consultation).
- Consideration of how to build better integration between planning and transport policies consistent with climate change goals in the course of the review of the Government planning policy suite (an outcome of the Planning White Paper).

The proposed review of planning policy by the new Government provides an opportunity to consider scope for designing new developments in a way that limits additional transport emissions, in a context where there will be potentially large numbers of new houses and other developments in the next two decades, and where location decisions could have impacts for meeting carbon budgets.

7 Commission for Integrated Transport (2009), Land use and Transport – Settlement Patterns and the Demand for Travel.

Box 4.6 CfIT evaluation of current planning guidance

CfIT argue that car travel originating from new housing development can be reduced by locating the development in appropriate settlements, and by restricting parking spaces in new development to reduce the incentives for residents to own cars.

CfIT note that these factors are not adequately addressed in current planning guidance:

More generally, CfIT argue that planning guidance on transport issues is framed around reducing the **need** to travel by car, rather than achieving an **actual reduction in car travel**, and that policies designed to achieve the former objective are unlikely to achieve the latter.

Table B4.6 CfIT evaluation of current planning guidance

Factor	Adequacy of guidance
Development location	
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)	Planning Policy Guidance 13: Transport (PPG13) advocates that additional housing should be focussed on 'existing towns and cities' (para 13) but does not discriminate between urban settlements of different size.
• that are self-contained having both a relatively high jobs/worker ratio and sufficient facilities	Other than the general reference of aiming for a 'broad balance at the strategic level between employment and housing' (para 30) the importance of these additional factors is not highlighted in the guidance.
• in areas where the size and proximity (or more strictly accessibility) of other settlements is relatively low	Not highlighted in the guidance.
• 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	Not highlighted in the guidance.
• 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). CfIT note that application of Green Belt policies exacerbate this effect	Not highlighted in the guidance.
Parking restriction	
Car travel originating from new housing development can be reduced by restricting parking spaces in new development to reduce the incentives for residents to own cars. Planning Policy Guidance 13: Transport (PPG13) recognised this, setting out national specified maximum standards for nonresidential parking provision, which CfIT argue are aimed at preventing individual planning authorities being subject to 'pressures' to allow greater parking provision in order to 'capture' developer investment.	Planning policy on housing makes no acknowledgement of the scope for such measures within housing development (i.e. via control of parking and by positive promotion of alternatives including car clubs and car share); instead Planning Policy Statement 3: Housing (PPS3) states that Local Planning Authorities should develop residential parking policies "taking account of the expected levels of car ownership".
	Planning Policy Statement 4: Planning for Sustainable Economic Growth (PPS4) removes the national specified maximum standards for nonresidential parking provision introduced in PPG13, replacing them with policies developed at the local level.

Source: Commission for Integrated Transport (October 2009), Background Technical Report: Land use and Transport – Settlement Patterns and the Demand for Travel.

Reducing emissions from vans

In our December 2008 report advising on carbon budgets and the long-term target, we set out an analysis of scope for reducing emissions from vans through a range of measures including stop-start, hybrid and plug in hybrid powertrains, and non-powertrain measures (e.g. more aerodynamic design, gear shift indicators, low rolling resistance tyres). We set out an Extended Ambition scenario under which new van CO_2 falls by around 11.4 %, and a Stretch Ambition scenario under which it falls by around 27.7% in the period to 2020[8]. We suggested the need for a new policy framework at the European level to drive innovation and unlock emissions reduction potential.

In October 2009 the EU published a draft framework for new van emissions which envisages ambitious targets over the period to 2020:

- The framework proposes a new standard for new van emissions of 175 g/km (relative to the EU average of around 203 g/km in 2009). This will apply to 75% of new vans from 2014, 80% from 2015 and 100% from 2016.
- The framework also includes a 2020 target that new van emissions should fall to 135 g/km.

Our analysis suggests that the emissions reductions in the proposed EU framework can be achieved through a combination of powertrain (predominantly hybrids with an additional contribution from PHEVs) and non-powertrain measures. DfT estimate the costs to the UK of achieving the proposed EU targets is around £5/tCO_2[9].

Given the need to reduce van emissions, both to contribute to meeting the first three carbon budgets and to prepare for meeting the fourth and subsequent budgets, we recommend that the UK Government strongly supports the draft EU framework, including through the introduction of complementary levers (e.g. better information, awareness raising, price levers), and we will include the draft EU targets in our indicator framework against which we will assess future progress reducing van emissions.

Progress in Devolved Administrations

There have been a number of initiatives in the Devolved Administrations to reduce transport emissions, both through low-carbon technologies and consumer behaviour change (Box 4.7). It will be important that positive proposals and good first steps are followed by comprehensive policy approaches if Devolved Administration emissions targets are to be achieved and appropriate contributions to UK carbon budgets made.

8 We originally estimated the reference new van CO_2 in 2020 at 271 gCO_2/km. However new van CO_2 in 2009 (the first year for which published data is available) was around 206gCO_2/km. This difference does not affect our previous estimates of van emissions or abatement potential, which are based on official statistics and relative rather than absolute levels of abatement.

9 DfT (2010), Impact Assessment of proposed EU new van CO_2 regulation.

Box 4.7 Progress in Devolved Administrations

Scotland

The Scottish Government launched a consultation in June 2009 to consider how the development and uptake of low-carbon vehicles (defined as vehicles 'powered by alternative fuels or technologies, including electric vehicles, plug-in hybrids, hybrids, stop-start micro hybrids, hydrogen vehicles or equivalent') may best be accelerated, and proposing that 95% of all vehicles purchased (including the entire public sector vehicle fleet) should be low-carbon by 2020. In June 2010 the Scottish Government announced £8 million funding to develop charging facilities and to assist councils and bus companies with the purchase of low-carbon vehicles.

Seven project areas are taking part in Scotland's Smarter Choices, Smarter Places demonstration initiative. Work on infrastructure improvements and planning of behaviour change campaigns was carried out between September 2008 and April 2009. The public phase of the work was launched in each of the seven project areas in May 2009 and will continue until March 2011.

Wales

The Welsh Assembly Government is currently preparing its Climate Change Strategy (due later in 2010) following consultation in 2009. Proposals currently under consideration include investment in low carbon transport infrastructure, park and ride schemes and an inter-modal Freight Consolidation Centre.

Northern Ireland

The Department for Regional Development in Northern Ireland has established a Transportation Policy Division to assist in the development of sustainable transport arrangements and contribute to work identifying and costing options to reduce emissions from transport. The outcome of this work will inform the current review of Northern Ireland's Regional Transport Strategy (RTS). A revised RTS document is due for public consultation later in the year and is aimed at tackling rising transport emissions through changing driver behaviour, modal shift and better journey planning.

4. DfT's carbon reduction delivery plan

The DfT's Transport Carbon Reduction Delivery Plan published in March 2010 describes the current policy framework for delivery of emissions reductions. The Delivery Plan also sets out how DfT intends to measure progress towards reducing transport emissions, including a set of variables to be tracked and a number of policy milestones which mirror the Committee's indicators (Box 4.8).

Box 4.8 Transport Carbon Reduction Delivery Plan monitoring framework

The Transport Carbon Reduction Delivery Plan sets out UK and EU policy expected to result in emissions reductions, and the framework of information with which DfT intends to measure and monitor transport emissions and the progress of policies in delivering transport emissions reductions. This framework consists of the following indicators and milestones for relevant drivers and policies:

Tier 1 Indicators: Overall sector GHG emissions

- Transport GHG emissions 1990-2008
- Absolute change in transport GHG emissions since 1990

Tier 2 Indicators: Disaggregated sector GHG emissions

- GHG emissions 1990-2008 by mode
- Absolute change in GHG emissions since 1990 by mode

Tier 3 Indicators: Main drivers of sector emissions

- Freight distance (vehicle km and tonne km) by mode
- Passenger travel distsance by mode
- Cars by VED tax bands (gCO_2/km emissions)
- % by volume of road transport fuel from biofuels

Tier 4: Policy milestones and policy indicators

- Various milestones and policy indicators relating to cars and vans, sustainable travel, bus, rail and freight

Contextual factor indicators

- Population, Employment, GDP, etc.

We have a number of recommendations for improving the plan including defining levels of ambition against which progress reducing emissions can be monitored, ensuring that the level of ambition is commensurate with required emissions reductions, and committing to new approaches and policies required to deliver emissions reductions:

- **Defining indicator trajectories:** One major problem with the framework is that it does not include trajectories for the variables to be tracked, and does not therefore provide a basis for assessing whether adequate progress is being made towards meeting carbon budgets. In order to address this, trajectories for key variables (e.g. new car emissions, electric car roll out, car miles, new van emissions) should be added to the plan so that future progress reducing emissions can be transparently and meaningfully monitored.
- **Ensuring sufficient ambition:** The plan does not currently commit to aiming to achieve the EU target for new car emissions (95 g/km in 2020), or suggest firm ambition on electric cars (we propose 1.7 million electric cars in 2020), or aim for appropriately high levels of eco-driving training. Ambitious targets for specific measures are required to provide confidence that emissions reductions required to meet carbon budgets will be achieved.
- **Committing to new approaches and policies:** New policy approaches are required to drive emissions reductions (e.g. to encourage purchase of more efficient cars and vans, roll out of Smarter Choices, new approaches to land use and transport planning). The departmental plan/ indicator framework should include milestones for development of policies in these and other areas.

It will be important to develop the departmental plan in the ways outlined above to help deliver the required step change in reducing transport emissions required to meet the carbon budgets.

Table 4.1 The Committee's transport indicators

ROAD TRANSPORT		Budget 1	Budget 2	Budget 3	2009 trajectory	2009 outturn
Headline indicators						
Emissions (% change on 2007)	Total	-11%	-19%	-29%	-2%	-7%
	Car	-17%	-24%	-34%	-1%	-6%
	Van	11%	23%	36%	2%	-3%
	HGV	-13%	-16%	-19%	-5%	-12%
gCO_2/km (carbon intensity of a vehicle kilometre)	Car	155	137	117	163	170
	Van	255	242	215	257	224
	HGV	752	711	673	776	785
Vehicle kilometres with impact of Smarter Choices (billion vkm)	Car	421	419	420	422	413
Supporting indicators						
Vehicle technology						
New car gCO_2/km	Car	142	110	95 (by 2020)	158	150
New electric cars registered each year (value at end of Budget period)		11,000	230,000	550,000	0	242
Stock of electric cars in vehicle fleet		22,000	640,000 (240,000 delivered through pilot projects in 2015)	2,600,000	0	1,976
Biofuels						
Penetration of biofuels		5%	8%	10%	3%	3%
Decision on whether RTFO target can be met sustainably		2011/12			n/a	n/a

Table 4.1 The Committee's transport indicators

Demand side measures					
Proportion of drivers exceeding 70mph		0%*	0%	n/a	n/a
Car drivers who have undergone eco driving training	1,050,000	2,800,000	4,550,000	0	10,000
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
Wider monitoring					
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 drivers exceeding 70mph					
Agreement of modalities for reaching an EU target of 95 gCO_2/km 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, 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.					

*These are the values implied by the estimated savings from speed limiting. The Committee 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.

Notes:

1. While we present outturn vs. trajectory figures for 2009, it is not our expectation that our trajectories will be achieved precisely for every indicator in every year. There may be some year to year variation, which is acceptable. Similarly it may be the case that some indicators are not met while others are over-achieved; this may still on average constitute sufficient progress. A problem will be signalled however if under-achievement persists, if a large number of indicators are off-track or if specific indicators or milestones which are key to unlocking abatement in the longer term are not met.

Key: Headline indicators Implementation indicators Milestones Other drivers

Chapter 5: Opportunities for reducing emissions from agriculture

Introduction and key messages

In our December 2008 report we published the first UK Marginal Abatement Cost Curve for agriculture. This highlighted a significant emissions reduction potential through cost-saving measures relating to soils and livestock. Given this potential, we suggested that agricultural emissions reductions should form part of the Government's wider strategy for meeting carbon budgets, and that new incentives would be required to encourage changed farming practice.

In this chapter, we do four things:

- We consider latest agriculture emissions data.
- We revisit our assessment of agricultural emissions reduction potential in light of new evidence.
- We consider at a high level the incentive framework for changing farming practice.
- We set out a draft indicator framework against which future progress reducing agricultural emissions can be judged.

The key messages in the chapter are:

- Estimated agriculture emissions fell by 1% in 2008 continuing a longer-term trend where emissions fell by 21% over the period since 1990, largely due to less fertiliser use and reduced livestock numbers as a result of CAP reform.
- The agriculture emissions reduction targeted for England in the Low Carbon Transition Plan appears low relative to underlying maximum potential. It should therefore be regarded as indicative, with the possibility of significant further emissions reductions through soils and livestock measures and manure management/anaerobic digestion. Devolved Administrations should also set targets at least in line with the LCTP ambition and seek to unlock full underlying potential.
- A range of policies beyond provision of information/encouragement should be seriously considered to address barriers to action. The Government should ensure development of a more robust evidence base which better identifies current farming practice and the emissions impact of changed practice. This would underpin strategic approaches and support new policies to unlock agriculture emissions reduction potential.
- Given the uncertainties in projecting agriculture emissions, the focus should be on implementation of measures. We propose a draft framework of indicators reflecting key emissions-reducing measures (e.g. farmer uptake) as well as emissions drivers (e.g. livestock numbers, fertiliser usage) for further development (Table 5.1 at the end of this chapter).

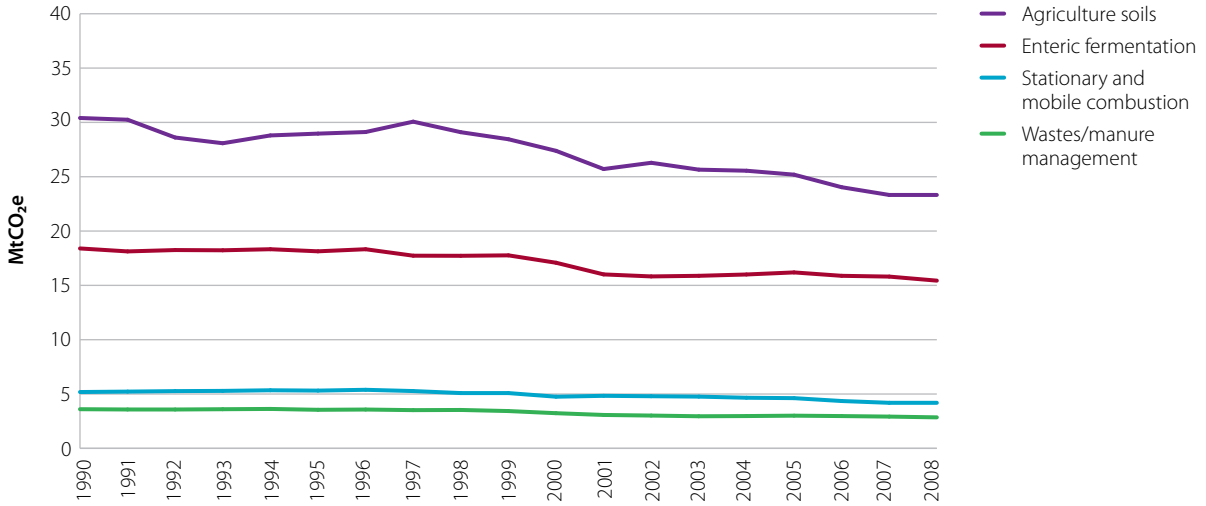
We set out the analysis that underpins these messages in seven sections:

1. Progress reducing agricultural emissions
2. Scope for future reductions in agricultural emissions
3. Incentives for reducing agricultural emissions
4. Indicators of progress reducing agricultural emissions
5. Longer-term agricultural emissions reductions
6. Land use, land use change and forestry
7. Defra's carbon reduction delivery plan

1. Progress reducing agricultural emissions

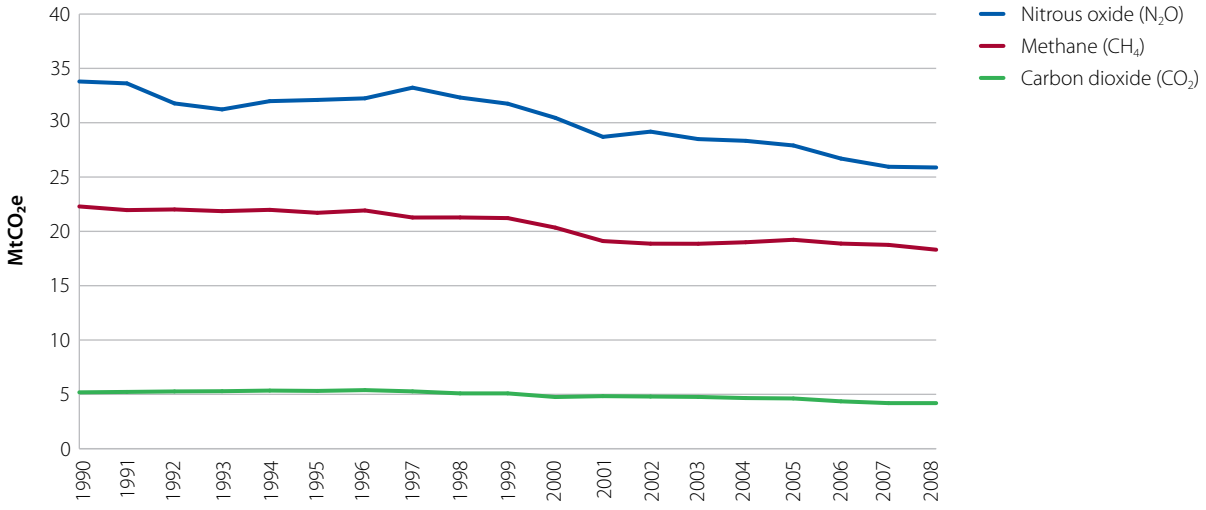
Agriculture GHG emissions fell by 1% between 2007 and 2008. 2009 emissions figures will not be available until 2011 and thus the impact of the recession on agriculture is not yet known.

Figure 5.1 Agriculture CO_2e emissions by source (1990-2008)



Source: NAEI (2010).

Figure 5.2 Agriculture CO_2e emissions by greenhouse gas (1990-2008)



Source: NAEI (2010).

In the period since 1990, agriculture emissions have fallen by around 20%, from 61 $MtCO_2e$ to 48 $MtCO_2e$:

- Emissions from all agriculture sources have fallen since 1990: soils (-23%), enteric fermentation (-16%), wastes/manure management (-21%), and stationary/mobile combustion (-19%) (Figure 5.1).
- Emissions have fallen across the range of greenhouse gases: nitrous oxide (N_2O): -23%, methane (CH_4): -18% and CO_2: -19% (Figure 5.2).

As in other sectors we focus on emissions arising from direct agricultural sources, but we note that reductions in N_2O resulting from reduced fertiliser use will also have emissions benefits upstream as fertiliser production is associated with high industrial CO_2 emissions (e.g. global emissions from fertiliser production fell by 14% between 1990 and 2007).[1]

Emissions drivers (nitrous oxide)

Nitrous oxide emissions (53% of total agriculture emissions in 2008) arise naturally in agricultural soils through biological processes but are greatly influenced by a variety of agricultural practices and activities, including:

- The quantity of synthetic nitrogen (N) and organic fertilisers applied to both arable and managed pasture land.
- The deposition of manure onto soils by grazing animals.
- The nitrogen in crop residues returned to soils.
- The fertiliser application method, including technique (e.g. timing) and other land management practices (e.g. drainage), which can affect the proportion of nitrogen taken up by the crop, retained in the soil or released as N_2O or other pollutants.

Currently the UK inventory for N_2O emissions arising from agricultural practices and activities on soils is calculated mainly based on the quantity of nitrogen fertiliser applied (both synthetic and organic) and the quantity of agricultural lands to which it is applied. The fertiliser application method (e.g. technique) is not currently captured in the inventory, nor is it systematically monitored.

Total hectares of cultivated arable and managed pasture land within the UK remained fairly constant between 1990 and 2008[2], but the quantity of fertiliser applied has fallen significantly since 1990. Recorded N_2O emissions per hectare of cultivated land have fallen in line with reductions in fertiliser use (Figure 5.3):

- Between 1990 and 2008 total synthetic and organic nitrogen input application rates for croplands and managed pasture in the UK fell by 32% from 163 to 96 kg N per hectare[3], with a corresponding decline in emissions per hectare. This reduction has been focused on pasture land (Figure 5.4):
  - The application rate for synthetic nitrogen[4] on arable land has remained fairly constant between 1990 and 2008 (around 140-150kg/ha). Arable crop yields have simultaneously improved (e.g. cereal yields have increased by 20%), suggesting some improvement in efficiency.
  - The synthetic nitrogen application rate on grassland has fallen from 129 to 55 kg/ha (57%) between 1990 and 2008. This has coincided with reduced livestock numbers as a result of CAP reform (see "Emissions drivers – methane" below), and as such may be attributable to reduced stocking densities along with possibly improved efficiency in fertiliser use.
- These fertiliser application trends coincided with a rise in fertiliser prices from £100/tonne in 1998 to over £400/tonne in 2009[5] and the introduction of legislation aimed at other pollutants (i.e. Nitrates Action Programme, mandatory measures to tackle nitrate loss from agriculture, and the England Catchment Sensitive Farming Directive, an initiative to reduce impact of diffuse water pollution from farming and improve soil and land management practices). It is thus also possible that price increases and new policies have impacted fertiliser demand within the UK.

1 UNFCC GHG Data (2008).

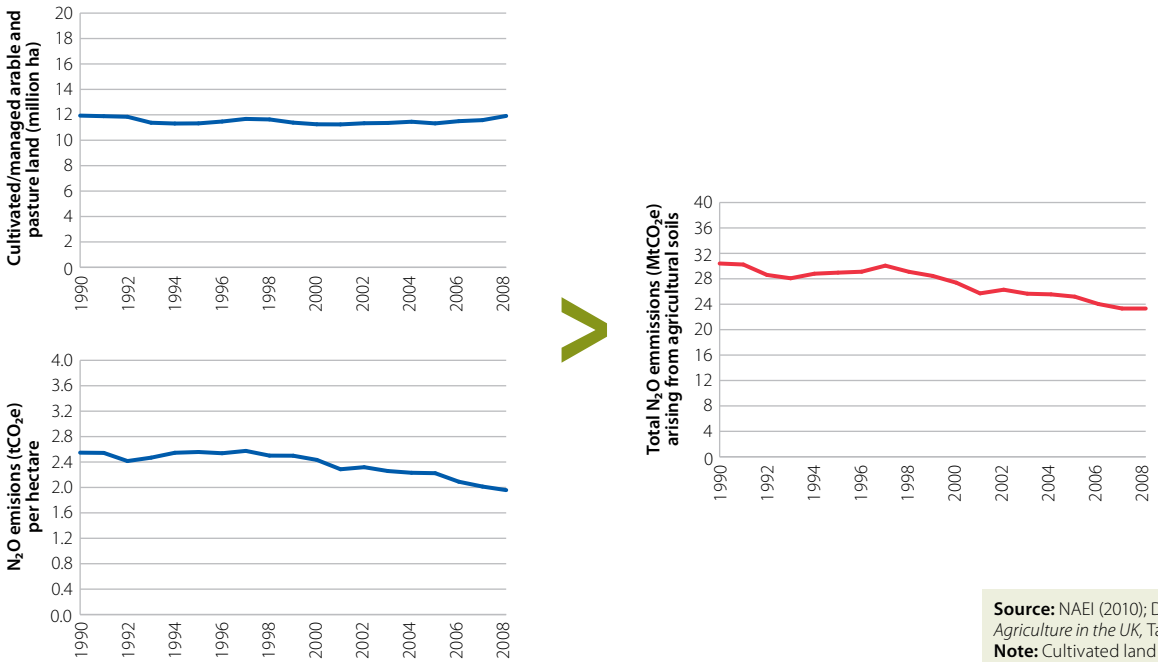
2 Defra (2009), *Agriculture in the UK,* Table 3.1.

3 CCC calculations based on nitrogen input data from NAEI Reports Database (2009), *UK Greenhouse Gas Inventory,* 1990 to 2008, Common Reporting Format Tables and agricultural land use data in Defra (2009), *Agriculture in the UK,* Table 3.1.

4 The *British Survey of Fertiliser Practice* only provides data on synthetic nitrogen application rates disaggregated by arable and pasture land.

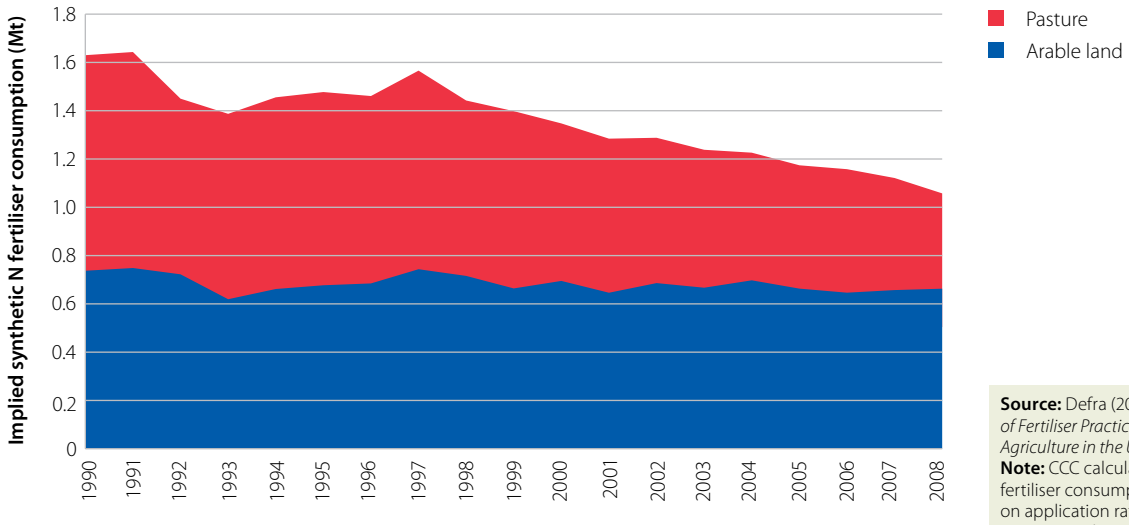
5 For UK-sourced ammonium nitrate straight N fertiliser. AIC (2009), *Fertiliser Statistics Report.*

Figure 5.3 Historical trends in managed arable and pasture land and N_2O emissions arising from agriculture soils (1990-2008)



Source: NAEI (2010); Defra (2009), *Agriculture in the UK*, Table 3.1.
Note: Cultivated land excludes rough grazing, uncropped arable land and other land (e.g. woodland).

Figure 5.4 UK consumption of synthetic nitrogen fertiliser on arable and managed pasture land (1990-2008)



Source: Defra (2009), *British Survey of Fertiliser Practice*; Defra (2009), *Agriculture in the UK*, Table 3.1.
Note: CCC calculations of UK fertiliser consumption based on application rates for Great Britain *(British Survey of Fertiliser Practice).*

Emissions drivers (methane)

Methane emissions (38% of agriculture emissions in 2008) within the agriculture sector mainly arise from enteric fermentation that occurs in the digestive systems of ruminants (e.g. cattle and sheep) and from manures. They are driven by:

- The number of livestock animals, which could be influenced by policy, economic factors, production efficiencies and the incidence of animal disease.
- The characteristics of those animals (i.e. their breed, size, yield, digestive systems, etc).
- What livestock are fed (e.g. a diet with a higher maize content can maintain animal performance while decreasing the production of methane).
- How manures are managed (e.g. methane emissions arising from the anaerobic digestion in slurry storage can be reduced by covering and aerating slurry and manure while stored).

At present, the UK inventory calculates methane emissions arising from enteric fermentation and manures largely on the basis of numbers of ruminant livestock, to which standard emission factors are applied.[6] Falling emissions estimates in the period since 1990 are therefore the result of falling livestock numbers – with cattle and calve numbers falling by 2 million (17%) and sheep and lamb numbers falling by 11 million (25%) – which could have three possible drivers:

- A decrease in consumption of livestock products (e.g. dairy, beef/veal and sheepmeat), with a corresponding decrease in domestic production;
- An increase in livestock net imports, with a corresponding decrease in domestic production;
- An improvement in efficiency per kg of product, to produce the same product from fewer animals.

Since 1990, UK consumption of livestock products has remained relatively constant, with the decrease in methane emissions mainly attributable to an increase in net imports following reform of the European Union Common Agricultural Policy (CAP) while production per animal has improved slightly (Figures 5.5, 5.6 and 5.7):

- UK consumption of milk has remained constant since 1990 and while beef/veal consumption decreased in the mid-1990s it has returned to 1990 levels in recent years with imports increasing to offset production decreases. Sheepmeat/lamb consumption has declined since 1990, with a corresponding decline in net imports.
- UK livestock numbers have declined more significantly since 2000 in response to CAP reform, which decoupled farming support payments from animal numbers.
- There is also some evidence of improved efficiencies within the livestock sector, with output per animal increasing between 1990 and 2008, potentially as a result of improved genetics, fertility, feeding and health measures:[7]
  - While the total UK dairy herd has reduced by a third between 1990 and 2008, the average milk yield per dairy cow per annum has improved by 1800 litres (35%). Total milk production has fallen by 10%.
  - Within the beef industry, the number of prime cattle required to produce each tonne of beef has decreased 5% from 3.23 in 1998 to 3.07 in 2008. Similarly within the sheep sector, 53.48 lambs were required to produce each tonne of meat in 2008 compared to 56.18 in 1998.[8]

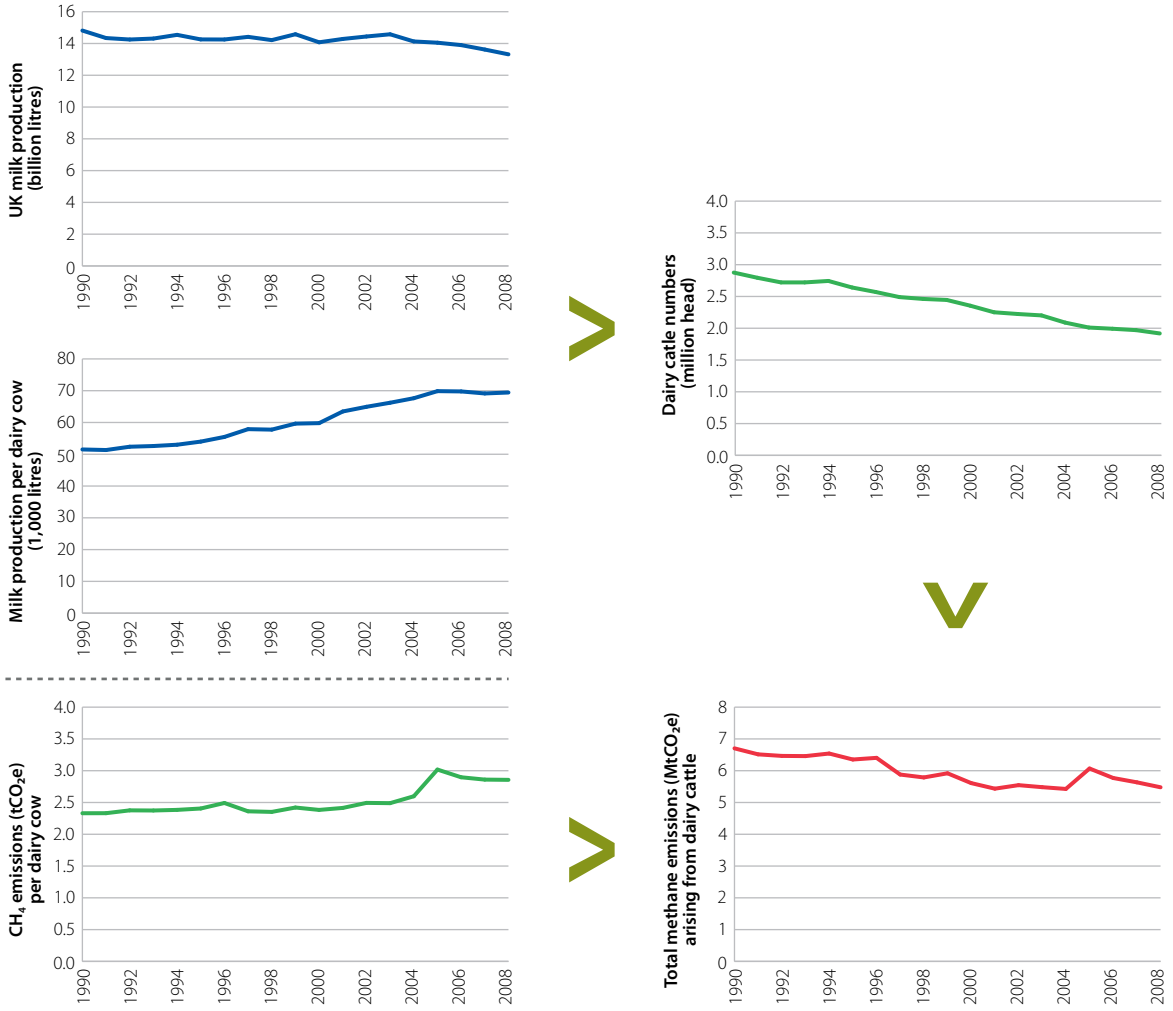
Emissions from manure management are also currently calculated based on livestock numbers and have fallen in line with methane emissions arising from enteric fermentation.

6 A more sophisticated accounting approach has been developed for dairy cattle, which factors in animal weight, energy intake, and milk yield, all of which work to influence the production of methane.

7 While methods to improve efficiency could increase emissions *per* animal, aggregate emissions are expected to decline as fewer animals are required to produce the same quantity of output.

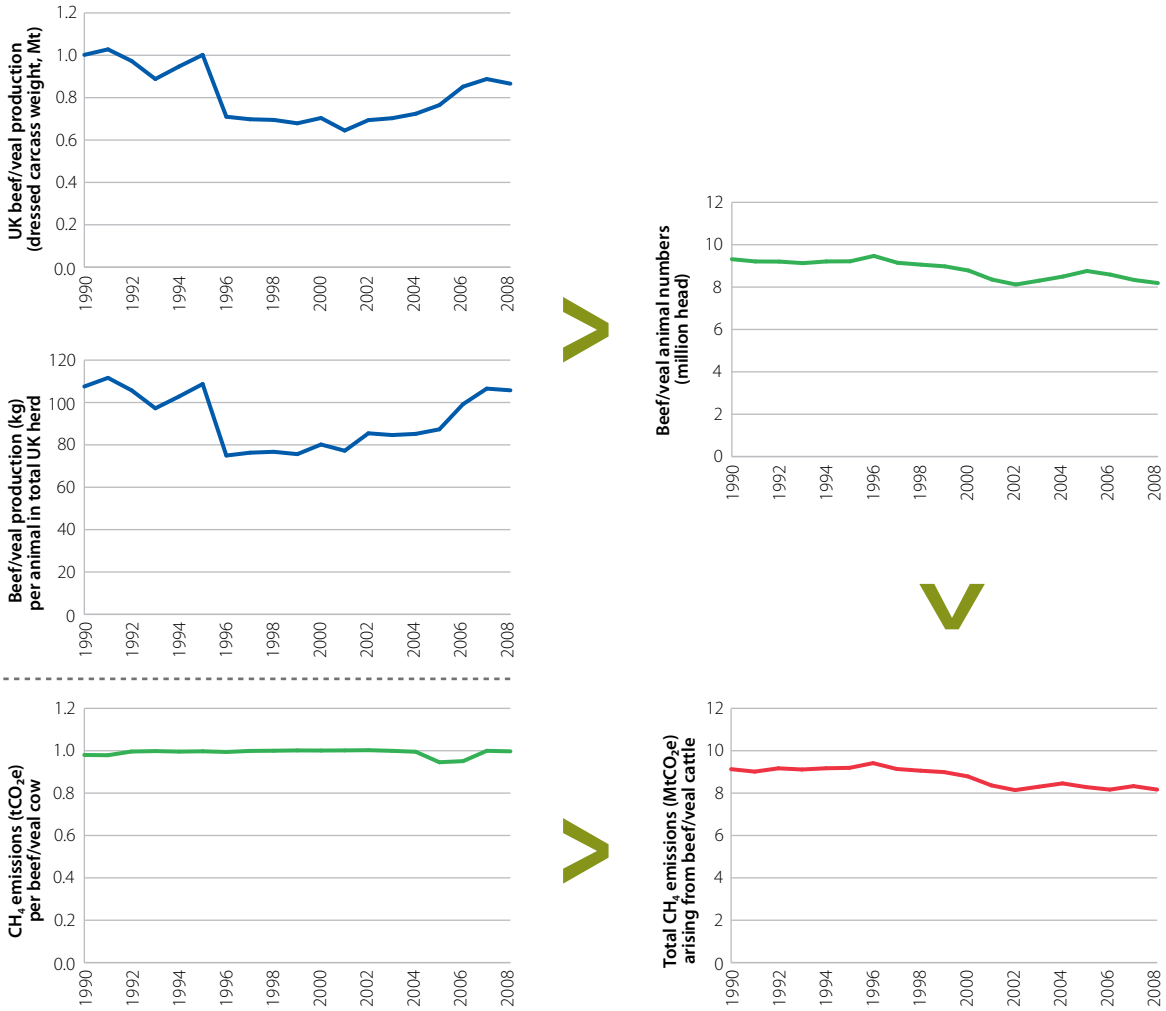
8 EBLEX (2009), *Beef and Sheep Roadmap*.

Figure 5.5 Historical trends in dairy cattle numbers, milk production and methane emissions (1990-2008)



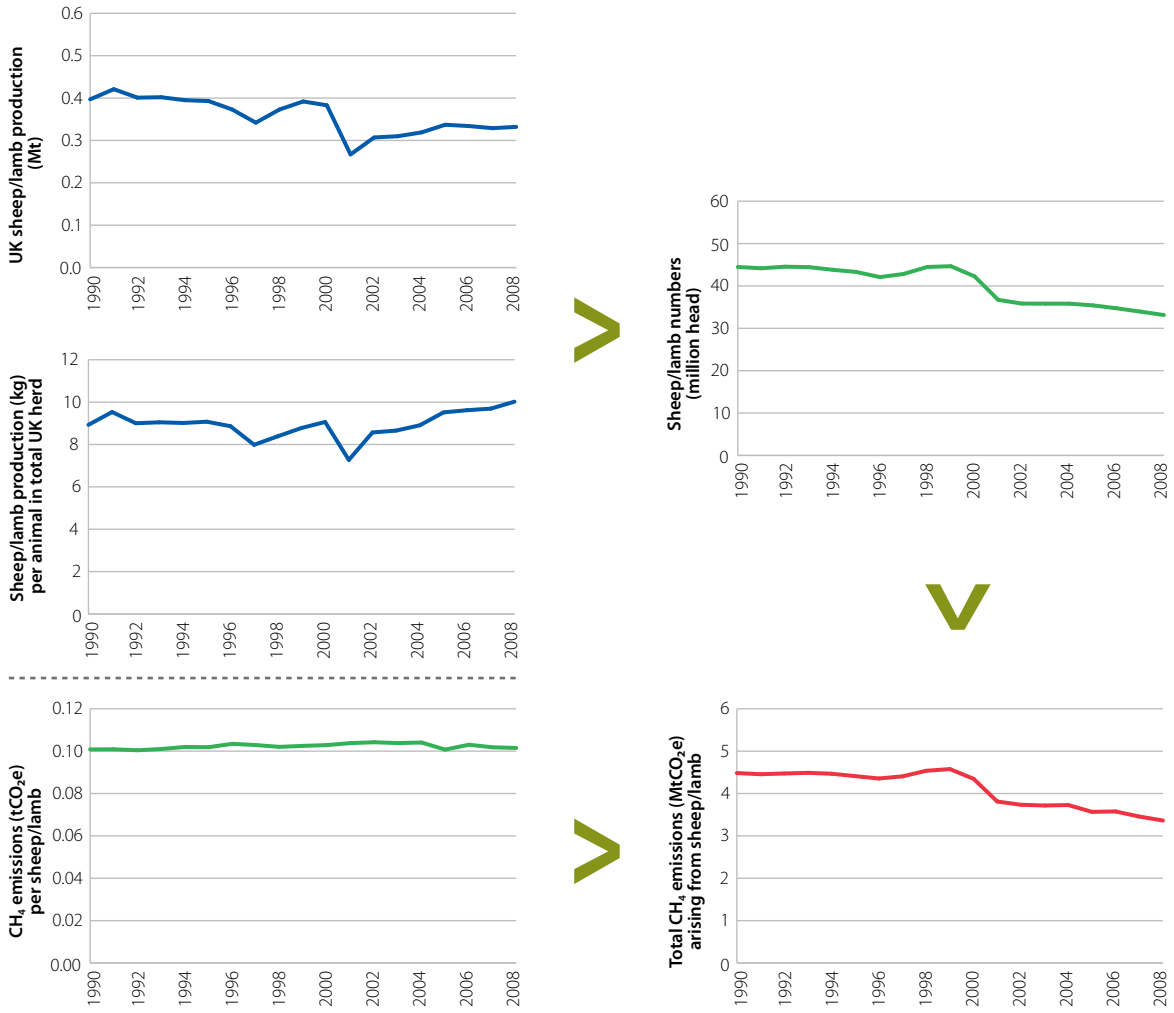
Source: NAEI (2010); Defra (2009), *Agriculture in the UK*, Table 5.17.

Figure 5.6 Historical trends in non-dairy cattle and calve numbers, beef/veal production and methane emissions (1990-2008)



Source: NAEI (2010); Defra (2009), *Agriculture in the UK*, Table 5.13.

Figure 5.7 Historical trends in sheep/lamb numbers, production and methane emissions (1990-2008)



Source: NAEI (2010); Defra (2009), *Agriculture in the UK*, Table 5.15.

2. Scope for future reductions in agricultural emissions

The first agriculture MACC

In our December 2008 report we published the first Marginal Abatement Cost Curve (MACC) for UK agriculture based on work commissioned to the Scottish Agricultural College (SAC). The agriculture MACC focused on opportunities for changed practices on-farm. It suggested that there is potential for cost-effective (i.e. at a cost up to £40/tCO_2e[9]) emissions reduction up to 13 $MtCO_2e$ in 2020 for the UK through measures that:

- Decrease N_2O emissions arising from crops and soils by improving the efficiency of fertiliser application and reducing the rate of conversion of applied fertiliser to N_2O.
- Decrease CH_4 emissions from livestock through introduction of productivity and fertility measures as well as dietary additives that reduce enteric fermentation.
- Decrease CH_4 emissions from manures through the installation of on-farm or centralised anaerobic digestion (AD) plants.

The analysis identified a technical potential of 9 $MtCO_2e$ available at negative cost (i.e. this would save money for farmers under the assumptions used in the MACC) with an additional 4 $MtCO_2e$ below £40/tCO_2e. The technical potential comprised:

- 9 $MtCO_2e$ from measures that decrease N_2O emissions from crops and soils (e.g. improved timing of mineral and organic fertiliser application).
- 3 $MtCO_2e$ from measures that reduce methane emissions from livestock (e.g. breeding for improved productivity and fertility, introduction of alternative feeding practices and use of dietary additives).
- 1 $MtCO_2e$ from the installation of anaerobic digestion plants (converting agricultural waste to renewable energy) either in a centralised location or on-farm.

Estimates of technical potential were adjusted to reflect barriers to uptake and scope for addressing these through policy. A central feasible scenario, defined by an incentive-based policy environment characterised by taxes and subsidies or a cap and trade scheme, found 6 $MtCO_2e$ of feasible potential available in 2020 of which 4 $MtCO_2e$ would be at negative or no cost to farmers.

We noted that there were a number of uncertainties in this analysis given the evidence base for abatement from the agricultural sector is at an early stage of development. However, we suggested that the analysis was sufficiently robust to demonstrate that there is significant potential for cost-effective emissions reduction from agriculture and that this should be addressed as part of broader strategy to meet carbon budgets.

Government and industry response

The Low Carbon Transition Plan (LCTP), published in July 2009, included an agriculture emissions reduction target of 3 $MtCO_2e$ in 2020 for England. As policy in the agriculture sector is largely devolved, the LCTP did not include potential emissions reduction in the Devolved Administrations.

The LCTP target of 3 $MtCO_2e$ for England is based on a re-evaluation of the SAC MACC central feasible scenario assessment.

- Defra's MACC assessment included a subset of abatement measures identified by the SAC MACC.
- The LCTP aggregate emissions reduction roughly corresponds to most but not all cost-saving measures identified in the central feasible potential MACC that are applicable to England.

To meet ambition in the LCTP for farming, an Industry GHG Action Plan was developed and published in February 2010 by the Climate Change Task Force, a joint collaboration between agriculture industry groups. The Industry GHG Action Plan (Box 5.1):

- Sets out a range of actions to meet the 3 $MtCO_2e$ target for England, mapping some to measures identified in the SAC MACC.
- Is cautious about the potential to deliver further emissions reduction on the basis of current evidence.
- Commits to evaluating existing industry advisory initiatives and to develop a delivery plan to implement proposed activities by autumn 2010.

The ambition in the LCTP and industry action plan is therefore conservative relative to the Committee's initial assessment that there is up to 8 $MtCO_2e$ in cost-effective emissions reduction potential available in England in 2020 (corresponding to 13 $MtCO_2e$ potential at the UK level) of which 6 $MtCO_2e$ is available at negative or no cost.

9 £40/tCO_2e was our central carbon price estimate in our December 2008 report.

Box 5.1 Industry GHG Action Plan

The LCTP encourages English farmers to take action themselves to reduce emissions to at least 10% lower than currently predicted by 2020 (equivalent to 3 $MtCO_2e$ p.a.). An Industry GHG Action Plan (GHGAP) developed by the Climate Change Task Force (a joint collaboration between the National Farmers' Union, the Country Land and Business Association, and the Agricultural Industries Confederation) in response to the LCTP focuses on emissions reduction through better farming management practices (e.g. more efficient use of fertiliser and better management of livestock and manure). The GHGAP is the primary vehicle to deliver the LCTP target for agriculture in addition to Government provision of advisory services and AD incentives.

The industry aims to put agriculture on a 'realistic but ambitious emissions reduction path' where farms benefit from improved productivity, resource efficiency, and renewables generation. The GHGAP maintains that changes in farming behaviour are best promoted through existing and trusted knowledge exchange and advisory services and lays out a framework to deliver upon its plan. This framework includes: evaluating existing advisory services to farmers, identifying barriers to farmer uptake of advice and suggesting mechanisms to facilitate uptake. The plan also calls for additional government and advisory support and funding where gaps in advice and information provision cannot be met by industry.

The GHGAP specifies concrete actions for delivering emissions reduction, linking many of the proposed actions to SAC MACC measures although with different targeted reductions for each category of mitigation measure (Table B5.1). It also lays out indicators of progress for monitoring uptake of measures although it is vague on precisely how actions will be monitored and farmers held accountable for action (or inaction). The Industry is working with Government to develop an accountable monitoring and verification system to ensure uptake of measures across English farms.

Table B5.1 Emissions savings by activity type in Action Plan and 2008 MACC analysis

	Industry GHG Action Plan		Original SAC Analysis (CFP)	
Measure type	**$MtCO_2e$**	**%**	**$MtCO_2e$**	**%**
Crops and soils	0.8	27%	3.9	71%
Livestock	1.6	53%	1.0	18%
AD	0.6	20%	0.6	11%
Total	3.0		5.6	

Government response in the Devolved Administrations

Our original MACC analysis also indicates that significant cost-effective abatement potential exists from agriculture in the Devolved Administrations (2 $MtCO_2e$ in Scotland, 1 $MtCO_2e$ in Wales and 1 $MtCO_2e$ in Northern Ireland). Scotland and Wales have proposed targets for reducing agricultural emissions (commensurate with these potentials), and are developing policy strategies that are also based around advisory services to promote uptake of low-carbon farming practices. Northern Ireland has not yet set a target but is in the process of developing a policy framework for emissions reduction from agriculture (Box 5.2).

Box 5.2 Devolved Administration agriculture mitigation programmes

Wales

The Welsh Assembly Government set up an independent Land Use Climate Change Group in January 2009 with representatives from farming, forestry, research and environmental sectors to examine how agriculture and rural land use can contribute to reductions in GHG emissions. The Group published a Land use climate change report in March 2010 which developed recommendations for reducing emissions to 2040, including exploring various scenarios for changed agricultural production systems. The Welsh Assembly Government is currently reviewing report recommendations with the goal to develop an action plan to take forward various mitigation proposals.

Wales has identified five key themes for reducing emissions from agriculture and land use: technical efficiencies in livestock production and fertiliser use, on-farm woodland creation through a new agri-environment scheme (Glastir); development of on-farm renewables, food supply chain efficiencies; and sustainable diets. Wales has put out a consultation that has proposed a 10% emissions reduction target for the sector by 2020 to be achieved via pursuit of low-cost technical efficiencies and the Glastir scheme. Technical efficiencies are to be promoted in the shorter term through advice and technology transfer by development centres. Intermediate and longer-term solutions currently being considered and prioritised for further research include anaerobic digestion, renewables, changes to livestock housing, and sustainable food strategies.

A Climate Change Strategy for Wales including the agriculture and land use sector will be launched in October 2010.

Scotland

Scotland published its Climate Change Delivery Plan in June 2009 which proposes a reduction target for the agriculture and agricultural land use sectors of 1.3 $MtCO_2e$ by 2020 (10% emissions reduction), under Scotland's target to reduce economy-wide emissions by 42%.

Scotland intends to meet targets for the sector through livestock productivity measures, improved nitrogen fertiliser management, improved manure and slurry management, anaerobic digestion development, protecting soil carbon and afforestation.

To deliver these measures, the Farming for a Better Climate initiative was launched in September 2009 to provide better information and advice to land managers. The Scottish Government also funds on-farm anaerobic digestion and renewables through its Rural Development Programme. Scotland has also established a number of Climate Change Focus Farms to enable transfer knowledge and spread awareness of best farming practice.

The Scottish Government has established an Agriculture and Climate Change Stakeholder Group to facilitate engagement with key industry contacts to develop a shared view of mitigation actions to deliver emissions reductions within the sector. Scotland is also beginning to examine opportunities for reducing emissions across the food chain.

Post-2020, the Scottish Government intends to achieve reductions through continued adoption of good practice with the potential for technological and management innovations such as changes in animal genetics and feedstuffs, increased sequestration, renewable energy development and states that consumers may also be prepared to reduce the greenhouse gas emissions 'embedded' in what they buy and consume.

Northern Ireland

Northern Ireland's Department of Agriculture and Rural Development (DARDNI) established an internal Steering Group during 2009 to develop a range of primary production mitigation measures based on a review of available scientific evidence. Five key themes have emerged; better livestock management, better nutrient and fertiliser management, locking in carbon in soils, peatlands and grass, locking in carbon in new and existing woodlands and optimising renewable energy and fuel efficiency on farms. These themes are currently subject to consultation processes across all segments of the NI agri-food industry and practical steps to implement each theme have been drafted to aid the consultation process. Greater efficiency and cost effectiveness are key to the approach and DARDNI plan to commence implementation on climate change mitigation by the issue of a Renewable Energy Action Plan in June 2010.

New analysis

Given uncertainties in our analysis and in subsequent Government MACC analysis and new evidence provided by Government and industry, we commissioned a consortium led by SAC to produce a revised assessment of emissions reduction potential from agriculture within the UK. This new analysis suggests that there is between 5 to 12 $MtCO_2e$ technical emissions reduction potential in 2020 in the UK at a price below £40/tCO_2e (Box 5.3 and Figures 5.8 and 5.9).[10]

Box 5.3 The new agriculture MACCs

The SAC consortium produced MACCs for both a pessimistic and an optimistic set of assumptions:

- The **pessimistic MACC** makes conservative assumptions about applicability of uptake, abatement rates and costs of abatement for various measures.
- The **optimistic MACC** assumes greater applicability of uptake, abatement rates and lower costs of abatement for various measures. (It also includes measures that would require substantive changes in policies and investment in research and development to support uptake).

These different assumptions lead to different levels of abatement potential and different costs for most individual measures, and lead to some different measures being included in each MACC:

- Both MACCs include a significant amount of potential from crops and soils measures but the optimistic MACC finds 7 $MtCO_2e$ in additional abatement due to greater potential from certain measures and inclusion of measures that are not cost-effective on the pessimistic MACC (e.g. drainage and nitrification inhibitors). The use of improved N use plants only appears in the optimistic MACC.
- Both MACCs find a similar level of abatement potential from livestock management measures. However dietary additives in the form of propionate precursors appear only in the pessimistic MACC, as substitutes for ionophores, which are at present illegal within the EU but are included in optimistic MACC assumptions.
- Estimated abatement potential from AD and manure management measures are identical in both MACCs (at just over 0.5 $MtCO_2e$).

The range indicates that there is a great deal of uncertainty around the level of abatement and costs around many measures, mostly in crops and soils measures and less related to livestock, manure management and AD.

However the new assessment also finds greater confidence in many measures (e.g. they are cost-effective and save emissions even in a pessimistic case). The agriculture emissions reduction targeted in the Low Carbon Transition Plan thus appears low relative to underlying potential and it is likely that there is more abatement potential available:

- The revised MACC analysis finds even in an extreme pessimistic scenario up to 5 $MtCO_2e$ in cost-effective abatement in the UK in 2020. This may be compared to the 3 $MtCO_2e$ targeted in the LCTP and industry action plan, which scales up to around 4.5 $MtCO_2e$ at the UK level.
- The optimistic scenario finds over twice as much abatement opportunity (12 $MtCO_2e$) as in the lower bound estimate.
- There are likely to be additional efficiency measures that farmers can implement that have not been identified in the revised MACC analysis (e.g. animal health, sheep farming and other improved management practices) to be further explored.[11]

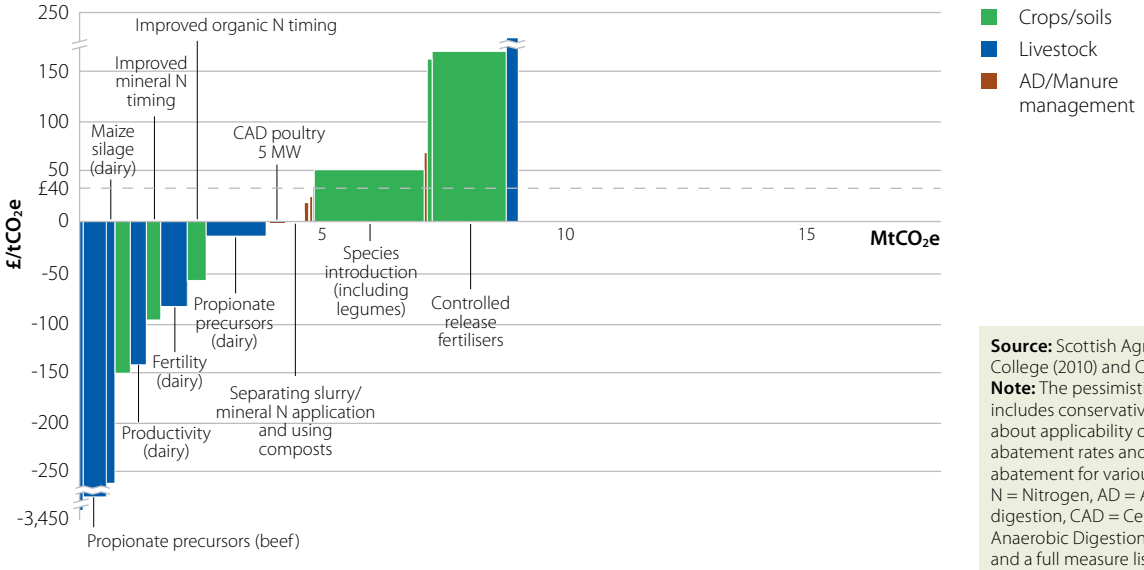
Given that the agriculture emissions reduction targeted in the Low Carbon Transition Plan for England is below underlying potential, and well below the optimistic maximum potential, it should therefore be regarded as indicative, recognising the potential to outperform through significant further emissions reduction from soils and livestock measures and manure management/AD.

It is also important that all Devolved Administrations set targets at a minimum in line with LCTP ambition – if not more ambitious targets – and also seek to unlock full underlying potential.

10 The new MACCs find 9-19 $MtCO_2e$ in technical potential at a price below £100/tCO_2e.

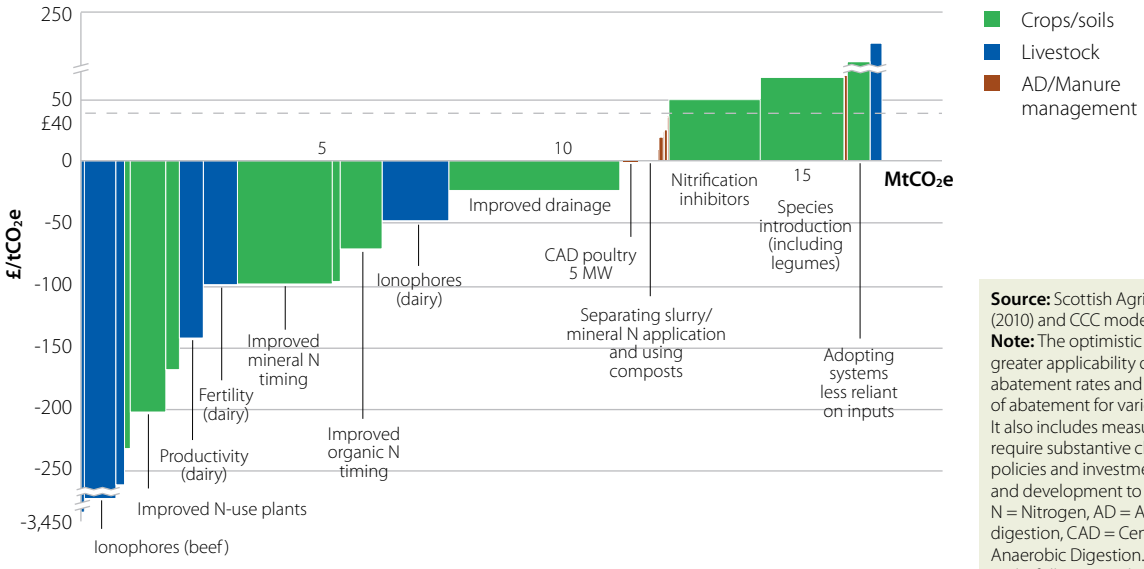
11 For example, the Scottish Agriculture College (2010) acknowledge the availability of a wider set measures to improve soil management and improved efficiencies in the sheep sector have been identified in the EBLEX Beef and Sheep Production Roadmap (2009) to reduce GHG emissions.

Figure 5.8 Agriculture MACC maximum technical potential, pessimistic case (2020)



Source: Scottish Agricultural College (2010) and CCC modelling.
Note: The pessimistic MACC includes conservative assumptions about applicability of uptake, abatement rates and costs of abatement for various measures. N = Nitrogen, AD = Anaerobic digestion, CAD = Centralised Anaerobic Digestion. More details and a full measure list is available in the technical annex on the CCC website.

Figure 5.9 Agriculture MACC maximum technical potential, optimistic case (2020)



Source: Scottish Agricultural College (2010) and CCC modelling.
Note: The optimistic MACC assumes greater applicability of uptake, abatement rates and lower costs of abatement for various measures. It also includes measures that would require substantive changes in policies and investment in research and development to support uptake. N = Nitrogen, AD = Anaerobic digestion, CAD = Centralised Anaerobic Digestion. More details and a full measure list is available in the technical annex on the CCC website.

3. Incentives for reducing agricultural emissions

Achieving emissions reductions through greater uptake of measures will require new approaches in England and the DAs to address current barriers to action. In implementing these it will be important also to consider the multiple policy objectives and various sensitivities related to agriculture (Box 5.4). We now consider at a high level options to strengthen incentives for farmers.

Policy options

In our December 2008 report we listed five policy options to support emissions reduction in agriculture:

- **Voluntary agreements**, as in the current policy approach where the agriculture industry has voluntarily committed to achieving a reduction of 3 $MtCO_2e$ tied to implementation of specific measures but also allowing for flexibility given new information.
- **Information provision**, which encompasses two areas: providing better information and advice to farmers on best practice to reduce GHG emissions, and developing a better understanding of emission reduction opportunities by getting better information about the current state of farming practice. There is a read-across here to other sectors, for example to buildings and industry, where proposed roll out of Display Energy Certificates (DECs) and Energy Performance Certificates (EPCs) will encourage energy efficiency improvement and provide better information to inform policy design (see Chapter 3).
- **Grants, subsidies, charges, levies and taxes**, which could encompass a wide mix of incentives and penalties to encourage low-carbon farming. For example, the Common Agricultural Policy could be reformed to allow incentives for actions that more directly reduce agricultural emissions. Fertiliser taxes, which have been applied in other countries (e.g. Austria, Finland and Sweden) might be considered to encourage efficiencies in fertiliser application. Incentive mechanisms could also be linked to voluntary agreements, for example as for Climate Change Agreements within the commercial and industrial sector, which allow energy-intensive businesses to receive currently up to an 80% discount on the Climate Change Levy by meeting voluntary energy efficiency or carbon-saving targets.

Box 5.4 Reducing agricultural emissions whilst meeting other objectives for the sector

The UK agriculture industry is characterised by a number of often competing pressures and objectives, which include amongst others, providing a sustainable, healthy and secure food supply and maintaining and enhancing rural landscapes. Policies focusing on one objective will often have implications for other objectives. This includes impacts from measures to reduce greenhouse gas emissions from agriculture:

- In some cases these impacts may be positive, for example avoiding excess application of nitrogen can reduce the energy and emissions impacts of fertiliser production upstream and can also contribute to improved water quality.
- In other cases there may be potentially negative impacts, for example measures related to dietary supplements may raise animal health and welfare concerns.

The marginal abatement cost curves we commissioned from SAC reflect the private costs and direct GHG benefits of mitigation but do not directly account for possible impacts on other objectives of the sector. However, SAC did consider these issues qualitatively, and concluded that many measures to reduce emissions are likely have co-benefits for other objectives (e.g. water quality and reduced soil erosion).

Where there are conflicting implications there may be opportunities to address these through policy design, for example concerns over leakage can be addressed by engaging international cooperation or through choice of funding mechanisms. The Committee therefore believes that the sector can contribute to tackling climate change whilst achieving other objectives. However, we recognise the multiple policy objectives and various sensitivities related to agriculture and, as such, it will be important that in seeking to unlock increased abatement the Government's strategy reflects the full set of issues.

- **Cap and trade scheme**, whereby a price is placed on GHG emissions from agriculture and incentives are provided to encourage farmers to search for the most efficient way to lower their emissions. Participants monitor their greenhouse gas emissions and removals, report these to Government, and surrender permits or claim for emissions reduction (e.g. as in the new Carbon Reduction Commitment scheme aimed at encouraging energy efficiency improvement in the large non-energy-intensive sector).
- **Direct regulation**, which could involve the introduction of emissions standards or limits that each farmer is allowed to emit from agricultural activities or could involve restrictions or required implementation of farming practices to reduce emissions arising from crops/soils and livestock (e.g. restrictions on timing of fertiliser application, mandatory soil nutrient testing and livestock feeding regimes). As in other sectors, regulatory measures may be required to achieve full take-up of cost-effective emission reduction potential.

We noted potential complexities associated with some policies in the context of agriculture (e.g. difficulties measuring emissions at the farm level and variation in emissions from farm to farm due to climate and soil type). However we argued that these are not insurmountable given the evolving smart inventory and the possibility of using proxies for monitoring emissions reductions (e.g. fertiliser usage and farmer uptake of action). Therefore we recommended that a policy framework should be developed to unlock the available emissions reduction potential.

Government/industry approach

The initial approach by Government and industry to reducing agricultural emissions is one based on light-touch encouragement through provision of advisory services as well as improvement of the evidence base:

- The Low Carbon Transition Plan suggested that farmers should be encouraged to implement measures. In support of this, Defra will launch a low-carbon advisory service from early 2011, and will work with the industry to identify and address gaps in existing advice and knowledge delivery services.
- The Industry GHG Action Plan envisages knowledge transfer through levy boards, industry bodies, government and agriculture suppliers/distributors.
- Defra's Climate Change Plan commits to investing in the evidence base to better understand and measure emissions from biological systems, developing a more accurate inventory that can reflect mitigation activities, exploring what further potential there is to reduce emissions and at what cost, and fostering innovation and development of new technology.

Other approaches to unlocking emissions reduction potential

The industry-led approach is a useful first step to engage the sector and to collect better information about baseline activity to reduce uncertainties. However, there is a risk that the chosen approach will not deliver the full emissions reduction potential available in the agriculture sector for a number of reasons:

- There is limited evidence that knowledge transfer alone has addressed barriers and changed practice in other areas of the farming industry. For example, the England Catchment Sensitive Farming Directive introduced in 2006 has succeeded in bringing about improvements to soil and land management practices, but includes capital grants and encouraging uptake of resource protection options funded through agri-environment schemes alongside advice.[12] There is also a question as to whether effective delivery and uptake of advice is scalable from the targeted subset of English farmers to all UK farms.
- UK farming has been heavily regulated via the EU Common Agricultural Policy, where farmers are accustomed to changing behaviour through economic incentives:
  - Under Cross Compliance, 90% of English farmers have changed their behaviour to meet 'cross-compliance' criteria (including environmental, food safety and animal health/welfare factors) linked to Single Farmer Payments.

12 Defra (2008), *ECSFDI Monitoring and Evaluation Framework*.

Box 5.5 Lessons learned from SMEs and the non-energy-intensive sector

The policy framework for unlocking emissions reductions from non-residential buildings in the SME sector has been aimed at providing information and financial support (see Chapter 3). Given the limited success of these voluntary measures, the Committee has previously recommended and DECC is at present assessing, alternative policy options (e.g. introduction of regulatory measures) to achieve greater uptake of cost-effective emissions reduction potential in the sector.

For medium and large non-energy-intensive firms, which are comparable to some farms, the Carbon Reduction Commitment has been introduced to cap emissions from electricity and heat consumption, and thereby provide financial incentives for energy efficiency improvements.

Despite differences between farms and non-energy-intensive firms we note several key commonalities, which may imply that barriers to the effectiveness of a voluntary approach in the SME and non-energy-intensive sector also exist in agriculture. These commonalities include:

- Emissions arise from processes that are an inevitable part of business activity (energy use, fertiliser application, raising livestock), but reductions of which are not the primary focus of business planning (e.g. focus may rather be on increasing production, complying with regulations, finding markets for produce).
- Lack of time and resources make raising awareness and changing behaviour difficult.
- Business planning horizons are often short.

Information on existing practice and abatement potential is also limited for both SMEs and farms. In the SME sector we previously recommended that Energy Performance Certificates (EPCs) and Display Energy Certificates (DECs) are rolled out to improve transparency in the sector (see Chapter 3). Similarly it will be necessary to improve understanding of current farming practice to better identify existing abatement potential in the agriculture sector.

  - Under Environmental Stewardship, 65% of English agricultural land has been voluntarily opted into agri-environment schemes where farmers receive payment on basis of 'income foregone'.

- In other sectors (e.g. large non-energy-intensive, SMEs) provision of information/awareness-raising has not been fully successful in unlocking cost-saving measures to reduce emissions and new approaches have either been introduced or are being considered (Box 5.5).

Therefore the current approach should be effectively monitored (see Section 4 below) and other approaches seriously considered. Specifically, further evidence is required to establish that an approach based on information provision would adequately address barriers and result in implementation of measures, and to establish practicality of other approaches given complexities of the agriculture sector (Box 5.6).

The Low Carbon Transition Plan recognises this and commits to develop a shortlist of alternative policy options for intervention by the end of 2012 and to consider options in the Defra Climate Change Plan which would build on the existing regulatory framework (e.g. the Nitrates Action Programme, new regulation under the Pollution Prevention and Control Act 1999) or to develop new options consisting of economic incentives with penalties.

Box 5.6 Barriers and Complexities to Policy

There are a number of barriers and complexities to developing policies targeting emissions reductions in agriculture. These include:

- **Informational:** There is currently limited measurement of emissions at the farm level.
- **Behavioural:** The farming industry is characterised by individual farmers making decisions on the basis of factors in addition to profit, including perceptions of risk, attitudes (e.g. towards technology or changed practice), and opinions of other farmers and professionals.
- **Competitive:** Agriculture is a globally competitive industry and policies could result in displacement of production abroad with no emissions benefit.
- **Heterogeneity:** There are over 300,000 UK farm holdings of different sizes and farm types. These farms encompass 17 million hectares of land and face regional diversity related to climate, soil type, water conditions, etc, all of which can affect emissions.

However, we argued in our December 2008 report that none of these complexities should be seen as prohibitive:

- An improved emissions inventory will be available in future (Box 5.7).
- Policies can be developed that incentivise behaviour change: this has been done before in the agriculture sector and to achieve emissions reductions in other sectors.
- Mitigation that adversely impacts competitiveness can be addressed by engaging international cooperation or through choice of funding mechanisms.
- There are other sectors of the economy where there are diffuse and heterogonous sources of emissions, but where policies have been introduced to reduce emissions (e.g. energy efficiency).

4. Indicators of progress reducing agricultural emissions

Measuring emissions

Our indicators for other sectors cascade from a high-level emissions trajectory covering the period to 2022 (i.e. the end of the third budget). In the case of agriculture, there is a complexity relating to measurement of emissions. Whereas it is relatively straightforward, for example, to measure emissions from burning of fossil fuels, there are considerable uncertainties over the level of emissions from soils and livestock.

The current methodology used in the UK emissions inventory would not reflect all emissions reduction due to implementation of specific crops, soils and livestock measures (Box 5.7). However, there are two ways that this issue can be addressed within an indicator framework:

- Work is under way to develop a Smart Inventory which would better reflect emissions reduction due to implementation of measures.
- As with other sectors, the indicator framework should include underpinning indicators which capture implementation of measures in addition to high-level emissions trajectories.

Therefore we do not regard current problems with the inventory methodology as being prohibitive in terms of setting out an indicative emissions trajectory or underpinning indicators to be firmed up as further evidence is available.

Box 5.7 An Improved UK Agriculture Inventory

The current UK agriculture inventory uses IPCC Tier 1 methodologies to calculate emissions from agriculture. These methods are simplified approaches to accounting, consisting of generic emissions factors.

- For **crops and soils**, N_2O emissions are calculated using fertiliser surveys and Tier 1 standard emission factors.
- For **livestock**, generic CH_4 emission factors are multiplied by number of animals to determine aggregate emissions arising from enteric fermentation and manure.

The current inventory does not account directly for many of the mitigation measures that farmers can incorporate.

- For **crops and soils**, for example, the use of nitrification inhibitors, which reduce the amount of N_2O emissions arising from fertiliser application but do not necessarily lead to a reduction in fertiliser application levels, would not be recognised in the inventory. Measures that reduce fertiliser applications (e.g. avoiding excess N application) would be recognised.
- Similarly for **livestock**, actions related to changed livestock diets that decrease the production of methane may not get recognised. Only measures that reduce herd numbers would directly reduce methane emissions calculated in the inventory.

There is ongoing improvement to the agricultural inventory:

- Country-specific Tier 2 emissions factors have been developed for dairy which account for changes in animal weight and milk yield, both of which influence methane production.
- Defra has committed to developing a more sophisticated methodology for measuring, reporting and verifying emissions across the inventory (Tier 2 or Tier 3 methodologies) that would be able to better capture all mitigation activities implemented on farms. The first phase of this smarter agricultural inventory is due to be completed by 2014.

Defra has also committed to better understanding and measuring emissions from biological systems, given there is a great deal of variability from farm to farm based not only on management practice but on climate, soil type, animal type, feed, etc.

Indicators – emissions projections

Our methodological approach to setting out an emissions trajectory in other sectors has been to start with a reference emissions scenario and then net off our estimates of feasible emissions reduction. Following this approach in the case of the agriculture sector raises a question of the appropriate reference scenario:

- Government has an official projection for the agriculture sector in which, absent a targeted emissions reduction policy, emissions in future will remain broadly constant at 2008 levels.
- However, emissions have fallen since 1990, when no targeted emissions reduction policy framework was in place, suggesting uncertainty over the path for emissions to 2020.

We use the Government projections in the absence of an available alternative but recognise the possibility that emissions could continue to fall without implementation of measures in the MACC. To reflect this uncertainty we will:

- Build in a range of emissions reductions covering the ambition in the LCTP scaled to the UK level, up to our most optimistic estimate of emissions reduction potential. Netting this from the reference projection gives a range for emissions in 2020 of 31-40 $MtCO_2e$ (Figure 5.10).
- Focus on implementation of measures rather than monitoring emissions alone, as for other sectors.

Indicators – emissions drivers

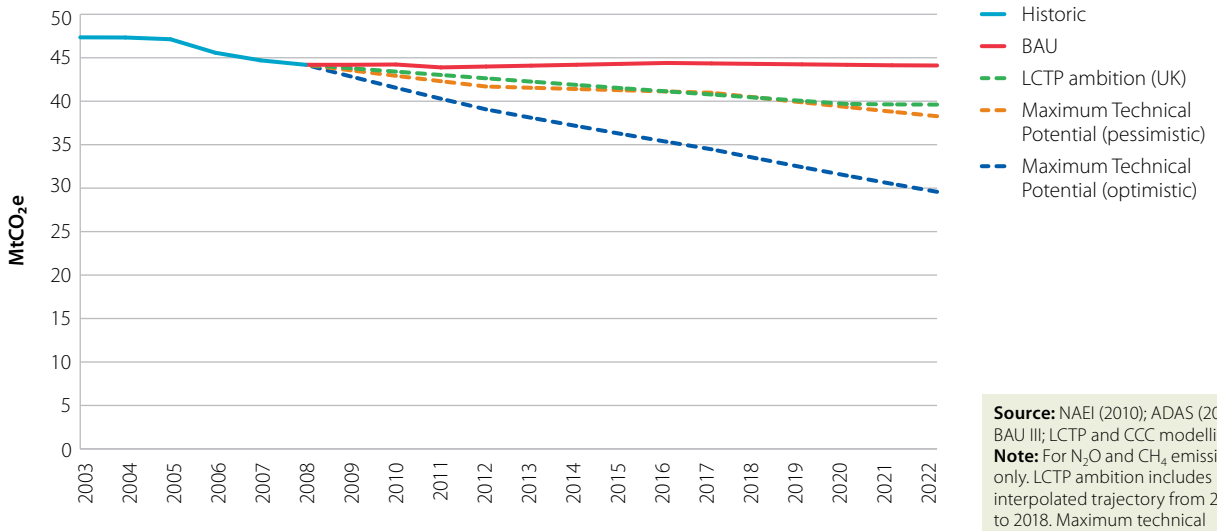
In other sectors we set out a hierarchy of indicators, beginning with headline indicators for emissions, emissions intensity and demand, followed by implementation of measures (e.g. roll-out of loft, cavity and solid wall insulation), forward indicators for implementation (e.g. planning applications to build low-carbon capacity) and policy milestones to drive implementation.

For agriculture the next level of indicators below emissions covers fertiliser use, livestock numbers and GHG efficiency of production, and we therefore propose trajectories for these consistent with the emissions trajectories described above, and drawn from the measures in our revised MACC:

- Fertiliser use and livestock numbers are the drivers of emissions in the current inventory, and many of the abatement measures in the MACC relate, at least in part, to one of these falling (whilst maintaining production levels).
- However, fertiliser use and livestock numbers could fall for other reasons; in particular they could fall due to an increase in imports associated with emissions leaking overseas. It will be important therefore to also monitor that there is an equivalent improvement in GHG efficiency (i.e. emissions per kg of product).
- Our trajectories imply:
  - To deliver abatement in line with full uptake of cost-effective measures in our optimistic MACC in 2020: fertiliser use declines by approximately 25% from 2007 levels of 1 million tonnes; average yields across the dairy sector increase by up to 60% corresponding to an approximate 35% reduction in animal numbers; and average yields across the beef sector increase by up to 25% corresponding to a 20% reduction in animal numbers to keep production levels constant.
  - To deliver abatement in line with full uptake of cost-effective measures in our pessimistic MACC in 2020: fertiliser use declines minimally from 2007 levels; average yields across the dairy sector increase by up to 50% corresponding to an approximate 30% reduction in animal numbers; and average yields across the beef sector increase by up to 15% corresponding to a 10% reduction in animal numbers to keep production levels constant.

At this stage, and given current uncertainties, these numbers should be regarded as indicative, with better evidence about farming practice and future agriculture activity required in order that the trajectories can be firmed up.

Figure 5.10 Historical agriculture emissions and potential emissions reduction under LCTP and through greater uptake of measures (2003-2022)



Source: NAEI (2010); ADAS (2007), BAU III; LCTP and CCC modelling.
Note: For N_2O and CH_4 emissions only. LCTP ambition includes interpolated trajectory from 2008 to 2018. Maximum technical potential trajectories based on SAC (2010) and CCC modelling.

Indicators – farming practice

The trajectories above will pick up some, but not all of the measures to reduce emissions (e.g. it will not reflect the impact of nitrification inhibitors or some livestock dietary measures).

The next level of our indicator framework therefore reflects actual farming practice, and the extent to which this incorporates measures identified by the Scottish Agricultural College in developing the revised MACC.

There are certain measures identified in the MACC where greater confidence exists (e.g. are proven technologies, are considered best practice, and yield consistent abatement results) with minimum resolution of other issues required, and thus the aim should be to deliver full emissions reduction potential through full uptake of measures. These include:

- For **crops and soils**: nutrient management practices, including improved efficiency in using fertiliser (e.g. making full account of nitrogen in manure applications, timing application to match crop requirements, using composts and straw-based manures in preference to slurry where practical, and separating slurry and mineral N application).
- For **livestock**: improved breeding for fertility and productivity.
- For **AD**: installation of on-farm and centralised anaerobic digestion facilities for a total capacity of up to 50 MW by 2020 as identified in the revised MACCs.
- For **manure management**: covering and aerating slurry and manure while stored. Our indicators include up to 20% of dairy manures and up to 2% of beef manures stored in covered tanks and lagoons by 2020.

There are some other measures where confidence exists over the effectiveness in reducing emissions and the likely cost-effectiveness, but where further resolution of concerns in other areas is required before full uptake can be pursued. For example, subject to satisfactory resolution of animal welfare concerns, there should be a shift to all relevant farms utilising dietary additives (e.g. propionate precursors) and diet changes (e.g. maize-silage) should be fully implemented where appropriate (e.g. if land use change issues can be resolved).

There are also various measures for which there is less confidence in abatement potential by 2020 because baseline farmer practice and activity, regional relevance and applicability, and/or net GHG benefits are poorly understood. These measures require further evidence to establish viability in UK and in regional contexts. These include soil management measures (such as reduced tillage and improved drainage) and use of nitrification inhibitors. The use of more N-efficient plants (including species introduction) may also require more time to develop and deploy new varieties.

Ideally there would be increasing levels of uptake of the above practices, with close to 100% uptake where applicable by 2020. However, before we are able to set out trajectories for increased implementation of the above measures there is a need to improve the evidence base and monitoring framework, particularly as regards understanding of current practice. The delivery component of the Industry GHG Action Plan should be designed to provide evidence of current practice and uptake of measures. We will work with Defra and the industry to develop specific indicators for monitoring uptake of the above farming practices.

Indicators – policy milestones

In other sectors we have emphasised the need to develop the policy framework to drive delivery of emissions reduction measures. The final level of our indicator framework for agriculture therefore relates to policy milestones, for which there are a number of key actions for the near-term:

- Development of delivery plan component of Industry GHG Action Plan;
- Launch of low-carbon advisory services;
- Development of an improved smart inventory (first stage) by 2014, as currently proposed by Defra;
- A full review of policy options for intervention, as currently planned for 2012;
- Development of the evidence base and monitoring framework, alongside development of the smart inventory and consideration of policy options.

Developing the indicator framework

We will discuss this proposed framework – summarised in Table 5.1 – with Government and industry, and use it as the basis for our annual assessment of progress in reducing agricultural emissions in our annual reports to Parliament. In order to underpin the framework, it will be important for the Government, working with industry, to develop a more robust evidence base covering current farming practice and scope for improvement. We will update our indicator framework in line with evolving evidence on farming practice and implications for emissions reduction potential.

5. Longer-term agricultural emissions reductions

If appropriate policies are introduced, the ensuing emissions reduction would be at least of the same order of magnitude as for key policies in other areas (e.g. Smarter Choices, Zero Carbon Homes, the Carbon Reduction Commitment) and would therefore make a useful contribution to meeting carbon budgets. In addition to saving money for farmers, agriculture emissions reduction will reduce the need for purchase of credits to meet carbon budgets.

However, even with a 5 $MtCO_2e$ emissions reduction in 2020 (i.e. the full technical abatement from our pessimistic scenario at a price below £40/tCO_2e, which is slightly higher than the LCTP target scaled to the UK but less than potential in the optimistic scenario), residual emissions will be of the order 39 $MtCO_2e$. Whilst meeting the 2050 target to reduce emissions by 80% relative to 1990 at an economy-wide level does not require an 80% reduction in every sector, it is clear that more significant emissions reduction from agriculture beyond 2020 will be required. In our modelling of the path to meeting the 2050 target, for example, we assumed that non-CO_2 emissions, of which agriculture currently accounts for around 45%, fall by 70% in 2050 against 1990 levels (51% against today's levels).

There are two sources where significant cuts may potentially be achieved:

- Supply-side measures (e.g. all on-farm measures described in our revised MACC, together with emerging options in both technology and farm practice).
- Demand-side changes (e.g. a shift in diets towards less carbon-intensive foods).

We will provide an assessment of scope for supply- and demand-side emissions reductions through the 2020s in the context of our advice on the fourth carbon budget, to be published before the end of 2010.

6. Land Use, Land Use Change and Forestry

In our December 2008 report we identified savings potential of up to 2 $MtCO_2e$ for the UK forestry sector through afforestation, and we also noted the role for forestry in providing an increased biomass supply. In our report to the Scottish Government in February 2010 we noted that Scotland has an ambition to unlock that potential (0.4 $MtCO_2e$ in Scotland) and included that in our Extended Ambition scenario.

We have not considered further emissions reduction potential from land use and land use change. There remain considerable scientific and analytical uncertainties over the potential in this area and over soil carbon sequestration more generally. Further work is required to establish if this is an area where the UK can reduce its emissions to meet carbon budgets.

We will return to opportunities to reducing emissions from land use change and forestry in the context of our advice on the fourth budget.

7. Defra's carbon reduction delivery plan

Defra's Climate Change Plan published in March 2010 describes the current approach to reducing emissions from the farming sector (see Section 3 above "Government/industry approach"). The plan also sets out a basic monitoring framework with key variables to track and desired direction of travel as well as policy milestones. Defra has committed to further developing the monitoring framework and to seek additional data sources for desired indicators as part of its proposed evidence plan. Results should be defined trajectories for key drivers against which future progress can be judged (Box 5.8).

In considering the plan, we have focused on three key areas:

- **Emissions reduction ambition.** Given underlying cost-effective technical potential, Defra's Carbon Budget Delivery Plan for agriculture and the targets set by the Devolved Administrations could be more ambitious. Despite present uncertainty in measuring, reporting and verifying emissions reduction, there are further emissions reduction opportunities available. Emissions reduction targets in the Devolved Administrations should be increased to at least the level for England, and the combined target of 4.5 $MtCO_2e$ for the UK should be seen as a lower bound for effort.
- **Delivery mechanisms.** The current voluntary approach is a useful start, but other policy approaches are likely to be required. We therefore welcome the plan to develop a set of options for further intervention.
- **Monitoring framework.** It will be important to develop a framework to monitor agriculture emissions reduction activity, to provide better information about current practice and feasible improvement, and to provide a basis for new policies. An improved monitoring framework is proposed to be developed in collaboration between the Government and industry as well as through an improved inventory that can better reflect mitigation activities.

We will work with Defra and the farming industry in these key areas, and particularly in developing an evidence base to understand current practice, emissions reduction potential, and incentives to deliver this potential.

Box 5.8 Defra's Indicator Framework for Farming

TIER 1: Overall sector GHG emissions

- Changes in total AFLM emissions[13]

TIER 2: Disaggregated sector emissions

- Changes in emissions by sub-sector (agriculture, forestry, land use and land use change)
- Changes in agriculture emissions by GHG

TIER 3: Main drivers of sector emissions

- Livestock population
- Nutrient use (soil nitrogen balance)
- Fuel use (volume)
- Change in area of land

TIER 4: Policy outcome indicators

- Livestock: various efficiency indicators related to breeding, health, and feed
- Crops and soils: efficiency indicators related to soil testing and fertiliser application timing
- Anaerobic digestion: proportion of farmers using AD
- Manure management: proportion of manures kept under cover/in open and of animals housed under different systems
- Indicators related to household consumption of various food commodities and energy-efficiency uptake
- Milestone indicators related to Industry GHG Action Plan and delivery of low-carbon advice

CONTEXTUAL FACTOR INDICATORS

Trends in UK food production and consumption, agricultural commodity prices, fertiliser usage, biofuels production, and agricultural productivity indices

13 Defra's indicator framework encompasses agriculture, forestry and land-use change. We have focused in this chapter on indicators relevant to the agriculture sector.

Table 5.1 The Committee's agriculture indicators

AGRICULTURE		Budget 1	Budget 2	Budget 3
Headline indicators				
Emissions (indicative % change from 2007 reflecting range from LCTP ambition scaled across UK to optimistic MACC Maximum Technical Potential trajectory)*				
CO_2e emissions *(% change against 2007)*		-4 to -10%	-7 to -22%	-10 to -33%
GHG emissions *(% change in CO_2e against 2007)*	N_2O	-2 to -12%	-3 to -27%	-5 to -36%
	CH_4	-6 to -7%	-12 to -16%	-18 to -27%
	CO_2**	n/a	n/a	n/a
Source emissions *(% change in CO_2e against 2007)*	Soils	-2 to -13%	-3 to -30%	-5 to -40%
	Enteric fermentation	-5 to -6%	-10 to -16%	-15 to -28%
	Animal waste	-12 to -13%	-22 to -17%	-31 to -26%
	Machinery/fuels**	n/a	n/a	n/a
Drivers (indicative % change from 2007 levels reflecting range from pessimistic to optimistic MACC Maximum Technical Potential trajectory)*				
Crops and soils	Synthetic N fertiliser consumption (% change in kt against 2007) ***	0 to -3%	0 to -6%	0 to -28%
Dairy cattle	Number of head of livestock (% change on 2007) ****	-10 to -11%	-23 to -36%	-34 to -39%
	Milk per animal (% change in kg/head on 2007) ****	Up to +11 to +13%	Up to +29 to +36%	Up to +52 to +65%
	Average CH_4 emissions per animal (% change on 2007)*****	-6%	-15 to -16%	-26 to -29%
Beef cattle	Number of head of livestock (% change on 2007) ****	-5 to -8%	-10 to -16%	-15 to -23%
	Meat per animal (% change in kg/head on 2007) ****	Up to +5 to +8%	Up to +11 to +19%	Up to +18 to +30%
	Average CH_4 emissions per animal (% change on 2007)*****	-6 to -7%	-13 to -16%	-21 to -25%
Sheep and lamb		Abatement options not identified in MACC		

Key: Headline indicators Implementation indicators Milestones Other drivers

Table 5.1 The Committee's agriculture indicators

AGRICULTURE		Budget 1	Budget 2	Budget 3
Supporting indicators				
Farming Practice				
Measures where greater confidence exists (e.g. proven technology, considered best practice, consistent abatement results) with minimum resolution of other issues. Indicative levels.				
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.		Up to 100% where applicable
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.		Up to 100% where applicable
Anaerobic Digestion	Total installed capacity – on-farm (MW)	Up to 5	Up to 10	Up to 14
	Total installed capacity – centralised (MW)	Up to 11	Up to 26	Up to 40
	% and level of poultry manures collected	Up to 20% or 250kt	Up to 50% or 570kt	Up to 70% or 900kt
Manure management	% manure/slurry stored in covered tanks or lagoons	Dairy: up to 6%	Dairy: up to 13%	Dairy: up to 20%
		Beef: up to 0.5%	Beef: up to 1%	Beef: up to 2%
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.		

Table 5.1 The Committee's agriculture indicators

AGRICULTURE	Budget 1	Budget 2	Budget 3
Policy Milestones			
Development of delivery component of Industry GHG Action Plan	Autumn 2010		
Launch of improved low-carbon advisory service	2011		
Industry GHG Action Plan implemented	Autumn 2010 to 2013		
Development of smart inventory		2014 (1st phase)	
Full review of voluntary approach and development of policy options for intervention	end of 2012		
Establishment of baseline farming practice and monitoring framework for Industry GHG Action Plan	Ongoing, to be completed by 2013		
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, etc.			
Livestock: tCH_4/tonne dressed carcase weight (cattle & calves), weight of carcase produced per day of age, calves produced per cow per year, etc.			
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 (2014) and implications for farming practice and emissions.			

*Measures at a price <£40/tCO_2e. The Industry GHG Action Plan provides an indicative breakdown of emissions reductions in England by source and GHG, which has been scaled across the UK.
**Our work to date has focused on abatement potential from non-CO_2 sources.
***We assume that reductions in fertiliser use are focused on synthetic, rather than organic, fertiliser. We will monitor sales and survey data on applications. To ensure that reductions are not achieved through reduced ouput we will also monitor total yields.
****Reductions in livestock numbers together with improvements in yield would meet dairy quotas and keep beef production constant at 2007 levels.
***** The UK inventory at present will not capture reductions in emissions intensities as a result of uptake of particular measures.

Notes:

1. Numbers indicate amount in last year of budget period i.e. 2012, 2017, 2022.
2. Our draft indicators lay out indicative trajectories for emissions reductions, key drivers, and changes in farming practice ranging from uptake of mitigation measures in the Industry GHG Action Plan to those included in the optimistic scenario of the MACC assessment. We note the uncertainties in laying out specific trajectories, given that the current agriculture inventory would not capture many mitigation methods, a better understanding of current farming practice is required, and that emissions projections may not reflect future trends in agriculture activity. We will further develop and modify our set of indicators as these issues are resolved in upcoming years.

Key: Headline indicators Implementation indicators Milestones Other drivers

Future work of the Committee

The Committee has a number of deliverables in 2010-2012, either required under the Climate Change Act or requested by Government:

2010

- **Low carbon R&D review.** This review was requested by the Government's Chief Scientist. It will include assessments of technologies to be prioritised for support in the UK, and the strategic framework for delivering this support. The review will be published in July 2010.
- **Review of the second phase cap for the Carbon Reduction Commitment.** This review was requested by DECC. It will propose a cap for the second phase of the Carbon Reduction Commitment based on current evidence and set out steps towards finalising the cap. It will also consider broader design questions (e.g. the extent to which the scheme should be used to strengthen incentives for renewable energy investments). The date for publication of this review is September 2010.
- **Advice on the level of the fourth budget.** This advice is required under the Climate Change Act. It will include an assessment of developments in climate change science since our 2008 report, and an assessment of the evolving international framework. It will set out pathways for the UK through the 2020s reflecting global pathways, the 2050 target and feasible emissions reductions. The review will be published before the end of 2010.

2011

- **Review of renewable energy ambition.** This was commissioned by the new Government as set out in the Coalition Agreement document. We will consider scope for and desirability of investment in renewable electricity and heat, both to 2020 and beyond, reporting back in Spring 2011.
- **Advice on the Scottish cumulative emissions budget.** This will draw out implications from the analysis of the UK's fourth budget and advise on a cumulative emissions budget for Scotland covering the period to 2050.
- **Third annual report to Parliament.** This will review progress reducing emissions as GDP returns to growth. It will include assessments of emissions trends, progress implementing measures against our framework of leading indicators, and progress meeting policy milestones to drive the required step change in the pace of emissions reduction. It will be published in June 2011.
- **Advice on use of offset credits to meet the second carbon budget.** This advice is required no later than June 2011 under the Climate Change Act.

- **Review of international shipping emissions.** The Committee has already provided a high-level assessment of international shipping emissions in the context of giving advice on the 2050 target. Further more detailed work is required to underpin advice on inclusion of shipping and aviation in carbon budgets (see below).
- **Review of sustainable bioenergy.** Various forms of bioenergy – biomass, biogas, biofuels – are potentially key to reducing emissions (e.g. in power, heat, surface transport, aviation, shipping, etc.). However, there is uncertainty as regards the level of sustainable biofuels given rising food demand and therefore constraints on available land for growth of feedstock. The Committee has provided a preliminary analysis of bioenergy in the context of the review of UK aviation emissions, and will set out scenarios in the context of the advice on the fourth budget. Further detailed work is required to underpin this high-level analysis, both to inform advice on inclusion of international aviation and shipping in carbon budgets (see below), and to provide more confidence on options for meeting the fourth budget.

2012

- **Advice on inclusion of international aviation and shipping in carbon budgets.** This advice is required under the Climate Change Act. The Committee previously recommended that international aviation and shipping should be in the 2050 target, and that international aviation should be reflected in decisions on carbon budgets. The Government implicitly accepted this advice, both in adopting the 2050 aviation target, and in its modelling of pathways to 2050. However, a formal decision on whether the net carbon account should be defined to include international aviation and shipping is required in 2012 under the Climate Change Act, following advice from the Committee. This will build on high-level advice on inclusion of aviation and shipping as part of the broad work on the fourth carbon budget.
- **Fourth annual report to Parliament.** This will consider emission trends, progress reducing emissions and evidence of the step change – which should be happening by this time.

Glossary

Achievable emissions intensity
The minimum average annual emissions intensity that could be achieved in a given year, given the installed capacity, projected demand and the projected profile of that demand.

Anaerobic Digestion (AD)
A treatment process breaking down biodegradable, particularly waste, material in the absence of oxygen. Produces a methane-rich biogas that can substitute for fossil fuels.

Biofuel
A fuel derived from recently dead biological material and used to power vehicles (can be liquid or gas). Biofuels are commonly derived from cereal crops but can also be derived from dead animals, trees and even algae. Blended with petrol and diesel biofuels it can be used in conventional vehicles.

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.

BREEAM
BRE Environmental Assessment Method (BREEAM) is a voluntary standard for rating the environmental performance of both new and existing buildings. It was established in the UK by the Building Research Establishment (BRE).

Bunker Fuel
Fuel consumed for international marine and air transportation.

Carbon Capture and Storage (CCS)
Technology which involves capturing the carbon dioxide emitted from burning fossil fuels, transporting it and storing 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 amount of carbon dioxide emission that would give rise to the same level of radiative forcing, integrated over a given time period, as a given amount of well-mixed greenhouse gas emission. For an individual greenhouse gas species, carbon dioxide equivalent emission is calculated by multiplying the mass emitted by the Global Warming Potential over the given time period for that species. Standard international reporting processes use a time period of 100 years.

Carbon Emissions Reduction Target (CERT)
CERT is an obligation on energy supply companies to implement measures in homes that will reduce emissions (such as insulation, efficient lightbulbs or appliances).

Carbon Reduction Commitment (CRC)
A mandatory carbon reduction and energy efficiency scheme for large non-energy intensive public and private sector organisations. CRC will capture CO_2 emissions not already covered by Climate Change Agreements and the EU Emissions Trading System and started in April 2010.

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.

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 (i.e. without an internal combustion engine) fuelled by battery power.

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 Union Emissions Trading Scheme (EU ETS)
Cap and trade system covering the power sector and energy intensive industry in the EU.

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.

Fuel Duty
A tax on petrol and diesel. In May 2008, the UK tax was £0.55 per litre for diesel and £0.52 for unleaded petrol.

Fuel Poverty
A fuel poor household is one that needs to spend in excess of 10% of household income on all fuel use in order to maintain a satisfactory heating regime.

Full hybrid
A vehicle powered by an internal combustion engine and electric motor that can provide drive train power individually or together.

Funded Decommissioning Programme (FDP)
A plan developed by operators to tackle back-end waste and decommissioning costs of nuclear power stations.

Generic Design Assessment (GDA)
Generic Design Assessment (GDA), also known as pre-licensing, is the process of ensuring that the technical aspects of designs for nuclear power plants are safe ahead of site-specific license applications.

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, hence it is commonly called the Greenhouse Effect.

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.

Heat pumps
Can be an air source or ground source heat pump to provide heating for buildings. 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.

Heavy Good Vehicle (HGV)
A truck over 3.5 tonnes (articulated or rigid).

Infrastructure Planning Commission (IPC)
A new body established by the Planning Act (2008) to take decisions on planning applications for major infrastructure projects.

Ionophores
Feed additives that can improve the performance of cattle. They are currently banned in the EU.

Justification
Regulatory Justification is based on the internationally accepted principle of radiological protection that no practice involving exposure to ionising radiation should be adopted unless it produces sufficient net benefits to the exposed individuals, or society, to offset any radiation detriment it may cause. This principle is included in the European Council Directive 96/29/ Euratom 13 May 1996.

Levelised cost
Lifetime costs and output of electricity generation technologies are discounted back to their present values to produce estimates of cost per unit of output (e.g. p/kWh).

Methane (CH_4)
Greenhouse gas with a global warming potential of 20 (1 tonne of methane corresponds to 20 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.

$MtCO_2$
Million tonnes of Carbon Dioxide (CO_2).

National Policy Statement (NPS)
National Policy Statements are produced by the Government and establish the national case for infrastructure development and set the policy framework for the Infrastructure Planning Commission (IPC) to take decisions.

Nitrification inhibitors
Chemical additives that slow the rate of conversion of fertiliser ammonium to nitrate and reduce the changes for nitrogen losses.

Nitrous oxide (N_2O)
Greenhouse gas with a global warming potential of 300 (1 tonne of nitrous oxide corresponds to 300 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).

Pay As You Save (PAYS)
Attaches the cost of low carbon refurbishment to the property rather than the homeowner, allowing payments to be spread out over an extended period of time.

Propionate precursors
Feed additives that reduce the production of methane in ruminants.

Renewable Heat Incentive (RHI)
Will provide financial assistance to producers (householders and businesses) of renewable heat when implemented in April 2011.

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. One ROC is issued for each megawatt hour (MWh) of eligible renewable output generated.

Smart meters
Advanced metering technology that allows suppliers to remotely record customers' gas and electricity use. Customers can be provided with real-time information that could encourage them use less energy, (e.g. through display units).

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.

Technical potential
The theoretical maximum amount of emissions reduction that is possible from a particular technology or practice. This measure ignores constraints on delivery and barriers to firms and consumers that may prevent up take.

Tidal range
A form of renewable electricity generation which uses the difference in water height between low and high tide by impounding water at high tide in barrages or lagoons, and then releasing it through turbines at lower tide levels.

Tidal stream
A form of renewable electricity generation which harnesses the energy contained in fast-flowing tidal currents.

United Nations Framework Convention on Climate Change (UNFCCC)
Signed at the Earth Summit in Rio de Janeiro in 1992 by over 150 countries and the European Community, the UNFCCC has an ultimate aim of 'stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.'

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).

Abbreviations

BEEP	Building Energy Efficiency Programme
BREEAM	BRE Environmental Assessment Method
CAD	Centralised Anaerobic Digestion
CAP	Common Agricultural Policy
CCA	Climate Change Agreement
CCC	Committee on Climate Change
CCGT	Combined-Cycle Gas Turbine
CH_4	Methane
CCS	Carbon Capture and Storage
CERT	Carbon Emissions Reduction Target
CESP	Community Energy Saving Programme
CHP	Combined Heat and Power
CLG	Department for Communities and Local Government
CRC	Carbon Reduction Commitment
CRDPs	Carbon Budget Reduction Delivery Plans
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
ENSG	Electricity Network Strategy Group
EPC	Energy Performance Certificate
EU ETS	European Union Emissions Trading Scheme
EUA	European Union Allowance
FDP	Funded Decommissioning Programme
FIT	Feed-in Tariff
GDA	Generic Design Assessment
GHG	Greenhouse Gas
GHGAP	Agriculture Industry Greenhouse Gas Action Plan
GVA	Gross value added
HEM	Household Energy Management Strategy
HGV	Heavy goods vehicle
ICAO	International Civil Aviation Organisation
IMO	International Maritime Organisation
IPC	Infrastructure Planning Commission
LCTP	Low Carbon Transition Plan
MPP	Major Power Producer
N_2O	Nitrous oxide
NG	National Grid
NPS	National Policy Statement
NTS	Non-Traded Sector
OFTO	Offshore Transmission Owner
OLEV	Office for Low Emission Vehicles
PHEV	Plug-In Hybrid Electric Vehicle
RHI	Renewable Heat Incentive
RO	Renewable Obligation
ROC	Renewable Obligations Certificate
RTFO	Renewable Transport Fuel Obligation
SMEs	Small & Medium Enterprises
SMMT	Society of Motor Manufacturers and Traders
VED	Vehicle Excise Duty

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