The emissions path through the 2020s is of crucial importance in building a low-carbon economy. During this period there is scope for widespread deployment of low-carbon technologies including clean power generation, electric vehicles and low-carbon heat generation. Therefore there is an opportunity to build on the progress required under the first three carbon budgets, and accelerate the pace of emissions reduction from 2020 to 2030. The need for such an acceleration is reflected in our recommended budget. This is stretching but feasible, and can be delivered at a cost of under 1% of GDP. It will bring economic benefits to the UK and, with similar action in other developed countries, will mitigate risks of dangerous climate change. Given these benefits, we urge the Government and Parliament to legislate the proposed Domestic Action budget, and to put in place the policies required to ensure that that budget can be delivered.

Executive summary

Reduction in UK greenhouse gas emissions by 2050 (relative to 1990 levels) required to limit the risks of dangerous climate change.

80% by 2050

Emissions reduction in 2020 (relative to 1990) under our proposed tightening of second and third carbon budgets.

37%

Our proposed fourth budget for 2023-2027 – to be delivered through Domestic Action.

1950 MtCO₂e

Required reduction in emissions from today to 2030.

46%

Further required reduction in emissions from 2030-2050.

62%

The cost of meeting the fourth carbon budget and the 2030 target.

Under 1% GDP
Given both our confidence in the fundamental science and current uncertainties, we continue to recommend a two step approach:

- Carbon budgets and targets should be based on the climate objective and pathways in our 2008 report:
  - Central estimates of global temperature increase by 2100 should be limited to as little above 2°C over pre-industrial levels as possible, and the likelihood of a 4°C increase should be kept to very low levels (e.g. less than 1%).
  - To meet this objective, global emissions should peak by 2020 and be halved or more by 2050; the UK should therefore aim to achieve at least an 80% emissions reduction in 2050 relative to 1990 levels.

- Significant research effort is aimed at resolving current uncertainties; we will continue to monitor scientific developments and periodically review implications for carbon targets and budgets.

We therefore use the pathways from the 2008 report as a benchmark for understanding progress and challenges in moving to a new global deal in Chapter 2, and the targets for the UK implied by these pathways in recommending the fourth carbon budget in Chapter 3. Our advice on the fifth carbon budget (scheduled for 2015) will provide an opportunity to revisit these pathways following the publication of the IPCC’s Fifth Assessment Report.

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**Revisiting the science of climate change**

Global average temperatures from 2000-2009 were around 0.75°C above pre-industrial levels.

Limiting central estimates of global warming by 2100 close to 2°C will reduce (but not avoid) the risks from climate change.

Many societies and ecosystems will not be able to adapt to 4°C of warming. The risk of reaching this should be kept to very low levels.

The number of climate research papers reviewed by the Committee this year, providing us with the latest understanding of climate science.

Global CO₂ emissions increased 6-fold over the 20th Century.

CO₂ concentration has not been as high as today for at least the last million years, possibly much longer.

The last decade has been the hottest since records began.
6. How we use the international context in this report

As with our previous advice on carbon budgets and the 2050 target, our approach in advising on the level of the fourth carbon budget is to view this as a UK contribution to required global emissions reduction.

This chapter has set out our analysis of EU actions, global pathways and carbon price implications consistent with the Copenhagen Accord and delivery of our climate objective. We use these blocks of analysis to underpin our advice on the fourth budget in a number of ways:

- EU action to 2020 informs whether the UK should move to the Intended budget or retain the currently legislated Interim budget.
- Global emissions pathways (to meet the climate objective) inform the UK long-term target.
- The shape of the global pathway (e.g. pace of reduction, early vs. late action) informs the broad shape of the UK path to the long-term target.
- Global and EU emissions pathways underpin our carbon price projections to 2050, which we use to identify cost-effective abatement options and develop UK emissions pathways through the 2020s.

The next chapter sets out in detail how we move from this international assessment to develop UK pathways and a fourth carbon budget consistent both with required global pathways and the UK’s 2050 target.

The international context – implications for the fourth carbon budget

IEA estimate of the additional cost of failing to reach an ambitious global deal at Copenhagen.

Countries made pledges under the Copenhagen Accord.

When global emissions could peak, if high-end ambition pledges made under the Copenhagen Accord are met.

By 2030 world should cut current emissions by around 25%.

By 2030 EU should cut emissions by around 55% (relative to 1990 levels).

The carbon price we use in 2030.
• **New policies to deliver the first three budgets.** Our recommended fourth budget builds in emissions reductions to achieve the first three budgets. Given limited progress reducing underlying emissions in recent years, a step change in the pace of emissions reduction is required. New policies to drive the step change include approaches to energy efficiency improvement in residential and non-residential buildings, consumer behaviour change in transport, and more widespread use of carbon-efficient practices on farms.

• **Further evidence to resolve uncertainties** around certain options to cut emissions in the 2020s. These include district heating, abatement options in agriculture and industry, and implications of electric vehicle deployment for power networks. The evidence base should be developed in these areas, with new policies introduced as appropriate.

• **Implications for EU policies and measures.** There is a set of policies that the UK Government should push for to set the EU on a cost-effective and credible path to its 2050 target, and which would reinforce UK action to meet the fourth carbon budget, including:

  – Supporting the move to an EU 30% emissions reduction target in 2020 relative to 1990 levels.
  – Agreeing an appropriate emissions reduction target for 2030 (e.g. around a 55% reduction relative to 1990).
  – Tightening of the EU ETS emissions cap, both in 2020 and through the 2020s.
  – Setting 2030 targets for new car and van emissions (e.g. around 50 gCO2/km for cars and 80 gCO2/km for vans).
  – Reforming the EU Common Agricultural Policy, which is due for revision in 2013, so that it links subsidies and incentives to climate change mitigation objectives.
  – Supporting technology development, particularly for CCS in industry.

We discuss these implications in detail in chapters 2 and 4 to 7, then consider the implications for the wider economic and social circumstances laid out in the Climate Change Act in chapter 8.

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**The Fourth Carbon Budget**

The proposed carbon budget for 2023-27, to be delivered through Domestic Action.

- **Reduction in emissions by 2030 (relative to 1990)** consistent with the Domestic Action target.
- **Proposed credit use to plan for in meeting the Domestic Action target.**
- **Indicative tighter carbon budget for 2023-27,** as a potential global offer.
- **Reduction in emissions in 2030 (relative to 1990)** consistent with the Global Offer budget.
- **Required CO2 reduction by 2050 (relative to 1990), assuming less progress in international aviation and shipping and non-CO2.**
- **Estimated cost of meeting the fourth carbon budget.**

- 1,950 MtCO2e
- 60%
- 0 MtCO2e
- 1,800 MtCO2e
- 63%
- Around 90%
- Under 1% GDP
The path from 2030 to 2050

Emissions in 2030 are 67 MtCO₂ in our Medium Abatement scenario, with further reduction required to 2050 including (Figure 4.17):

- A low or zero-carbon car and van fleet, comprising electric and plug-in hybrid vehicles, with the possibility of hydrogen vehicles.
- The possibility of hydrogen HGVs.
- Biofuels meeting demand for residual liquid fuels (e.g. from plug-in hybrid vehicles, HGVs).
- Rail electrification

Given our assessment of what is possible in other sectors, it is likely that an emissions reduction of 90% or more will be required in surface transport to meet the economy-wide 80% target. The implication of this is that conventional cars and vans should be fully phased out by the mid-2030s, in order that the car and van fleet is zero- or low-carbon by 2050.

10. Implications for first three budget periods

The main implications for the first three budget periods relate to electric vehicles, biofuels and hydrogen:

- **Electric vehicles.** It is unlikely that there could be very significant roll-out of electric cars and vans in the 2020s from a standing start in 2020. Therefore in order to support required decarbonisation in the 2020s, it will be important to make progress on electric vehicle deployment in the first three budget periods. This reinforces the need for transitional Government support to cover the cost of electric car batteries, together with investment in a battery recharging network. In addition, the economics of electric vans should be assessed in more detail and transitional support arrangements introduced as appropriate. Assessment of network implications from significantly increased penetration of electric cars should be undertaken and used to inform design of investment programmes.

- **Second generation biofuels.** Research, development and demonstration of second generation biofuels is required if these are to play an important role in the 2020s. Consideration should be given to options for supporting R&D and pulling through second generation biofuels (e.g. through a requirement to meet EU biofuels targets with a greater proportion of second generation biofuels).

- **Hydrogen.** There should be continued support for hydrogen technologies as part of a wider technology strategy in order to support deployment in the 2020s in markets where vehicle range is of particular importance.

The Committee will continue to monitor progress developing a framework for and rolling out electric cars in the period to 2020, and will explore scope for adding indicators relating to progress in electric vans, second generation biofuels, and hydrogen.
Reducing emissions from buildings and industry through the 2020s

The UK’s total emissions coming from buildings and industry.

Energy consumed in homes for space and water heating.

Leaky solid walled houses should be properly insulated by 2030, that’s about half of the total.

Number of homes which could be heated by low carbon heat by 2030.

Heat pumps can be up to 4 times more efficient in generating heat from electricity when compared to conventional electric heating systems.

By 2050, we expect the buildings sector to be zero carbon in order to meet the 80% target.

There is scope for reducing industry emissions by almost half between now and 2030.

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- **R&D.** Further technology research and development is needed including:
  - Advanced insulation materials
  - Biomass gasification & CHP
  - Heat pump COPs

There are also three areas that we have identified where further evidence is required:

- **Biomass.** This is a potentially important option for decarbonisation of industry, but with uncertainties over available sustainable supply. Further evidence is required on likely sustainable biomass availability through the 2020s and beyond. The Committee will report on this as part of a broader review of bioenergy, to be published before the end of 2011.

- **District heating.** The possibility of using waste heat from low carbon power generation is attractive but uncertain. Further evidence is required on technical and economic aspects of heat generation, transport, distribution and heat demand in order to better understand the extent to which this is likely to provide a viable option for deployment in the 2020s.

- **Industry.** The evidence base for abatement potential within industry needs strengthening. This includes both the sectors we have covered in this report and additional sectors (e.g. the construction sector), as well as non-heat related combustion (e.g. drying and separation). In addition, there may be scope for abatement through reducing demand in industry (e.g. light-weighting of steel products) and reduction in consumption by end consumers, although further data on this is required.
• **Interconnection benefits.** Our analysis suggests that increased interconnection could be potentially beneficial in addressing demand volatility. However, we have not carried out a detailed cost-benefit analysis of specific options. More detailed analysis is required to ensure that projected benefits outweigh costs, following which new projects should be developed as appropriate.

• **Industrial capacity.** We have highlighted the need for significantly increased investment in low-carbon power generation. Whilst this would appear to be feasible based on what has been achieved in other countries historically, it is not clear what gap currently exists in the UK as regards industrial capacity, though some organisations have raised concerns. Further assessment is required to identify the gap, together with remedial measures that may be required in addition to creation of demand for low-carbon generation and expected market response.

• **Smart grid.** Our analysis suggests that smart grids could greatly help in managing increased intermittency and more peakiness of demand in the system.

Given this evidence, it will be important to develop economy-wide scenarios for decarbonisation through the 2020s, drawing out implications for the power sector and using these to frame both technology support over the next decade and beyond, and the introduction of new market arrangements under which there is tendering of long-term contracts for low-carbon capacity.

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Power sector decarbonisation to 2030

**Share of total UK emissions from power generation.**

- 28%

**The carbon intensity of power will need to fall from around 500 g/kWh today to 50 g/kWh by 2030.**

- 97% of electricity should be generated by low-carbon sources in 2030, compared to 26% now.

**Low-carbon capacity needs to be added to the system in 2020s – a mixture of nuclear, renewables and CCS.**

- 30-40 GW

**DECC will consult on options for market reform.**

**The power sector will need to almost completely decarbonise by 2050.**

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28 For example, The Institute of Mechanical Engineers (2010) Nuclear Build: A Vote of No Confidence.
7. Implications for the first three budget periods

To deliver emission reductions from agriculture outlined in this chapter, there are a number of implications for action in the first three budgets:

- Implement measures to 2020 as targeted by the Government and industry in the GHG Action Plan
- Resolve uncertainties in agriculture, including:
  - The measurement of emissions via an improved Agriculture GHG Inventory
  - Estimated abatement potential from soils and livestock measures, both as regards the state of current farming practices and the emissions impact of measures
- Explore abatement potential from more radical options through research and technological development
- Consider the full range of policies to support further emission reductions, including:
  - For supply-side abatement, ranging from voluntary to EU-level to other approaches
  - For demand-side abatement (e.g. reducing waste along food chain and encouraging rebalancing of diets), ranging from information-provision to taxes

For LULUCF activities to contribute to emissions reduction in the fourth budget, the implications for action in the first three budgets are as follows:

- Resolve uncertainties in LULUCF activities including:
  - Afforestation: improve understanding and monitoring of soil carbon emissions and emissions savings from fossil fuel substitution
  - Agricultural land management practices: identify soil carbon sequestration practices that offer true additional mitigation potential
  - Peat soils: bring evidence together to understand the scale of the opportunity around peatland restoration/management
- Consider policies to support LULUCF activities, including the role of economic incentives, grants, and markets to promote private investment in woodland creation.

Reducing emissions from agriculture and land use, land-use change and forestry

Agricultural emissions currently 8% of the UK total.

If left unabated beyond 2020, agriculture will account for 28% of permitted 2050 emissions.

Possible to reduce 2030 emissions by 18% from current levels.

Agricultural abatement potential in 2020s.

Share of abatement potential that also increases farmers profits.

Potential agricultural GHG emissions in 2030.

Abatement potential in 2030 from forestry, if planting starts today.
3. Scenarios for emissions in the devolved administrations

We now bring together our reference emissions projections and our assessments of abatement potential and set out indicative emissions scenarios for the devolved administrations through the 2020s. Our analysis suggests that in total there is potential to reduce direct emissions in the sectors analysed by around 48%, 36%, and 49% by 2030 in Scotland, Wales and Northern Ireland in the Medium Abatement scenario, compared to 2008 (Figure 8.9). We will use this analysis to help inform our advice on targets on emissions reduction in Scotland in 2011.

4. Developing options to reduce emissions at the national level

In each of the key areas, deep cuts in emissions through the 2020s from the abatement options above will require action now to develop options, both at the UK and at the national levels:

- New policies will be required to support energy efficiency improvement in the period to 2020 and beyond.
- Government support will be required for development of markets for low carbon heat and electric vehicles.
- Government financial and other support will be required if renewable electricity resource potential is to be exploited.
- New policies will be required to encourage farmers to reduce emissions.

Given the balance of reserved and devolved powers, there will often be an important role for the UK in driving emissions reductions. However, the devolved administrations have a crucial role to play, ensuring that appropriate incentives are in place to encourage implementation of measures where cost effective potential is available.