Chapter 1: Approach to setting the Fifth Carbon Budget

1. The value of carbon budgets
2. Scope of carbon budgets
3. Balancing the criteria in the Climate Change Act
4. Feasibility of delivery
5. Areas of uncertainty and implications for budget setting

The Climate Change Act (2008) requires the Committee on Climate Change to provide advice to the Government about the appropriate level for the fifth carbon budget (covering the years 2028 to 2032) before the end of 2015. The Act specifies the factors the Committee must consider in that advice. These are discussed in detail below but, in essence, they mean that the Committee's advice should be based on the cost-effective path to the Act's ultimate 2050 objective (i.e. to reduce emissions by at least 80% from 1990 levels), consistent with international commitments and considerations such as affordability, competitiveness, energy security and the Government's fiscal position.

This report contains the final advice based on a very broad review of the evidence accompanied by detailed, independent analysis and expert judgment. It reflects the Committee's view that the progress made to date must continue in the future. Underneath that steady overall progress is a varying rate of progress across the different sectors of the economy: some have reduced emissions more quickly but cannot continue that to 2050 (like the power sector), others have reduced more slowly but must do more in the future (like heating for buildings, agriculture). Much of the detail contained in this advice report, and the accompanying Technical Report, is about the most cost-effective balance in emission reduction across the sectors in the period from 2028 to 2032.

Chapters 2-5 present analysis and evidence relevant to the criteria that the Committee are required to balance in recommending the carbon budget:

- science and international and European circumstances (Chapter 2),
- technology and economics (Chapter 3);
- fiscal circumstances, competitiveness, fuel poverty and security of supply (Chapter 4); and
- the differences in circumstances between England, Wales, Scotland and Northern Ireland (Chapter 5).

Chapter 6 pulls these together and sets out the recommended level of the fifth carbon budget. It also includes accompanying recommendations that are required under the Act, such as the treatment and implications of emissions from international aviation and shipping.

This report is supplemented by a Technical Report on *Sectoral scenarios for the fifth carbon budget*.[1] It sets out more detail about the scenarios we have developed to support this advice. The scenarios discuss the evidence the Committee has used to reach the view that the reduction in emissions in its final advice can be delivered while balancing all the factors it is required to consider. They are not intended as a prescriptive path and deliberately acknowledge the uncertainty inherent in the time-frames of carbon budgets. In advance of this advice the Committee has also published two reports with specific evidence about particular factors the Committee must consider: *The scientific and international context for the fifth carbon budget*[2] and *Power sector scenarios for the fifth carbon budget*[3].

The rest of this chapter gives a background to carbon budgets, expands on the criteria that the Committee must consider and sets out some of the challenges in doing so over a decade in advance.

1 available from https://www.theccc.org.uk/publications
2 available from https://www.theccc.org.uk/publication/the-scientific-and-international-context-for-the-fifth-carbon-budget
3 available from https://www.theccc.org.uk/publication/power-sector-scenarios-for-the-fifth-carbon-budget

1. The value of carbon budgets

Carbon budgets set five-year caps on net emissions of greenhouse gases across the UK economy. They are set 12 years ahead of their start year to provide time for actions to minimise costs and maximise benefits to households and businesses of achieving the budgets. They must be set to be consistent with the UK's long-term statutory goal to reduce emissions by at least 80% on 1990 levels by 2050.

The Committee on Climate Change is an independent body. Its advice is based on a systematic review of wide-ranging evidence about the costs and benefits of reducing emissions in all parts of the economy. That review incorporates understanding of the implications of the inherent uncertainty about future developments.

The Climate Change Act sets out the criteria that must be considered in setting carbon budgets (see section 3). The Committee provides an independent assessment of those criteria based on the best available evidence and extensive stakeholder engagement (Figure 1.1 and Box 1.1).

The carbon budgets combine stability in the overall target (the desired end or outcome in terms of emissions reduction) with flexibility in the balance of effort across different sectors and between options within sectors (the means by which that emissions reduction is achieved). This recognises the uncertainties in setting budgets 12 years ahead while preserving the advantages of doing so. In particular:

- **Stability of ends**. The carbon budgets are enshrined in law under the Climate Change Act, which specifies that the budgets can only be altered in response to a significant change in circumstances since the budget was set. This stability is important in order to provide clarity for those making decisions about how best to deliver the required reduction in emissions.
- **Flexibility in the means to that end**. The design of carbon budgets allows for flexibility for different balances of effort to reduce emissions across sectors and technologies. Between now and the start of the fifth carbon budget period in 2028, households, businesses, investors and the Government will learn more about the most effective combination of actions to meet the carbon budget. Some of that learning will come from the efforts to meet previous carbon budgets.

The fifth carbon budget covers the years 2028-2032 and marks the halfway point from the first carbon budget to the 2050 target.

It follows on from the first four carbon budgets which require a 52% reduction in emissions from 1990 by 2025.[4] The first carbon budget was met, and emissions in 2014 were below the level required by the second carbon budget, 36% below 1990 levels (Figure 1.2). This reflects a combination of steady progress to date and the ongoing impact of the financial crisis.

The Government must legislate the fifth carbon budget by the end of June 2016, taking account of the advice contained in this report. In line with the requirement in the Climate Change Act, the Government will then publish its proposals and policies for meeting the budget (Figure 1.3). The Committee will provide an assessment of these plans as part of our annual statutory reports to Parliament.

4 The budget was originally set to require a 50% reduction in emissions on 1990, but since then the 1990 inventory has been revised in line with UNFCCC guidelines.

Figure 1.1: Evidence and engagement for this report

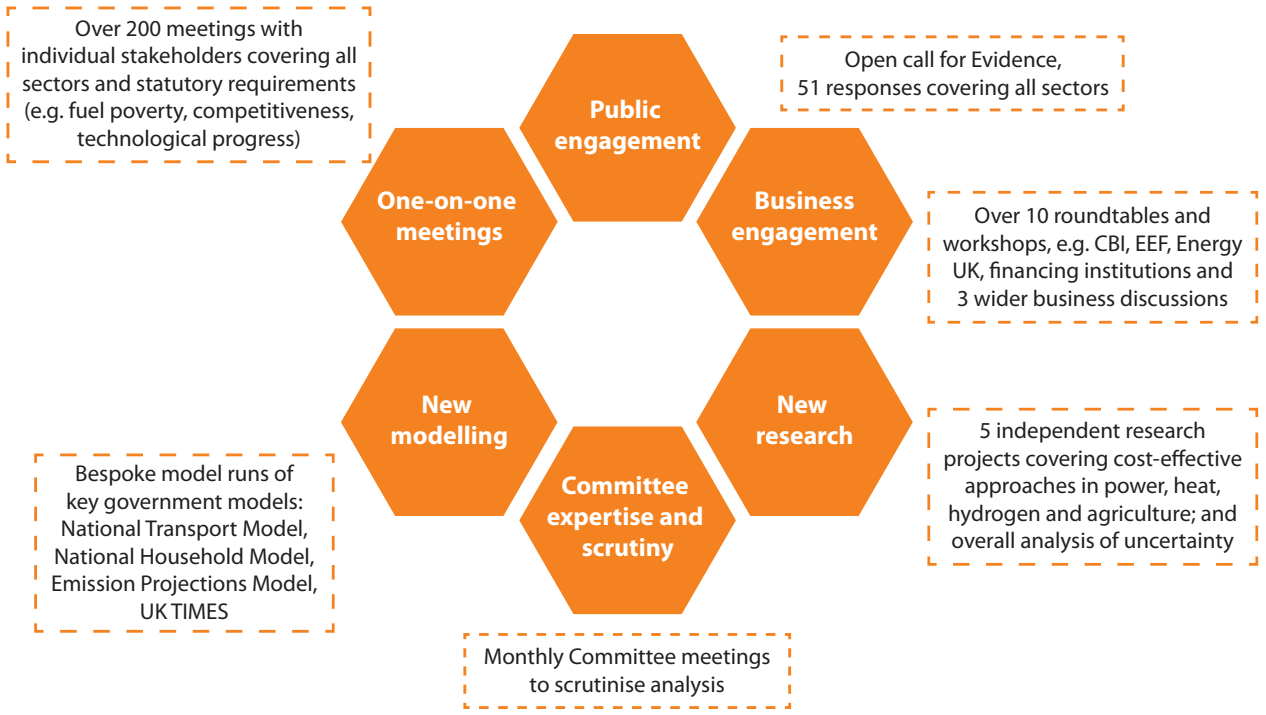
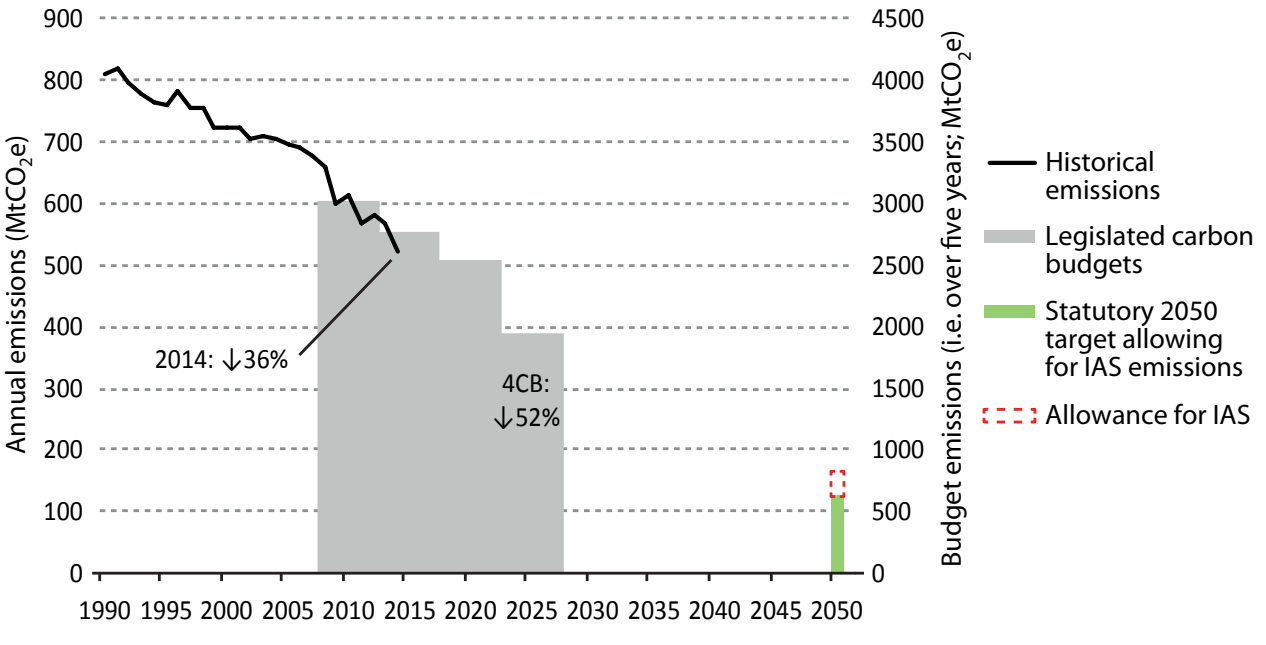


Figure 1.2: Legislated carbon budgets and the 2050 target



Source: CCC analysis.
Notes: IAS = International aviation and shipping.

Box 1.1: Call for Evidence responses and stakeholder workshops

Call for evidence

On 25 March 2015 we published a Call for Evidence on the CCC website, containing 15 questions climate science and international circumstances. It was open for a 10-week period and closed on 1 June 2015.

We received 51 responses spanning power, buildings, transport, industry, agriculture, bioenergy and community energy, from a range of companies, trade associations, NGOs and academics, as well as a local authority. All responses will be published in full on our website, www.theccc.org.uk, along with a list of organisations.

Stakeholder workshops

As an input to the fifth carbon budget advice, we held and contributed to over 20 workshops and roundtables that covered a variety of sectors and issues. These were attended by representatives from umbrella organisations, a wide range of individual businesses, NGOs, academia and Government departments. These included:

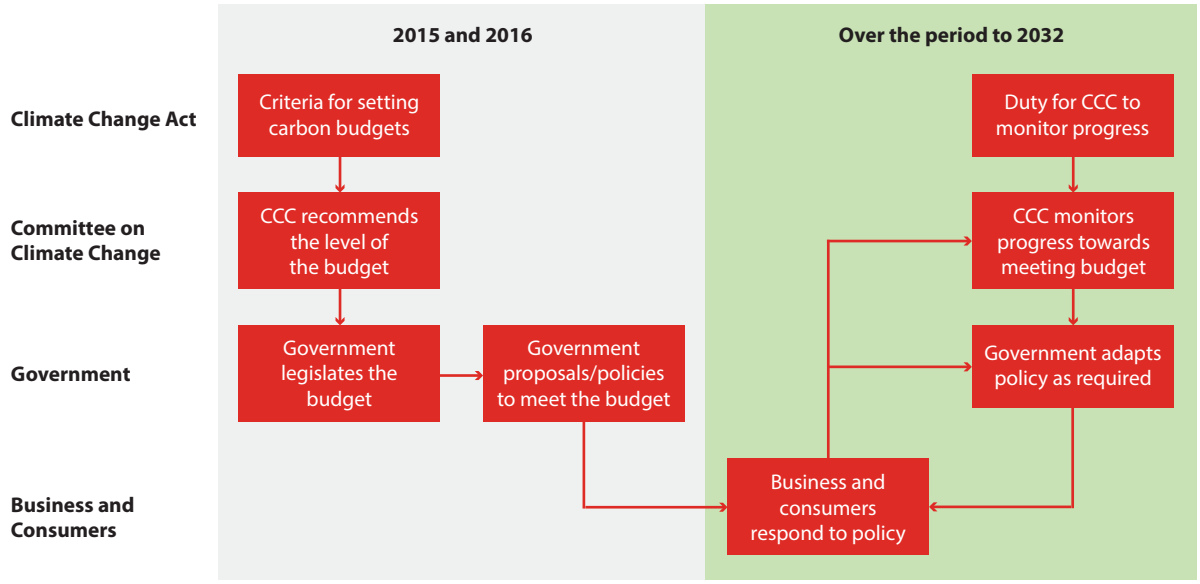
- Roundtables hosted at Shell, KPMG and the CBI on the value and impact of the fifth carbon budget on business. Participants included a range of businesses to ensure the discussion covers impacts across the UK business sector.
- Events on specific areas including science and international circumstances, electricity market reform, carbon capture and storage, finance for power sector investment, post-2020 vehicle emissions targets, low-carbon heat, solid wall insulation, industrial decarbonisation roadmaps and agriculture.

This engagement was valuable in gathering evidence on the opportunities for emissions reduction across the economy, the barriers to doing so and the potential impacts of carbon budgets, and policies to meet them, on business and wider society.

We also heard about the value of carbon budgets themselves. A common message was that while the carbon budgets are important in providing an overall point of reference, they need to be supported by a sufficient degree of clarity over the policies to achieve them in order to provide the confidence to make investments.

Many larger businesses have head offices and Boards located outside the UK. Those Boards do not follow every policy detail but reach judgments based on their sense of overall direction. That is particularly important when it comes to whether to invest limited corporate financial capital in the UK or another country.

Figure 1.3: Process for setting and meeting carbon budgets



2. Scope of carbon budgets

The carbon budgets cover emissions of all six greenhouse gases included under the Kyoto Protocol (i.e. carbon dioxide, methane, nitrous oxide and the three F-gases: HFCs, PFC and SF_6). Each greenhouse gas is treated consistently (based on the Global Warming Potential 100-year index) to allow a like-for-like comparison consistent with the Protocol. The accounting framework for the final budget divides the sources of emissions into the 'traded' sector and the 'non-traded' sector depending on whether they are covered by the EU emissions trading system (EU ETS) (see Chapter 2).

Only one non-negligible source of emissions is currently excluded from carbon budgets. The UK share of emissions from international aviation and shipping (IAS) is not currently within the scope of carbon budgets. Regardless of whether the IAS sectors are included in carbon budgets, the Act requires those emissions are "taken into account" because the ultimate 2050 objective must incorporate those emissions to be consistent with international goals supported by the UK and the latest scientific understanding. In practice, that means carbon budgets need to allow for emissions from IAS by ensuring that emissions from other sectors are at a level consistent with meeting the overall 2050 target when IAS emissions are included (see section 2 of Chapter 3).

The Government will decide in 2016 whether or not international aviation and/or international shipping will be brought into the scope of carbon budgets. We provide advice on this issue in Chapter 6. We do not know what the Government will decide, so our recommendation for the fifth carbon budget is set in a way that enables the budget recommendation (also in Chapter 6) to be legislated once this decision has been taken.

3. Balancing the criteria in the Climate Change Act

Under the Climate Change Act, the Committee's carbon budget recommendation is required to take account of a range of considerations (Box 1.2).

- The latest climate science indicates how much action is required globally to reduce emissions consistent with limiting global temperature increase to 2°C, as currently agreed internationally and supported by the UK (Chapter 2).
- The latest European climate and energy package for 2030 defines a minimum UK contribution to that goal and defines the UK 'net carbon account' for sectors of the economy within the EU Emissions Trading System (also Chapter 2).
- Economic circumstances and technology are reflected in our assessment of scenarios for the cost-effective path to the 2050 target (Chapter 3).
- Considerations of competitiveness, and of social circumstances including fuel poverty and energy affordability, help us to choose between scenarios and identify opportunities and challenges posed by the carbon budgets (Chapter 4).
- Differences between England, Wales, Scotland and Northern Ireland give us a more granular understanding of what is feasible and the challenges in delivering it (Chapter 5).

Box 1.2: Criteria for setting carbon budgets in the Climate Change Act

The Climate Change Act sets out how the Committee is legally required to advise on and how the Government must set carbon budgets, which:

- *"must be set with a view to meeting … the target for 2050"*; and
- Must take into account:
  - *"scientific knowledge about climate change*;
  - *technology relevant to climate change*;
  - *economic circumstances, and in particular the likely impact of the decision on the economy and the competitiveness of particular sectors of the economy*;
  - *fiscal circumstances, and in particular the likely impact of the decision on taxation, public spending and public borrowing*;
  - *social circumstances, and in particular the likely impact of the decision on fuel poverty*;
  - *energy policy, and in particular the likely impact of the decision on energy supplies and the carbon and energy intensity of the economy*;
  - *differences in circumstances between England, Wales, Scotland and Northern Ireland*;
  - *circumstances at European and international level*;
  - *the estimated amount of reportable emissions from international aviation and international shipping for the budgetary period or periods in question"*.
- while *"complying with the European and international obligations of the United Kingdom"*.

Source: Climate Change Act (2008).

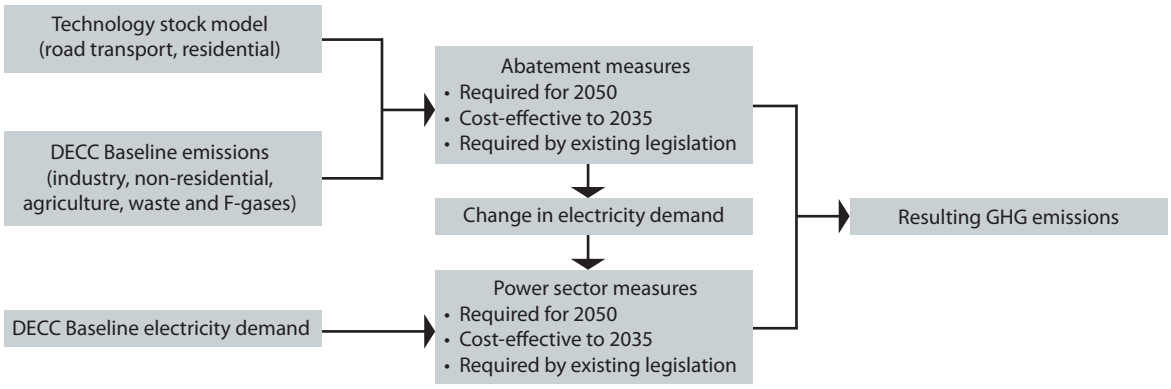
Our recommendation for the level of the fifth carbon budget is built on a detailed assessment of the opportunities to reduce emissions up to and within the budget period (2028-32) and consistent with the need to reduce emissions in 2050 to at least 80% below 1990 levels (Figure 1.4). Where the identified measures to reduce emissions would have important wider implications (e.g. for fuel poverty or industrial competitiveness), these are taken into account in building our scenarios (see Chapter 4):

- We undertake a detailed techno-economic assessment of the opportunities to reduce emissions over the period to 2035, and what is needed to ensure that the necessary level of decarbonisation by 2050 remains feasibly achievable without imposing excessive costs beyond the budget period (see Chapter 3). This includes consideration of barriers to deployment, infrastructure, stock turnover rates and feasible rates of market development.
  - Emissions reduction opportunities that are available at reasonable cost (which we judge against the Government's carbon values, reaching £78/tonne in 2030) are included in our scenarios at a level judged to be feasible.
  - Higher-cost investments that are important to meet the 2050 target are also included on a case-by-case basis. We include these measures where roll-out to 2032 is necessary to develop the option for later years. For example, we include deployment of carbon capture and storage, which is needed to develop the supporting UK infrastructure and the technology, and we include electric vehicle roll-out, which is needed as part of a realistic development towards reaching mass-market in the 2030s.
- Where measures to reduce emissions have wider benefits in areas linked to the Committee's statutory duties, for example reducing fuel poverty through improved insulation, they may be included in our scenarios even if the costs are relatively high when considered purely in terms of the reduction in greenhouse gas emissions they achieve.
- By focusing on the lowest-cost ways to reduce emissions and considering the full path to 2050, our scenarios aim to keep the costs of tackling climate change to a minimum. In areas where affordability is of particular concern, for example in energy-intensive industry, we consider whether or not to include higher-cost measures based on an assessment of the risk of carbon leakage and the potential for suitable policy design to mitigate this.
- We also take into account the impacts of climate change itself on meeting carbon budgets. For example, the impact of changes in heating and cooling demand, infrastructure and land use which arise from climate change that will occur because of historical and ongoing global emissions (see Chapter 4).

Our scenarios give an indication of what is possible through actions that are appropriate for a society committed to tackling climate change. They represent feasible ways to meet future emissions targets. They indicate that the recommended budget is deliverable while balancing the range of factors discussed above. They are not intended to be prescriptive as to which measures should be implemented, but rather identify the most appropriate overall rate of emissions reduction for the UK to pursue, following on from the fourth carbon budget, to stay suitably on track to the 2050 target.

Our scenarios for the fifth carbon budget also confirm that the fourth carbon budget remains the appropriate level of emission reduction for the period from 2023 to 2027.

Figure 1.4: Approach to constructing CCC scenarios



4. Feasibility of delivery

It is 15 years until 2030, the middle year of the fifth carbon budget period. Given the nature of the transformation required, this is not a distant prospect. Decisions are currently being made about infrastructure that may last upwards of a hundred years (e.g. roads, railway lines, airports, buildings), others that will last 20 to 50 years (e.g. electricity and heating infrastructure, large industrial and manufacturing investments) and many that could last at least a decade if not more (e.g. new vehicles, heating systems, farming practices).

In addition to setting the budget, decisions and strategic approaches will be needed in the near future in order to meet the budget in a sensible, least-cost way, and to be on track to meet the 2050 target. These decisions and strategies will be important for clarity over investments, commercialisation of key technologies, necessary development of infrastructure, development of markets for new technologies and consumer acceptance and behaviour:

- **Investment clarity**. Providing sufficient clarity over the future policy context is important to attract the investment required for decarbonisation in infrastructure, the technologies themselves and the supply chains that support them. This can be done via a combination of setting legally-binding targets (e.g. carbon budgets and sectoral agreements such as a 2030 EU target for vehicle emissions) and making regulatory and funding commitments at an appropriate level covering a sufficient timeframe (e.g. setting the Levy Control Framework, which caps funding for low-carbon electricity at an appropriate level for a 10-year window).
- **Technology commercialisation**. Some of the key technologies required to meet the 2050 target are not yet fully mature, and require a strategic approach to commercialisation in order for them to play a full part in a least-cost emissions reduction strategy. For example, the period to 2032 will be vital to the development of carbon capture and storage, which has the potential to almost halve the cost of meeting the UK's 2050 target.[5]

5 CCC (2012) *The 2050 Target* found that the central estimate of the cost of meeting the 2050 target increased from 0.5% of GDP to 0.9% of GDP without CCS. ETI (2015) *Carbon capture and storage - Building the UK carbon capture and storage sector by 2030* found that a "complete failure to deploy CCS would imply close to a doubling of the annual cost of carbon abatement to the UK economy" in 2050.

- **Infrastructure development**. In order to enable the uptake of key technologies, it will be necessary to develop new infrastructures. For example, a crucial part of reducing the cost of carbon capture and storage will entail developing CO_2 infrastructure clusters, decarbonisation of heat supply will require roll-out of heat networks, and uptake of ultra-low emission vehicles will require development of facilities to charge plug-in vehicles and/or refuel hydrogen vehicles.
- **Market development**. Some of the technologies that will be important in reducing emissions in the long term have yet to be deployed on a widespread basis in the UK. Near-term development of markets for ultra-low emission vehicles and heat pumps will be important for roll-out rates to reach levels that allow them to contribute significantly to meeting the fifth carbon budget and the 2050 target.
- **Consumer acceptance and behaviour**: Some of the changes required to reduce emissions will be facilitated by current behavioural trends (e.g. increased control over demand for energy and other products facilitated by technology) and others might require further changes in how we demand and use products (e.g. when and how cars are driven). These changes in behaviour take time to evolve and are partly a function of innovation and actions by private and public institutions.

Each of these aspects requires the Government to take a strategic approach and to put in place effective policies to drive the changes that will be required to meet the fifth carbon budget and be on track to meet the 2050 target.

It will be important that these policies are grounded in an understanding of what works, based on experience around the UK (including the increasing evidence base on different approaches adopted in the different nations of the UK) and elsewhere around the world. This is likely to lead to a mix of policy approaches, depending on the change required, including important roles for markets and regulation to determine both supply-side innovation and product development and demand-side behaviour and product use.

Given a suitable set of policies, measures required to meet the fifth carbon budget can feasibly be delivered. We set out scenarios to do that in Chapter 3 and required policy strengthening in Chapter 6.

5. Areas of uncertainty and implications for budget setting

It is important in recommending carbon budgets out to 2032 that key areas of uncertainty are given due consideration. Our analytical approach to developing scenarios that meet the recommended budget allows for different balances of technologies and behaviour change, both within and across sectors. This includes consideration of the likelihood of different changes over the period to 2032.

In practice, we illustrate the outcome of this process by formalising it in two scenarios that sit on either side of our best estimate of the central scenario that represents the cost-effective path: (see Chapter 3).

- **'Barriers' scenarios**: these achieve less than the central scenario because of difficulties in implementing some of the low-carbon measures included in the central scenario. The "barriers" scenarios are not intended as a "do nothing" or even "do very little" scenario. They are part of a risk assessment of our central scenario that acknowledges the risks of under-delivery in some areas and sets out the implications of that under-delivery.

- **'Max' scenarios**: in which more is achieved compared to the central scenario either because of the inherent uncertainty around the outcome of some measures or because some outcomes may prove quicker or less expensive to deliver than currently anticipated. These scenarios do not represent an upper bound but are intended to assess the upside potential inherent in actions to meet the fifth carbon budget.
- There is also uncertainty over the best mix of technologies to deliver a given level of effort. We characterise that in **'Alternative' scenarios** that meet the central level of effort in a different way.

While this approach sets out the scope for flexibility in meeting the budget, some key uncertainties remain about deployment of new low-carbon technologies, the role of behaviour change and on how much effort will be needed to meet the carbon budget. In recommending a level for the fifth carbon budget we have considered each of these categories of uncertainty and examined the various flexibilities available.

Progress to 2032 and to the 2050 target requires the roll-out of low-carbon technologies. The roll-out will be, in part, driven by changes in behaviour (e.g. consumers demanding new goods and services) and will also itself change behaviour (as consumers and businesses use the technologies). That includes some technologies that currently do not play a significant role and are therefore subject to greater uncertainty. However, in most sectors there is a range of low-carbon technologies available, enabling flexibility in how the budget is met.

- **Heat decarbonisation**. Significant uptake of low-carbon heat technologies is required to meet the 2050 target. While these changes are technically and economically feasible, there is uncertainty over the most cost-effective path to 2032 and over the take-up and use of these technologies by households and businesses.
- **Mainstream ultra-low-emissions vehicles**. Similar issues arise in transport as in low-carbon heat. There is still considerable uncertainty around the acceptability and use of ultra-low-emission vehicles (ULEVs) as well as some, but decreasing, uncertainty over their availability, cost and wider economics. The level of uncertainty in both areas is different when considering cars compared to vans or compared to heavy goods vehicles.
- **Carbon capture and storage (CCS)**. The technological components of CCS have been proven over recent decades in a range of contexts and locations globally. However, until projects show that these can be combined at the scale required at reasonable cost, uncertainty remains over the how much CCS can be deployed by 2050 and what proportion of emissions it will capture.

Even without effort to reduce emissions there is uncertainty over the level of future emissions as there is uncertainty over future economic trends, energy costs and how consumers of energy will respond to these. This adds to uncertainty over the current level of emissions because of difficulties in accurately measuring some sources of emissions, especially for non-CO_2 gases in agriculture and waste. These both translate to an uncertainty over how much effort will be required to meet a given budget.

The presence of these uncertainties requires a strategy that is sufficiently flexible to maintain necessary progress in decarbonising the economy. This includes the creation of options in the medium term, in order to keep open a range of ways of meeting the 2050 target. The need to create options will, in many cases, mean that we need to do more, sooner. In many cases this requires actively supporting a wider range of options (e.g. a range of technologies in power generation, low carbon-heat, vehicles, agricultural practice) ahead of the fifth carbon budget than if we had perfect foresight over the long-term path. It is not necessary that all these options exist in the UK – some can be developed in other countries, though even then UK action may be important in developing the market and encouraging acceptance of new technologies from UK consumers. An important consideration for the Committee in its annual Progress Reports to Parliament is where UK-based action is needed.

Such considerations enable us to propose a carbon budget that is robust to a wide range of eventualities, while remaining on track to meeting the 2050 target. Of course, this cannot cover every eventuality, which is why the Climate Change Act allows for the budget to be reviewed and potentially amended should circumstances change significantly. Consideration of uncertainty does not justify setting of a loose carbon budget now.