

Executive summary

1. This plan sets out how the UK will achieve decarbonisation within the framework of our energy policy: to make the transition to a low carbon economy while maintaining energy security, and minimising costs to consumers, particularly those in poorer households.

2. Emissions are down by a quarter since 1990.¹ Current policies put the UK on track to cut emissions by over a third, on 1990 levels, by 2020.

In the next ten years, we will develop and deploy the technologies that will be needed to halve emissions in the 2020s. This will put the UK on a path towards an 80% reduction by 2050.

3. By moving to a more efficient, low carbon and sustainable economy, the UK will become less reliant on imported fossil fuels and less exposed to higher and more volatile energy prices in the future.

Box 1: The Climate Change Act 2008 and the carbon budget framework

The Climate Change Act established a legally binding target to reduce the UK's greenhouse gas emissions by at least 80% below base year levels by 2050, to be achieved through action at home and abroad.² To drive progress and set the UK on a pathway towards this target, the Act introduced a system of carbon budgets which provide legally binding limits on the amount of emissions that may be produced in successive five-year periods, beginning in 2008. The first three carbon budgets were set in law in May 2009 and require emissions to be reduced by at least 34% below base year levels in 2020.

The fourth carbon budget, covering the period 2023–27, was set in law in June 2011 and requires emissions to be reduced by 50% below 1990 levels.³

This report sets out the proposals and policies for meeting the first four carbon budgets.

	First carbon budget (2008–12)	Second carbon budget (2013–17)	Third carbon budget (2018–22)	Fourth carbon budget (2023–27)
Carbon budget level (million tonnes carbon dioxide equivalent (MtCO ₂ e))	3,018	2,782	2,544	1,950
Percentage reduction below base year levels	23%	29%	35%	50%

¹ This figure includes the effect of emissions trading. UK territorial emissions have fallen by 28% over the same period.

² The base year is 1990 for carbon dioxide, nitrous oxide and methane, and 1995 for hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride.

³ To be reviewed in 2014 in light of EU Emissions Trading System cap.

Progress so far

4. Our past record shows that progress is possible. Between 1990 and 2010 emissions from power stations fell by almost a quarter, as the 'dash for gas' in the 1990s saw large numbers of coal-fired power stations replaced. In the last decade wind and other renewables have grown to the point that they now provide nearly a tenth of UK generating capacity. With nuclear power generating 16% of total UK electricity, a quarter of electricity generation is now low carbon.

5. In buildings, emissions have fallen by 18%, despite the growth in population and housing. Regulation has required the introduction of new, more efficient condensing boilers, saving at least £800 million this year on energy bills. Eleven million homes, 60% of all homes with cavity walls, have been fitted with cavity wall insulation. This will reduce the amount the UK spends on heating in 2011 by £1.3 billion.

6. In transport, emissions are roughly the same as they were in 1990. Emissions rose before 2007 as the economy grew and transport demand increased, but have since fallen due to improvements in new car efficiency, an increased uptake of biofuels and, to a lesser extent, the recent economic downturn.

7. Since 1990 industrial output has grown at an average of 1% a year while emissions have fallen by 46%. Industry has become more energy efficient and the UK's industrial base has shifted towards higher value, more knowledge-intensive sectors.

8. Agricultural emissions have fallen by almost a third, due in part to more efficient farming practices, while the diversion of waste from landfill, as a result of the landfill tax, has cut waste emissions by more than two thirds.

9. Government policies are already helping consumers. Our analysis predicts that average energy bills for domestic consumers will be 7.1% lower in 2020 than they would have been without policy interventions in place.

Vision

10. However, if we are to cut emissions by 80% by 2050, there will have to be major changes in how we use and generate energy. Energy efficiency will have to increase dramatically across all sectors. The oil and gas used to drive cars, heat buildings and power industry will, in large part, need to be replaced by electricity, sustainable bioenergy, or hydrogen. Electricity will need to be decarbonised through renewable and nuclear power, and the use of carbon capture and storage (CCS). The electricity grid will be larger and smarter at balancing demand and supply.

11. But there are some major uncertainties. How far can we reduce demand? Will sustainable biomass be scarce or abundant? To what extent will electrification occur across transport and heating? Will wind, CCS or nuclear be the cheapest method of generating large-scale low carbon electricity? How far can aviation, shipping, industry and agriculture be decarbonised?

12. The sectoral plans in this document seek to steer a course through this uncertainty.

13. **In the next decade**, the UK will complete the installation of proven and cost effective technologies that are worth installing under all future scenarios. All cavity walls and lofts in homes, where practicable, are expected to be insulated by 2020. The fuel efficiency of internal combustion engine cars will improve dramatically, with CO₂ emissions from new cars set to fall by around a third. Many of our existing coal-fired power stations will close, replaced primarily by gas and renewables. More efficient buildings and cars will cut fuel costs. More diverse sources of electricity will improve energy security and reduce exposure to fossil fuel imports and price spikes.

14. The UK is not alone in taking action on energy efficiency. Japan has set a goal of improving its energy consumption efficiency from 2003 levels by at least 30% in 2030. The Swedish Government has proposed an energy efficiency target to reduce energy by 20% between 2008 and 2020.⁴

⁴ International Energy Agency (2009) *Implementing Energy Efficiency Policies*.

15. Over the next decade the UK will also prepare for the future by demonstrating and deploying the key technologies needed to decarbonise power, buildings and road transport in the 2020s and beyond. Rather than picking a single winner, this plan sets out how the UK will develop a portfolio of technologies for each sector. This has two virtues. It will reduce the risk of depending on a single technology. And it will generate competition that will drive innovation and cost reduction.

16. In electricity, the three parts to our portfolio are renewable power, nuclear power, and coal- and gas-fired power stations fitted with carbon capture and storage. In transport, ultra-low emission vehicles including fully electric, plug-in hybrid, and fuel cell powered cars are being developed. In buildings, the technologies will include air- or ground-source heat pumps, and using heat from power stations. Both of these are solutions proven by their use in other countries.

17. **During the 2020s**, each of these technologies – low carbon electricity, low carbon cars and low carbon heating – will move towards mass roll-out. We estimate that between 40 and 70 gigawatts (GW) of new low carbon power will need to be deployed by the end of the decade. Emissions for the average new car will need to fall to between 50 and 70 gCO₂/km, compared with 144 gCO₂/km in 2010. Between 21% and 45% of heat supply to our buildings will need to be low carbon by 2030.

18. By developing options now, the UK will not only reduce the costs of deploying these technologies in the 2020s. It will also gain a long-term competitive advantage in sectors that play to our comparative strengths. These include offshore wind, carbon capture and storage, and information services to manage smart grids, heating controls and transport.

19. To 2030 and beyond, emissions from the hard-to-treat sectors – industry, aviation, shipping and agriculture – will need to be tackled. This will require a range of solutions to be tested by at the latest, the 2020s, including: greater energy efficiency; switching from oil and gas to bioenergy or low carbon electricity; and carbon capture and storage for industrial processes.

Sectoral plans

Low carbon buildings

20. In 2009, 37% of UK emissions were produced from heating and powering homes and buildings. By 2050, all buildings will need to have an emissions footprint close to zero. Buildings will need to become better insulated, use more energy-efficient products and obtain their heating from low carbon sources.

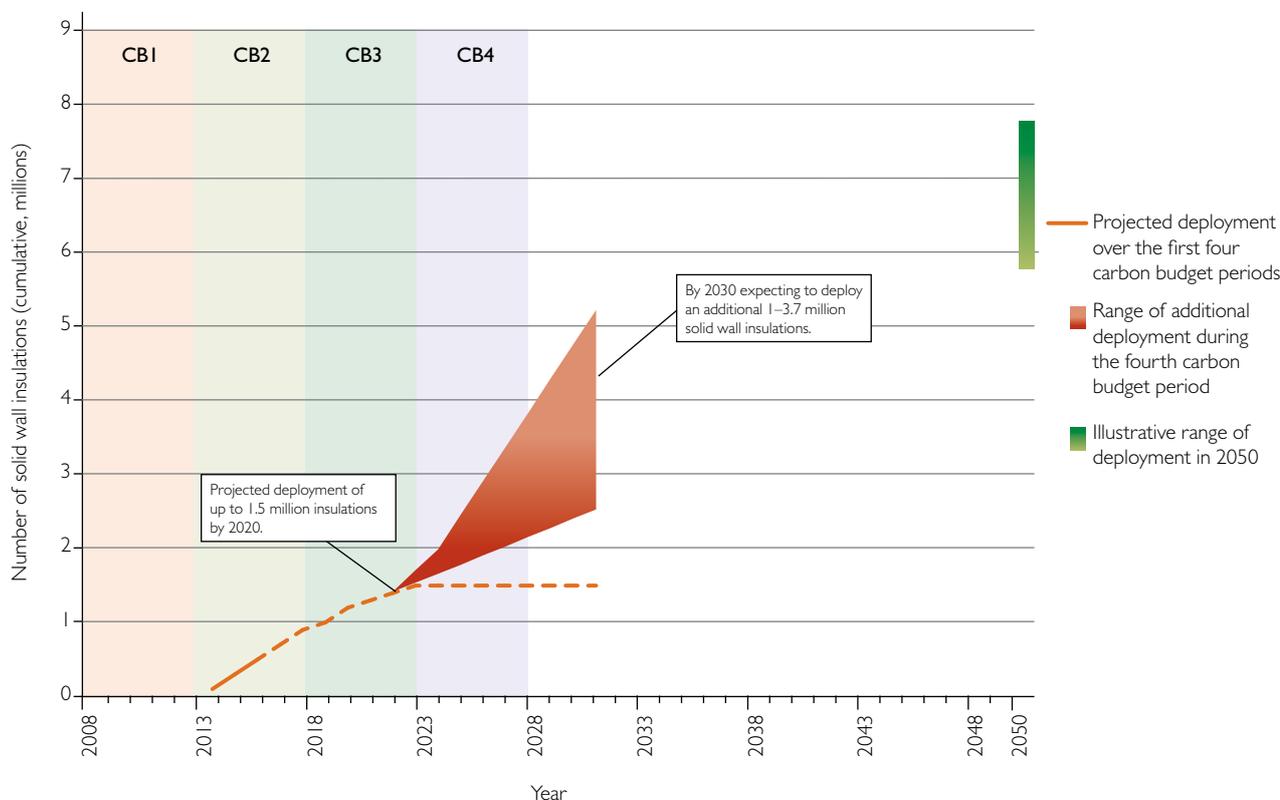
Energy efficiency

21. **Over the next decade**, with trends in installation rates maintained at today's levels, all cavity walls and lofts, where practical, will be insulated. Alongside this, the Government will support up to 1.5 million solid wall insulations and other energy efficiency measures such as double glazing.

22. The Green Deal, launching in 2012, will remove the upfront costs to the consumer of energy efficiency, with the cost being recouped through savings on their energy bills. The Energy Company Obligation will support this effort. It will place a duty on energy companies both to reduce emissions through undertaking solid wall insulation and to tackle fuel poverty by installing central heating systems, replacing boilers, and subsidising cavity wall and loft insulation. In parallel, Smart Meters will be deployed to every home to support consumers in managing their energy and expenditure intelligently. The Government will introduce zero carbon homes standards to cut the energy demand of new homes still further, reducing emissions and fuel bills. Through European energy standards and labelling we will promote the sales of the most efficient electrical appliances and products on the market.

23. **During the 2020s**, deployment of solid wall insulation will increase and installation costs will fall as the supply chain and the skills base become established. Chart 1 shows different levels of ambition for the uptake of solid wall insulation, ranging from 1 million to 3.7 million additional homes insulated by 2030.

Chart 1: Projected deployment of solid wall insulation over the first three carbon budgets, and illustrative range of deployment over the fourth carbon budget period and in 2050



Source: Department of Energy and Climate Change

Low carbon heating

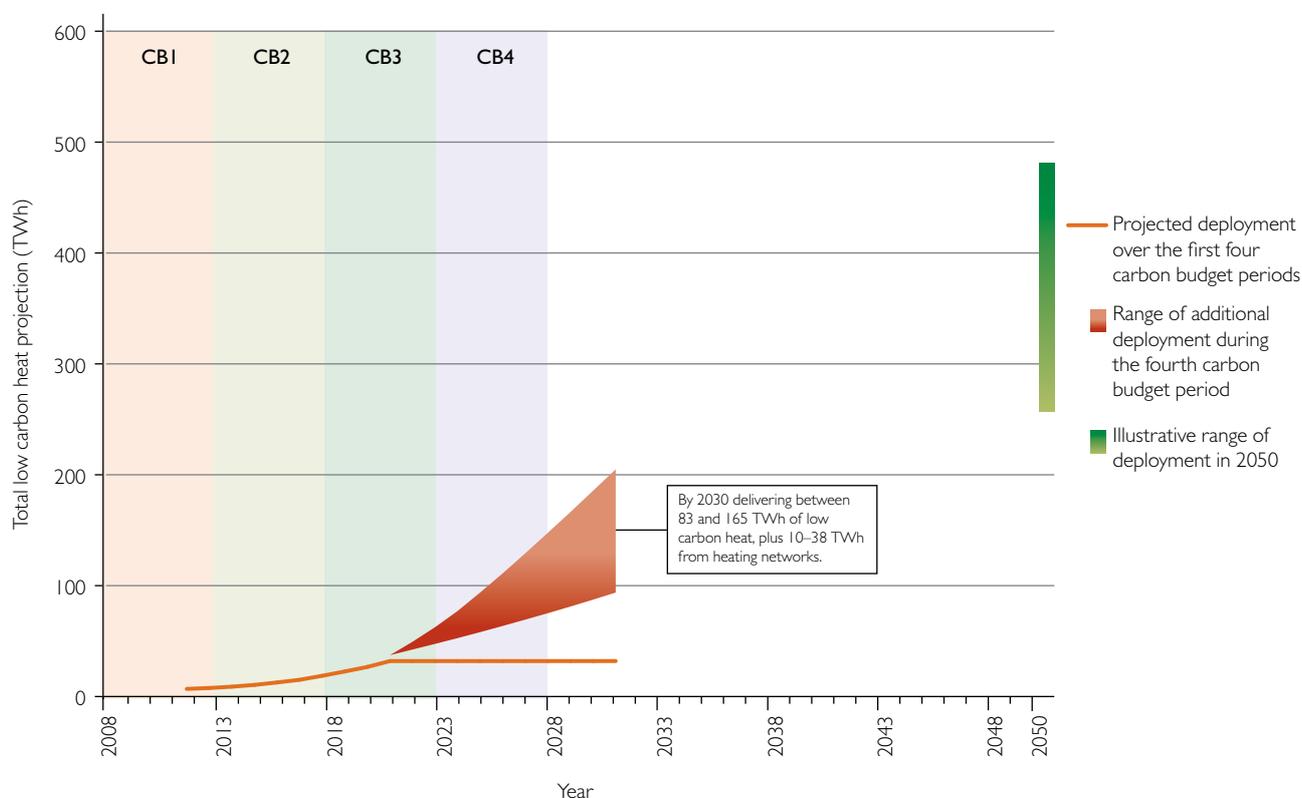
24. Energy efficiency is the immediate priority. But **in this decade** we also need to support ways of heating buildings without emitting carbon. Through the Renewable Heat Incentive (RHI) and Renewable Heat Premium Payment, over 130,000 low carbon heat installations are expected to be carried out by 2020.⁵ While we do not expect mass-market deployment of these technologies in this decade, there is an important opportunity to build the market, particularly in off-gas grid homes and in the commercial sector. At the same time the Government will work with local authorities, where appropriate, to lay the foundations for district heating networks, particularly in urban areas with more densely packed demand for heat. This should enable the long-term delivery of heat from low carbon sources.

25. **During the 2020s**, we need to begin the mass deployment of low carbon heat. Technologies such as heat pumps will begin to expand at scale into residential areas, overcoming current barriers such as cost and unfamiliarity, and working with the supply chain to meet consumer demand. At the same time, the heating networks that started in urban areas during this decade will begin to expand to meet demand in surrounding areas, and to compete with low carbon heat technologies in individual buildings, helping to keep costs down.

26. By 2027, based on the scenarios set out in this plan, emissions from buildings should be between 24% and 39% lower than 2009 levels.

⁵ This only includes installations as a result of RHI Phase I.

Chart 2: Projected deployment of low carbon heat in buildings over the first three carbon budgets and illustrative ranges of deployment potential in the fourth carbon budget period and in 2050



Source: Department of Energy and Climate Change

Low carbon transport

27. Domestic transport emissions make up nearly a quarter of UK emissions. By 2050, domestic transport will need to substantially reduce its emissions.

28. **Over the next decade**, average emissions of new cars are set to fall by around a third, primarily through more efficient combustion engines. Sustainable biofuels will also deliver substantial emissions reductions. As deeper cuts are required, vehicles will run on ultra-low emission technologies such as electric batteries, hydrogen fuel cells and plug-in hybrid technology. These vehicles could also help to deliver wider environmental benefits, including improved local air quality and reduced traffic noise.

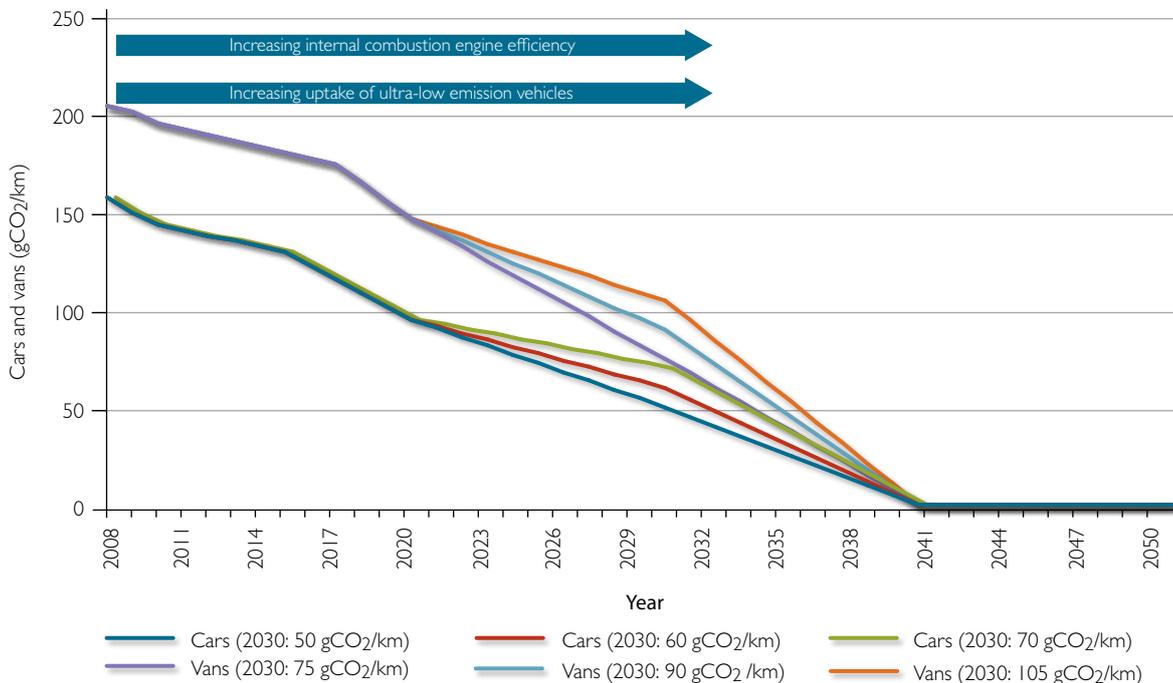
29. To ensure that these emissions savings are delivered, the Government will continue to work at European Union (EU) level to press for

strong EU vehicle emissions standards for 2020 and beyond in order to deliver improvements in conventional vehicle efficiency and give certainty about future markets for ultra-low emission vehicles.

30. To support the growth of the ultra-low emission vehicle market, the Government is providing around £300 million this Parliament for consumer incentives, worth up to £5,000 per car, and further support for the research, development and demonstration of new technologies.

31. **During the 2020s**, we will move towards the mass market roll-out of ultra-low emission vehicles, although further improvements in the efficiency of conventional vehicles and sustainable biofuels are also anticipated to play a key role. Based on current modelling the Government anticipates that average new car emissions could need to be 50–70 gCO₂/km and new van emissions 75–105 gCO₂/km by 2030.

Chart 3: Projected average new car and van emissions over the first three carbon budgets and illustrative ranges of average new car and van emissions in the fourth carbon budget period and to 2050



32. While cars and vans make up the largest share of emissions, other sectors will need to decarbonise over time.

33. To support people to make lower carbon travel choices, such as walking, cycling or public transport, the Government is providing a £560 million Local Sustainable Transport Fund over the lifetime of this Parliament.

34. Industry is leading the drive to reduce emissions from freight. The Logistics Carbon Reduction Scheme, for example, aims to reduce emissions by 8% by 2015, through improved efficiency and some modal shift to rail. For the longer term, to make deeper reductions in emissions, innovation will be needed in ultra-low emissions technologies such as sustainable biofuels and electric, hydrogen or hybrid technologies.

35. Emissions from aviation will be capped by being part of the EU Emissions Trading System (EU ETS) from 2012, ensuring that any increases in aviation emissions are offset by reductions elsewhere in the EU economy, or internationally.

36. By 2027, based on the scenarios set out in this plan, emissions from transport should be between 17% and 28% lower than 2009 levels.

Low carbon industry

37. Industry makes up nearly a quarter of the UK's total emissions. Over 80% of these emissions originate from generating the heat that is needed for industrial processes such as manufacturing steel and ceramics, and the remainder from chemical reactions involved in processes such as cement production. By 2050, the Government expects industry to have delivered its fair share of emissions cuts, achieving reductions of up to 70% from 2009 levels.

38. The Government will work with industry to ensure that low carbon growth continues into the future. Industry must make significant reductions in the emissions intensity of production, while the Government assists in maintaining the competitiveness of strategically important sectors. Emissions reductions will come from three sources: first, driving further efficiencies in the use of energy and materials and the design of industrial processes; second, replacing fossil fuels with low carbon alternatives such as bioenergy

and electrification; and third, from carbon capture and storage (CCS) to address combustion and process emissions, for example in cement and steel.

39. **Over the next decade**, the main chances for industry to decarbonise will come from taking up the remaining opportunities for energy efficiency, and beginning the move to low carbon fuels, such as using sustainable biomass to generate heat for industrial processes. Through the EU ETS and domestic policies such as Climate Change Agreements and the CRC Energy Efficiency Scheme the Government is helping to ensure that these cost effective energy efficiency measures are being taken up. Innovation efforts during this period will also be important, bringing down the cost of decarbonising industrial processes and moving technology options such as electrification and CCS closer to commercial reality. CCS technology research projects are being strongly backed by UK and international sources of funding, with the aim of turning CCS into a viable option for the coming decades.

40. **During the 2020s**, in addition to energy efficiency measures, reductions will be driven by switching to low carbon fuels. As with buildings, the Government expects industry to take advantage of the Renewable Heat Incentive, replacing expensive fossil fuels with low carbon heat alternatives and thereby accelerating the decarbonisation of industry in the 2020s. CCS technology is also expected to start to be deployed during this decade.

41. Throughout this transition the Government will work closely with industry to address the principal risks, including the impact of anticipated increases in energy costs, to ensure that UK industry remains internationally competitive. The Government announced a package of measures to support sectors which are particularly exposed to these risks.

42. By 2027, emissions from industry should be between 20% and 24% lower than 2009 levels.

Low carbon electricity

43. The power sector accounts for 27% of UK total emissions by source. By 2050, emissions from the power sector need to be close to zero.

44. With the potential electrification of heating, transport and industrial processes, average electricity demand may rise by between 30% and 60%. We may need as much as double today's electricity capacity to deal with peak demand. Electricity is likely to be produced from three main low carbon sources: renewable energy, particularly onshore and offshore wind farms; a new generation of nuclear power stations; and gas and coal-fired power stations fitted with CCS technology. Renewable energy accounted for approximately half of the estimated 194 GW of new electricity capacity added globally during 2010.⁶ Fossil fuels without CCS will only be used as back-up electricity capacity at times of very high demand. The grid will need to be larger, stronger and smarter to reflect the quantity, geography and intermittency of power generation. We will also need a more flexible electricity system to cope with fluctuations in supply and demand.

45. While the overall direction is clear, major uncertainties remain over both the most cost effective mix of technologies and the pace of transition. The Government is committed to ensuring that the low carbon technologies with the lowest costs will win the largest market share.

46. **Over the next decade**, we need to continue reducing emissions from electricity generation through increasing the use of gas instead of coal, and more generation from renewable sources. Alongside this, we will prepare for the rapid decarbonisation required in the 2020s and 2030s by supporting the demonstration and deployment of the major low carbon technologies that we will need on the way to 2050. The reforms to the electricity market will be the most important step in making this happen. The introduction of Feed-in Tariffs with Contracts for Difference from 2014 will provide stable financial incentives for investment in all forms of low carbon generation.

⁶ REN21 (2011) *Renewables 2011: Global Status Report*.

47. In addition, the Government is:

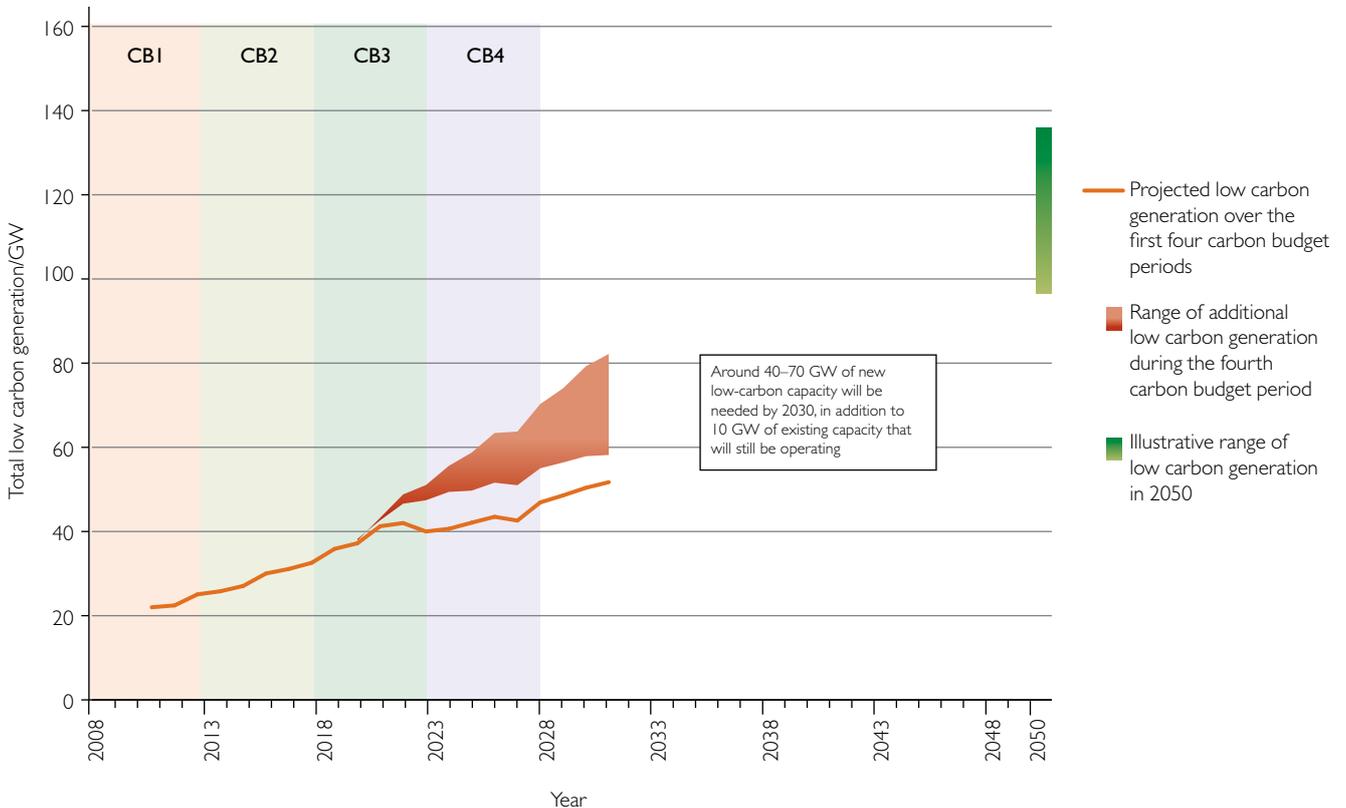
- helping industry to reduce the costs of offshore wind by setting up an Offshore Wind Cost Reduction Task Force with the aim of driving down the cost of offshore wind to £100 per megawatt hour (MWh) by 2020;
- supporting the development of CCS technology at scale in a commercial environment, to bring down costs and risks, with £1 billion set aside to support the programme;
- supporting the demonstration of less mature renewable technologies, and committing up to £50 million over the next four years to support innovation in marine and offshore technologies;
- enabling mature low carbon technologies such as nuclear to compete by addressing the barriers to deployment such as an under-developed UK supply chain; and

- working with Ofgem and the industry to deliver the investment required to ensure that the electricity transmission and distribution networks will be able to cope in the future.

48. Maintaining secure energy supplies remains a core government priority. New gas-fired generation will play a significant supporting role as 19 GW of existing generation capacity closes over the next decade.

49. Over the 2020s, large-scale deployment of low carbon generation will be needed, with, we estimate, 40–70 GW of new capacity required by 2030. This will drive a huge reduction in emissions from electricity supply. In the 2020s, the Government wants to see nuclear, renewables and CCS competing to deliver energy at the lowest possible cost. As we do not know how costs will change over time, we are not setting targets for each technology or a decarbonisation target at this point.

Chart 4: Projected deployment of low carbon generation over the first three carbon budgets and illustrative ranges of deployment potential in the fourth carbon budget period and in 2050



Source: Department of Energy and Climate Change, Redpoint modelling, 2050 Calculator

50. The scenarios modelled in this plan show that by 2030 new nuclear could contribute 10–15 GW, with up to 20 GW achievable if build rates are higher; fossil fuel generation with CCS could contribute as much as 10 GW; and renewable electricity could deliver anywhere between 35 and 50 GW – depending on assumptions about costs and build rates.

51. By the end of the fourth budget period, our analysis suggests that emissions from electricity generation could be between 75% and 84% lower than 2009 levels.

Agriculture, land use, forestry and waste

52. As set out above, the majority of emissions reductions will come from action in buildings, transport, industry and electricity generation. However, efforts elsewhere will continue to contribute – in the next decade, during the fourth carbon budget period, and ultimately to meeting the 2050 target.

53. In 2009, agriculture, forestry and land management together accounted for around 9% of UK emissions. The Government is encouraging practical actions which lead to efficiencies such as improved crop nutrient management and better breeding and feeding practices, which save both money and emissions. The Government is also working to improve its evidence base to better understand what this sector can feasibly deliver in the future. The Government will undertake a review of progress towards reducing greenhouse gas emissions from agriculture in 2012 which will assess the impact of existing measures and highlight further policy options. Next spring an independent panel will provide advice on the future direction of forestry and woodland policy in England.

54. In 2009, emissions from waste management represented a little over 3% of the UK total. The Government is committed to working towards a zero waste economy, and by 2050 it is estimated that emissions of methane from

landfill (responsible for around 90% of the sector's emissions) will be substantially below current levels. The Government is working to improve our scientific understanding of these emissions so that they can be managed better. Our strategy over the next decade was set out in the Action Plan which accompanied the Review of Waste Policy in England, and includes increases to the landfill tax. By the end of 2013 the Government will develop a comprehensive Waste Prevention Programme, and work with businesses and other organisations on a range of measures to drive waste reduction and re-use.

A plan that adds up

55. Part 3 of this report outlines some illustrative scenarios to demonstrate different ways in which the fourth carbon budget could be met through different combinations of the various ambitions in the different sectors. As the Government develops its policy framework further it will look to meet the fourth budget in the most cost effective and sustainable way and keep costs under review, developing clear impact assessments and consulting publicly on policies before it implements them. A full list of the Government's energy and climate change commitments for this Parliament is set out at Annex C.

56. We will also continue to work on the international stage to ensure that this is a genuinely collaborative global effort. Other countries are already taking actions to decarbonise their economies and we will continue to push for ambitious action both in the EU and globally. At the EU level, the UK is pushing for the EU to show more ambition by moving to a tighter 2020 emissions target, which in turn will drive a more stringent EU ETS cap. We will review our progress in 2014. If at that point our domestic commitments place us on a different emissions trajectory than the ETS trajectory agreed by the EU, we will, as appropriate, revise up our budget to align it with the actual EU trajectory.⁷

⁷ Before seeking Parliamentary approval to amend the level of the fourth carbon budget, the Government will take into account the advice of the Committee on Climate Change, and any representations made by the other national authorities.

Building a coalition for change

57. To make this transition, industry, the Government and the public need to be pulling in the same direction.

58. For industry, the global low carbon market is projected to reach £4 trillion by 2015 as economies around the world invest in low carbon technology. The innovation challenge for industry is in business models as well as technologies, with electric vehicles, renewable electricity and solid wall insulation requiring upfront investment, but delivering large savings in operating costs.

59. Industry must lead, but the Government can facilitate. This plan provides more clarity on the scale of the UK market opportunity and the pace of transition. In the next decade, the state will support innovation to ensure that key technologies can get off the ground. Rather than pick a winning technology, the Government will create markets that enable competing low carbon technologies to win the largest market share as the pace of change accelerates in the 2020s. New business models require new institutional frameworks that underpin long-term investment. That is the purpose behind both the Green Deal

and Electricity Market Reform. As we make the transition, the state will need to solve co-ordination problems and ensure that the system as a whole coheres – for example, to understand when infrastructure decisions are required relating to the electricity grid, the gas network and charging points for electric cars.

60. The plans for new electricity infrastructure and changes in the way in which we travel and heat our homes will require public support. While public opinion is in favour of tackling climate change, there is little agreement over how to go about it. This plan shows that the UK can move to a sustainable low carbon economy without sacrificing living standards, but by investing in new cars, power stations and buildings. However, it will require the public to accept new infrastructure and changes to the way in which we heat homes, and to be prepared to invest in energy efficiency that will save money over time. As part of this Carbon Plan, the Government is launching a new 2050 Calculator, to enable a more informed debate about UK energy choices and develop a national consensus on how we move to a low carbon economy. The Government will also use this plan to build more consensus globally on how moving to a low carbon transition is a practical and achievable goal.