Chapter 4: Wider economic and social considerations

1. Competitiveness
2. Fuel poverty
3. Maintaining reliable electricity supplies
4. Import dependency of UK energy supplies
5. Fiscal circumstances
6. Wider health and environmental impacts

The Climate Change Act (2008) sets out a range of considerations that the Committee must take into account when recommending carbon budgets:

- "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".

Climate science and international circumstances were addressed in detail in our report on the *Scientific and International Context for the fifth carbon budget*[1], and are summarised in Chapter 2. The cost-effective path to meeting the 2050 target is considered in Chapter 3, including relevant technologies and economic costs of reducing emissions.

With the exception of the differences in national circumstances (Chapter 5) and international aviation and shipping (Chapter 6), the other considerations are addressed in this chapter.

This chapter is set out in seven sections, with conclusions on each in Box 4.1 and at the end of each section:

1. Competitiveness
2. Fuel poverty
3. Maintaining reliable electricity supplies
4. Import dependency of UK energy supplies
5. Fiscal circumstances
6. Wider health and environmental impacts

These areas encompass a very wide set of potential costs and benefits. We provide individual conclusions in each case but no attempt is made to add up all the differing impacts. That is appropriate since it is not clear that a cost in one area, such as an increase in costs to households, can be offset with a benefit in another, such as reduced dependency on international fossil fuels. Instead, the Committee considers that the Act requires it to satisfy itself in each separate area whether there is a concern and, if so, an appropriate remedy.

1 available at https://www.theccc.org.uk/publication/the-scientific-and-international-context-for-the-fifth-carbon-budget

Box 4.1: Conclusions on issues covered in Chapter 4

The conclusions on each of the issues considered in this chapter are:

- **Competitiveness** risks to energy-intensive sectors from low-carbon policies are manageable: direct impacts are low-cost and sectors at risk are eligible for free allowances under the EU ETS; there are policies in place or planned to compensate or exempt industry from indirect impacts of higher electricity prices. Impacts in the fifth carbon budget period are likely to be lower given increased international pledges and action to implement low-carbon measures. It will be important to closely monitor these after the Paris 2015 agreement, during the development of Phase IV of EU ETS and in the lead up to the fifth carbon budget period. For some sectors, action to tackle climate change may create future opportunities.
- **Fuel poverty**. The additional impact of low-carbon investment on energy bills in the fifth carbon budget period is small. If energy efficiency measures can be effectively targeted at the fuel poor then overall numbers in fuel poverty would fall even as costs from supporting low-carbon investment increase.
- **Maintaining reliable electricity supplies**. Our power sector scenarios maintain security of supply requirements and involve a significant deployment of flexibility options (e.g. demand-side response, storage and interconnection) which bring down overall costs of managing intermittency. Deployment of electric vehicles and heat pumps can provide additional sources of system flexibility, alongside flexible back-up capacity.
- **Import dependency**. Our central fifth carbon budget scenario implies a reduction in imports of oil and gas across the UK economy of over 40%, compared to a world where no action is taken on climate change. This would therefore enhance the UK's energy sovereignty by reducing demand for imported fossil fuels, and also provide a hedge against price volatility and the associated risk of damaging economic impacts.
- **Fiscal impacts**. We have considered the main fiscal impacts likely to arise as a result of our fifth carbon budget scenarios, both positive (e.g. EU ETS auction receipts) and negative (e.g. lower fuel duty receipts as vehicle fuel efficiency improves). Our conclusion is that the overall net impacts are likely to be manageable, given the time available from now to the fifth carbon budget period to make adjustments.
- **Wider health and environmental impacts**. There are wider benefits from actions to meet carbon budgets, in addition to the long-term global benefit in mitigating climate change. These benefits, such as improved air quality, health and reduced noise, accrue immediately and directly to individuals, communities and habitats. Accounting for them strengthens the case for ambitious action to reduce emissions over the next two decades. At the same time, measures can be put in place to reduce local costs from action, including allowing communities to choose which approaches meet their particular priorities. In taking forward policies and plans to meet the fifth carbon budget, the synergies, costs and benefits for both adaptation and mitigation should be considered.

1. Competitiveness

Decarbonisation raises both challenges and opportunities for the competitiveness of UK firms. Challenges can arise if low-carbon policies disadvantage specific sectors or firms, potentially harming profits and driving location of production to other countries (often referred to as 'carbon leakage'). We considered these issues in depth in our 2013 report on *Managing competitiveness risks of low-carbon policies*[2] and found that competitiveness risks of carbon budgets are limited and manageable. We also found that the transition to a low-carbon economy can create opportunities for energy-intensive businesses, for example in investing in new markets and resource efficiency measures, and innovation in new technologies and processes across a range of sectors and applications.

In this section we consider competitiveness developments since our 2013 report. We note international developments towards the climate objective (see Chapter 2), update our assessment of competitiveness risks to the UK and how these risks can be mitigated through abatement measures, and consider other opportunities for UK industry.

International developments towards the climate objective

Competitiveness risks posed by the transition to a low-carbon economy depend in part on how fast the UK moves relative to others. In our report on the *Science and International Context for the fifth carbon budget*[3] we showed that many countries and sub-national bodies have made commitments for deep emissions reduction and are now delivering against these.

Ahead of the Paris conference in December 2015, over 160 of the 196 international parties have submitted emissions pledges to the UNFCCC, covering 95% of global emissions[4]. This includes all the major emitters (China, the US, the EU and India):

- **China** has pledged to peak emissions by 2030, to reduce the carbon intensity of GDP by 65% below 2005 levels in 2030 and to increase the share of non-fossil fuels in primary energy generation to around 20% by 2030.
- **The US** has pledged to reduce its emissions by 26-28% below 2005 levels by 2025. This is achievable with existing federal laws and State actions.
- **The EU** has pledged to reduce its emissions by at least 40% below 1990 levels by 2030.
- **India** has pledged to lower its emission intensity of GDP by 33-35% below 2005 levels by 2030 and to increase the share of non-fossil fuel based power generation capacity to 40%.

As well as national pledges, cities and businesses can have a significant impact on emissions; the top 1,000 emitting companies produce one-fifth of global greenhouse gas emissions. Pledges and collaborative measures among companies have grown in recent years, including in energy-intensive sectors:

- **Chemicals:** Several large chemicals companies have pledged carbon intensity reductions ranging from 11 to 40% for 2016-2020, including BASF (Germany), LG Chem (South Korea) and Tata Chemicals (India). Mitsui Chemicals (Japan) has pledged to reduce CO_2 emissions by 22% over the period 2005-2016.

2 available at https://www.theccc.org.uk/publication/carbon-footprint-and-competitiveness
3 available at https://www.theccc.org.uk/publication/the-scientific-and-international-context-for-the-fifth-carbon-budget
4 Correct as of 12 November.

- **Paper and packaging:** A number of companies in this sector are taking action such as improving energy efficiency, closing inefficient capacity and increasing low-carbon energy. International Paper Company (USA) has pledged to reduce emissions by 20% by 2020; Nippon Paper Industries Co Ltd (Japan) has pledged to reduce emissions from domestic mills by 25% by 2015; and Arkhangelsk Pulp and Paper Mill (Russian Federation) has pledged to reduce operational emissions by 30% by 2020.
- **Cement:** The Cement Sustainability Initiative (CSI) has 10 core members which have developed CO_2 mitigation plans and targets and are reporting progress. Others such as Cemex (Mexico) and Ambuja (India) have pledged to reduce emissions intensity by around 25% over the period 2015-2020 through deployment of energy efficiency and renewables.

Our analysis shows that implementation of low-carbon technologies, laws, measures and pledges have progressed (see Chapter 2). To the extent that other countries and sectors are implementing low-carbon measures, competitiveness risks to the UK are reducing.

We now turn to consider the specific risks posed by our carbon budgets.

Competitiveness risks to the UK

Competitiveness risks from carbon budgets arise where UK firms face higher costs from low-carbon measures than their competitors elsewhere. 'Carbon leakage' through the relocation of businesses or new investments could potentially drive output and jobs overseas. Depending on differences in the emissions intensity of production, industrial relocation could result in higher global emissions overall.

In this section we consider risks posed by measures to reduce direct emissions and risks that arise indirectly through higher electricity prices.

(i) Measures to reduce direct emissions

Industries subject to competitiveness risks due to low-carbon policies are ones that are energy-intensive and have a high degree of international trade:

- Energy-intensive industries are defined as spending more than 10% of their Gross Value Added (GVA) on energy.
- Industries are likely to be more at risk if their products are traded extensively with other countries (particularly countries outside the EU with no or limited climate policies).

Key energy-intensive industries are paper, metals (including iron and steel), non-metallic minerals, coke manufacture and refineries, chemicals, rubber and plastics, wood and textiles.

UK energy-intensive industries are included in the EU Emissions Trading System (ETS), requiring them to surrender allowances to cover carbon emissions associated with their energy consumption. Paying for such allowances would raise the costs of energy-intensive industries relative to competitors outside the EU that do not face carbon costs.

In order to mitigate such risks, the EU has developed an approach whereby free allowances are granted to energy-intensive firms subject to international competition. During Phase III of the EU ETS (2013-20), sectors deemed at risk of carbon leakage are allocated 100% free allowances, subject to industry benchmarks (other sectors receive less on a sliding scale). In Phase IV (2021-2030) benchmarks will become more stringent and the rules should incentivise carbon efficiency by allowing sectors with most improvement to keep some of the benefit of these changes.

For Phase IV of the EU ETS the EU proposes to continue to allocate free allowances, but the rules determining at risk sectors have been tightened and should focus more on sectors at risk compared with Phase III:

- Under ETS Phase III, there is very limited differentiation among industrial sectors since sectors accounting for more than 97% of industrial ETS emissions are on the carbon leakage list.
- Sectors can currently get free allowances under the trade intensity criteria, irrespective of their carbon costs. There is evidence[5] that trade intensity on its own is not a good indicator of leakage risk.
- Our analysis suggests that some sectors have surplus allowances in Phase III, whilst other eligible firms have not received them because the amount of allowances available is less than the amount determined by the 'at risk' criteria.

While this is our best assessment of the changes to the EU ETS rules, the rules have not yet been finalised and therefore the precise impacts of these changes are as yet unknown.

Our updated assessment for this report also identifies abatement measures for industry for the fifth carbon budget period, much of which are cost-saving or low-cost from a social perspective.

- Energy efficiency measures, waste heat recovery systems, materials efficiency and low-carbon electrification of some space and process heat are cost saving.
- Measures such as bioenergy for space and process heat and CHP are low-cost.
- Other measures such as carbon capture and storage have high up-front costs but are cost-effective at projected carbon values.

Where private costs are different to social costs (e.g. for CCS), Government support will be required. But overall our fifth budget abatement measures and continued free allocation of allowances in the EU ETS suggests that measures aimed at reducing direct emissions from industry do not pose competitiveness risks to UK firms to 2030.

(ii) Measures to reduce indirect emissions

Competitiveness risks arise not just through the costs associated with fossil fuel combustion within industry, but also indirectly through measures to decarbonise the power sector which add to electricity prices.

A comparison of current prices shows that the UK has one of the lowest gas prices, but one of the highest electricity prices internationally (Box 4.2).

Box 4.2: Industrial energy prices in the UK and key trading partners

Comparing UK industrial electricity and gas prices in 2014 against other countries shows that the UK had a relatively low industrial gas price, but a relatively high electricity price:

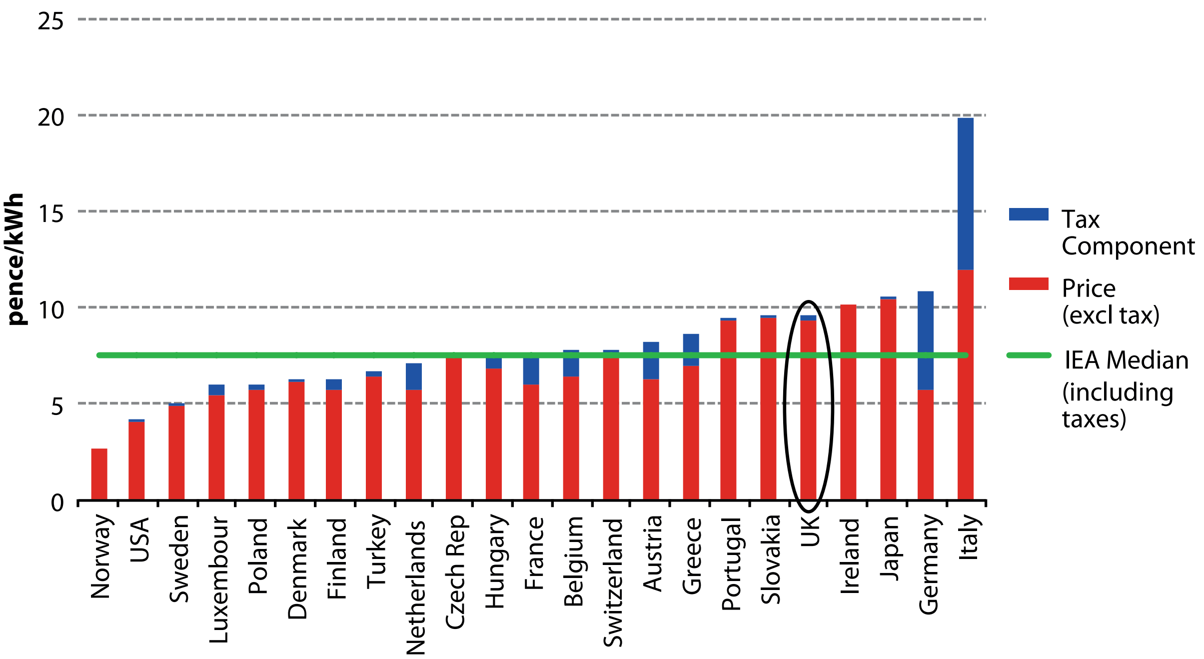
- The UK industrial electricity price is one of the highest internationally. The UK has a higher than average electricity pre-tax price, but a relatively low level of tax on electricity consumption (Figure B4.2a).
- The UK industrial gas price is one of the lowest internationally. This again partly reflects a relatively low level of tax levied on energy consumption (Figure B4.2b).

The International Energy Agency (IEA), which collects these statistics, does not provide a breakdown of taxes or polices encompassed within the pre-tax price (such as support for low-carbon investment).

5 Martin el al. (2012) Industry compensation under re-location risk: a firm-level analysis of the EU ETS.

Box 4.2: Industrial energy prices in the UK and key trading partners

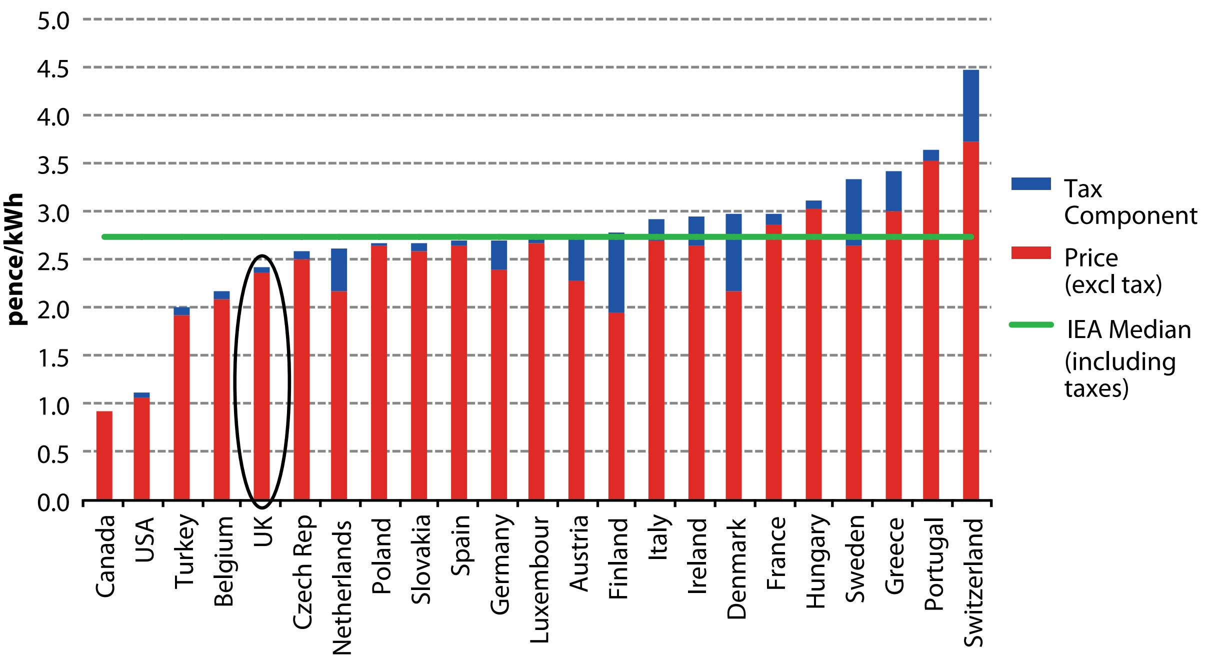
Figure B4.2a: International industrial electricity prices across the IEA, with and without taxes (2014)



Source: DECC, International industrial energy prices. Available at: https://www.gov.uk/government/statistical-data-sets/international-industrial-energy-prices.

Notes: Prices converted to pounds sterling using annual average exchange rates. Prices include all taxes where not refundable on purchase. Prices excluding taxes have been estimated using a weighted average of general sales taxes and fuel taxes levied by individual states.

Figure B4.2b: International industrial gas prices across the IEA, with and without taxes (2014)



Source: DECC, International industrial energy prices. Available at: https://www.gov.uk/government/statistical-data-sets/international-industrial-energy-prices.

Notes: Prices converted to pounds sterling using annual average exchange rates. Prices include all taxes where not refundable on purchase. Prices excluding taxes have been estimated using a weighted average of general sales taxes and fuel taxes levied by individual states.

Competitiveness risks for electro-intensive industries over the fifth carbon budget period depend on the path of electricity prices in the UK relative to key trading partners.

In our 2013 report[6], we estimated that higher electricity prices due to legislated carbon budgets could reduce profits of electro-intensive firms by £150-400m in 2020, or by £600m in the extreme case that none of the additional costs can be passed through to higher product prices. The package of compensation announced by government to address these risks is expected to be around £500 million a year from 2016-17, which is towards the top of this range.

The full compensation and exemption package covers:

- Compensation for the indirect costs of the EU ETS and Carbon Price Support (CPS) to 2019-20.
- Exemption of energy intensive industry from Contracts for Difference for low-carbon electricity.
- Compensation to cover the impact of renewables support, which is currently awaiting State Aid clearance by the European Commission.

These plans are in place until 2020 and may need to be extended, depending on the ambition and policy approaches adopted internationally.

Global market conditions facing many energy intensive sectors are challenging as the world continues to recover from the economic downturn. There have recently been site closures, including in the UK steel industry, although this can be attributed to global market conditions rather than UK low-carbon policy (Box 4.3).

Box 4.3: UK steel industry developments and closure of Redcar

In October 2015, the administrators for Redcar steelworks confirmed that the coke ovens and blast furnace would be closed. Following this, there have been announcements of another steel firm, Caparo, going into administration and 'mothballing' of other steel plants in the UK.

Changes in the global market for steel are key contributing factors:

- The **price of steel** has halved over the last year according to UK Steel. The global economy is still recovering from the economic downturn, and the demand for steel worldwide has not returned to pre-financial crash levels. This low demand has meant a relative over-supply of steel globally causing the fall in the price of steel.
- The **strengthening of the pound** by 15% over the last two years has made UK steel more expensive in international markets.
- **Electricity prices** are relatively high in the UK and have increased in recent years. Most of this rise in electricity cost has been due to the increasing wholesale cost of energy rather than government policies to support low-carbon investment. The steel sector is compensated for the carbon price impact on electricity costs and has an exemption from the Climate Change Levy, meaning that uncompensated climate change policies only constitute up to 2% of total costs. This is a lower order of magnitude compared with the global steel price and sterling appreciation.

The current problems in the steel market are global in nature. The UK steel sector has been impacted alongside others, with announcements of plant closure and reduced production across the world including other parts of the EU, US, Korea, South Africa and China.

Source: Exchange rate data can be found at http://www.bankofengland.co.uk/.

6 CCC (2013) *Managing competitiveness risks of low-carbon policies*. Available at: https://www.theccc.org.uk/publication/carbon-footprint-and-competitiveness/

Other opportunities for UK industry

The transition to a low-carbon economy provides economic opportunities for companies and countries which lead the way in developing new technologies, manufacturing new devices and providing supporting services to prosper. Whether UK based companies will gain will depend on a range of factors, including the degree to which they have a comparative advantage, the domestic policy environment and the extent to which early adoption of climate measures in the UK supports development of industry.

In our 2013 report, we highlighted that the UK has a comparative advantage in some key low-carbon technologies including parts of the chemicals and cement sectors, as well as aerospace, electronics and parts of heavy engineering and construction.

Some energy-intensive industries have already developed new low-carbon technologies and processes which make them well placed to compete in new markets on the path to a low-carbon world (e.g. low-temperature detergents, low-resistance tyres and lightweight materials in aircraft and cars).

The UK automotive manufacturing sector has an opportunity to become a world leader in the development and production of ultra-low emissions vehicles (ULEVs) as demand increases both domestically and globally.

- There has been at least £18 billion in low-carbon investment in the UK automotive manufacturing sector between 2003 and 2013[7].
- The Nissan Leaf became the first UK-manufactured ULEV in March 2013 and made up around 30% of all UK PHEV and BEV sales in 2014[8]. Jaguar Land Rover revealed three ULEV demonstration vehicles in September 2015, suggesting that other UK manufacturers could soon begin production of ULEVs[9].

UK industry figures have cited advantages in UK research and development capability and the longstanding, stable policy environment provided by EU legislation and the Climate Change Act as reasons for sustained investment in ULEV development[10].

Success will require innovation in new technologies and use of materials, growth of a skilled workforce, supported by a consistent government policy framework that will help build these supply chains.

Summary: Competitiveness risks to energy-intensive sectors from low-carbon policies are manageable: direct impacts are low-cost and sectors at risk are eligible for free allowances under the EU ETS; there are policies in place or planned to compensate or exempt industry from indirect impacts of higher electricity prices. Impacts in the fifth carbon budget period are likely to be lower given increased international pledges and action to implement low-carbon measures. It will be important to closely monitor these after the Paris 2015 agreement, during the development of Phase IV of EU ETS and in the lead up to the fifth carbon budget period. For some sectors, action to tackle climate change may create future opportunities.

7 LowCVP (2014) *Investing in the low carbon journey*. Available at http://www.lowcvp.org.uk/assets/reports/Investing%20in%20the%20low%20carbon%20journey%20-%20FULL%20REPORT.pdf

8 Society of Motor Manufacturers & Traders (SMMT) http://www.smmt.co.uk

9 http://newsroom.jaguarlandrover.com/en-in/jlr-corp/news/2015/09/jlr_low_and_zero_emissions_powertrain_090915/?&locus=2

10 LowCVP (2014) *Investing in the low carbon journey*.

2. Fuel poverty

Fuel poverty in the UK is a long-standing issue. The number of households in fuel poverty[11] was already high before carbon budgets were legislated. The number of fuel-poor households has risen from 3.3 million in 2007 to 4.5 million in 2013 (the latest data available), primarily due to energy price rises unrelated to carbon budgets[12].

Levels of fuel poverty are particularly high in the devolved administrations (Table 4.1) and some specific areas (e.g. 72% of homes are estimated to be in fuel poverty in the Western Isles of Scotland). These higher levels of fuel poverty are due to a combination of lower incomes, inefficient housing and a greater proportion of households not on the gas grid (and therefore facing higher energy prices).

Table 4.1: Fuel poverty levels and targets across the UK

	Proportion of households in fuel poverty	**Target**
England	12% (2013)	Fuel poor should live in homes of EPC rating C or better by 2030 (statutory, Fuel Poverty (England) Regulations 2014)
Scotland	39% (2013)	Eradicate fuel poverty, as far as is reasonably practicable, by November 2016 (statutory, Housing (Scotland) Act 2001)
Wales	30% (2012)	Eradicate fuel poverty by 2018 (statutory, Warm Homes and Energy Conservation Act 2000)
Northern Ireland	42% (2011)	Eradicate fuel poverty by 2016 (non-statutory, 2004 Fuel Poverty Strategy)

Source: DECC (2015) *Annual Fuel Poverty Statistics Report*, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/468011/Fuel_Poverty_Report_2015.pdf
Notes: This table uses the '10% definition' – i.e. a household is considered to be in fuel poverty if it needs to spend more than 10% of their income on fuel to maintain an adequate standard of warmth. This definition is still used in Scotland, Wales and Northern Ireland. England now uses the 'Low Income, High Cost' definition. Under this, a household is considered to be fuel poor if (a) they have required fuel costs that are above average (the national median level) and (b) were they to spend that amount, they would be left with a residual income below the official poverty line. Under this definition, 10.4% of households in England in 2013 are estimated to have been in fuel poverty.

Fuel poverty is a devolved policy issue. England and the devolved administrations have set ambitious targets for the reduction of fuel poverty (Table 4.1), which are statutory except in the case of Northern Ireland. Scotland has also recently announced that improving the energy efficiency of Scotland's homes and non-domestic building stock will be designated a National Infrastructure Priority. The aim is for all buildings to achieve a good energy efficiency rating over the next 15-20 years, both to achieve carbon reductions and to address fuel poverty.

It is too early to assess progress against the English target, which was legislated in December 2014. However, achievement of the devolved targets now looks unlikely. Given the continuing challenge faced by the UK's governments in dealing with fuel poverty, it is important to consider the potential impact of carbon budgets.

11 Based on the '10%' definition – see Table 4.1.

12 CCC (2014) Energy prices and bills – impacts of meeting carbon budgets. Available at https://www.theccc.org.uk/publication/energy-prices-and-bills-impacts-of-meeting-carbon-budgets-2014

Fuel poverty and energy efficiency

Fuel poverty is caused by a combination of low household income and high energy costs. Energy-inefficient housing is a key driver. The UK Government's fuel poverty statistics[13] show how the depth and likelihood of being fuel poor are associated with lower energy efficiency ratings:

- In England in 2013,[14] almost 50% of fuel poor households were in the least energy efficient properties (i.e. SAP ratings E, F or G) compared with 22% of the non-fuel poor.
- 31% of households living in the least efficient G-rated properties were in fuel poverty, with an average fuel poverty gap of £1,274.[15]
- The incidence of fuel poverty is lowest in households living in dwellings with insulated cavity walls (6%), and highest in dwellings with solid walls (16%), followed by homes with uninsulated cavity walls (11%).

Energy efficiency improvement has therefore been a major focus of government policy responses to fuel poverty. The new English fuel poverty target is specifically focused on improving energy ratings, and the devolved administrations have implemented additional energy programmes to combat fuel poverty.

Fuel poverty and carbon budgets

The energy efficiency measures included in our carbon budget scenarios will help to alleviate fuel poverty. Our central scenario (Chapter 3) includes insulation of an additional 1.5-2 million solid walls and around 3 million cavity walls between now and 2030. This will reduce energy consumption and bills. Low-carbon heat measures can also play a role in reducing fuel poverty, especially for the relatively high proportion of fuel-poor households that do not have gas heating (around 500,000 in England).

At the same time, our carbon budget scenarios also include measures that result in higher energy costs, in particular through power sector decarbonisation. Currently, the additional policy costs for low-carbon electricity over fossil-fuels are generally passed through to consumer energy bills. In contrast, costs for low-carbon heat via the Renewable Heat Incentive have, to date, been funded by public spending. We assume that this continues and that the costs of low-carbon heat in our scenarios are not passed through to bills, affecting fuel poverty, but instead have a fiscal impact (see section 5).

We published an in-depth assessment of the impacts of carbon budgets on energy prices and bills in December 2014[16]. For this advice, we have updated our assessment of policy costs, in line with our new power sector scenarios[17] and updated evidence on technology costs. Our estimates of policy costs in the 2020s are now lower than in December 2014, reflecting lower levels of deployment of low-carbon power generation assumed in the 2020s, as well as lower assumed costs for key technologies (e.g. offshore wind and solar).

- In 2014, a typical household paid around £45 through their annual electricity bill of around £470 (total energy bills are around £1,200) to support investment in low-carbon generation.
- In 2020, this support will increase to around £105. Those costs are already committed through investments that are underway and contracts that have been awarded.

13 DECC (2015) *Annual Fuel Poverty Statistics Report*. Available from: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/429873/Fuel_Poverty_Annual_Report_2015.pdf

14 Low Income, High Costs definition.

15 The fuel poverty gap represents the difference between the required annual fuel costs for each household and the median required fuel costs.

16 CCC (2014) *Energy prices and bills – impacts of meeting carbon budgets*. Available at https://www.theccc.org.uk/publication/energy-prices-and-bills-impacts-of-meeting-carbon-budgets-2014

17 CCC (2015) *Power sector scenarios for the fifth carbon budget*. Available at https://www.theccc.org.uk/publication/power-sector-scenarios-for-the-fifth-carbon-budget/

- In our scenarios, this support will increase to around £115 per household in 2025 and £120 in 2030, and fall thereafter.[18,19] The additional impact of this fifth carbon budget is about £15 on a typical household bill.
- Energy efficiency improvements funded through household bills added around £50 to annual energy bills (spread across both gas and electricity bills) in 2013, reduced under Government plans to around £35 in 2014. An increase back to the level in 2013 would be enough to fund future energy efficiency measures in our scenarios.

Taking together impacts on gas and electricity bills, full implementation of energy efficiency opportunities would offset most of the additional costs of supporting low-carbon investment when averaged across all households. However, for individual households the potential for savings will differ. For fuel-poor households specifically, effective design and targeting of energy efficiency policies is vital.

Modelling carried out for the Committee in 2014 using the National Household Model[20] suggested that there is scope for fuel poverty to fall under carbon budgets if measures are well targeted:

- If all fuel-poor households received a targeted share of the energy efficiency (e.g. insulation) and low-carbon heat measures included in our carbon budget scenarios, UK fuel poverty levels could be reduced to 3.3 million by 2030.
- For energy efficiency measures, this would require funding of around £1.4bn per year, a level which was achieved under the Energy Company Obligation until its scope was reduced in 2014.

Due to most of the low-carbon costs falling on electricity bills, households relying on electric heating will pay a higher proportion of their energy bill towards low-carbon policy costs than dual-fuel households. As there is already a higher incidence of fuel poverty amongst electrically heated households, this could further increase fuel poverty and will require a specific policy response.

Successful targeting of measures would greatly improve the achievement of both fuel poverty and carbon targets at least cost.

Meeting Government fuel poverty targets is likely to require additional funding. The marginal impact of measures for the fifth carbon budget is small, but the Committee will continue to monitor and assess impacts and advise on the appropriate response.

Scotland has recently announced that improving the energy efficiency of Scotland's homes and non-domestic building stock will be designated a National Infrastructure Priority. The aim is for all buildings to achieve a good energy efficiency rating over the next 15-20 years, both to achieve carbon reductions and to address fuel poverty. The area has seen numerous policy changes over recent years, so a long-term commitment to addressing fuel poverty and energy efficiency is an important step forward.

For England, the legislation of the new energy efficiency-based fuel poverty target also signals a long-term commitment. As set out in our previous advice on the fuel poverty strategy consultation, achieving the Government's target will require further funding.

Summary: The additional impact of low-carbon investment on energy bills in the fifth carbon budget period is small. If energy efficiency measures can be effectively targeted at the fuel poor then overall numbers in fuel poverty would fall even as costs from supporting low-carbon investment increase.

18 We have projected the carbon price facing UK power generation to be £42/tCO_2 (2014 prices), based on a projected EU ETS price of £24/tCO_2 and the carbon price support held constant at £18/tCO_2.

19 Exemptions proposed for industrial consumers at risk of competitiveness impacts would increase the costs to household consumers. We estimate this would add around an extra £5 to the annual bill for a typical household.

20 Centre for Sustainable Energy (2014) *Research on fuel poverty – The implications of meeting the fourth carbon budget*. Available at https://www.theccc.org.uk/wp-content/uploads/2014/11/CCC_FinalReportOnFuelPoverty_Nov20141.pdf

3. Maintaining reliable electricity supplies

The transition to a low-carbon electricity system brings new challenges in grid management, due to higher levels of intermittent and variable renewable generation (e.g. wind and solar), less flexible generation technologies such as nuclear, and higher demand from other sectors via electrification for heat and transport. These system challenges include the need for back-up firm capacity for wind and solar generation, the risk of excess generation at times of low demand, and the need for additional infrastructure to transmit power generated in more remote locations.

We published a detailed assessment of this challenge in our October report on *Power sector scenarios for the fifth carbon budget*[21]. We concluded that it is possible to manage a deeply decarbonised UK power system in 2030 with high levels of intermittent renewables (e.g. 40% of total generation) while maintaining security of supply.

Managing this transition at lowest cost while ensuring security of supply will require investment in flexible gas-fired generation capacity alongside expansion of international interconnection, flexible demand response and electricity storage:

- **Flexible unabated gas plant.** More efficient and flexible generation technologies are available that can operate stably at lower levels of output, provide faster frequency response than at current levels, and consume less fuel when part-loaded to provide system reserve. Greater use of these would require less overall thermal plant to be built to stabilise the system, be less likely to curtail renewables output, and reduce overall emissions.
- **Interconnection.** Interconnection already provides a valuable source of flexibility to the UK with 4 GW of capacity linked to Ireland, France and the Netherlands. Increased interconnection to these or other electricity markets (e.g. Norway) can improve security of supply and operating efficiency through sharing of back-up capacity as well as ancillary services, and better accommodate intermittent generation by taking advantage of the geographical diversity of renewable output and demand profiles. Studies have shown that greater levels of interconnection are generally associated with better security of supply.[22]
- **Demand-side response.** Shifting electricity demand away from 'peak' time periods, such as on a winter evening, towards periods when demand is lower, is known as Demand-Side Response (DSR). By shifting demand to off-peak periods with higher renewable output or by reducing the requirements for capacity during peak periods, DSR can help to manage large volumes of intermittent renewable generation and can significantly reduce the overall cost of a decarbonised system. New electricity demand from electric vehicles could provide further potential for DSR, as could heat pumps where they are rolled out in thermally efficient buildings or with storage. Widespread deployment and use of smart technologies (such as smart meters) will facilitate increases in demand-side response given sufficient consumer engagement.
- **Energy storage technologies.** There is currently around 3 GW of pumped hydro storage in the UK. Further deployment of bulk and distributed energy storage (e.g. battery technologies) can reduce the need for additional back-up capacity and infrastructure, by storing electricity when demand is low and discharging when demand is high.

21 CCC (2015) Power sector scenarios for the fifth carbon budget, available at https://www.theccc.org.uk/publication/power-sector-scenarios-for-the-fifth-carbon-budget

22 See for example Redpoint Energy (2013) Impacts of further electricity interconnection on Great Britain for DECC. Available at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/266307/DECC_Impacts_of_further_electricity_interconnection_for_GB_Redpoint_Report_Final.pdf

There is a cost to deploying these measures and managing intermittency, which for our scenarios we estimate at around £10 per MWh of intermittent renewable output (which may be compared to current costs of onshore wind of around £80/MWh, for example). We include that cost in our assessment of the lowest cost path for emissions (Chapter 3), of fuel poverty (above) and of the total cost of meeting our proposed budget (Chapter 6).

Costs would be likely to increase at much higher shares of intermittent renewables, but we exclude these higher shares from our scenarios. For example, intermittency costs could reach around £25/MWh for solar if capacity exceeds 40 GW or around £15/MWh for wind if capacity exceeds 50 GW, each within a power system reaching 50 gCO_2/kWh.

Our power sector scenarios all meet the Government's current reliability standard[23,] and take into account the new evidence on potential system impacts of individual low-carbon technologies in order to balance affordability and security of supply. For example, we constrain deployment of wind and solar to no more than 50 GW and 40 GW respectively in our 2030 power sector scenarios, and our Central scenario reaches an emissions intensity closer to 100 gCO_2/kWh than 50 g/kWh.

Summary: Our power sector scenarios maintain security of supply requirements and involve a significant deployment of flexibility options (e.g. demand-side response, storage and interconnection) which bring down overall costs of managing intermittency. Deployment of electric vehicles and heat pumps can provide additional sources of system flexibility, alongside flexible back-up capacity.

4. Import dependency of UK energy supplies

A diverse energy mix contributes to ensuring security of supply. The more reliant the UK is on imported fuels, the more exposed the economy is to significant changes in price. Moving towards a low-carbon economy will reduce demand for fossil fuels and can therefore mitigate against these risks.

In this section we show how the UK's import dependency on oil and gas varies under our fifth carbon budget scenarios, given Government projections for UK oil and gas production[24]. We do not consider the impact on imports of coal use, which will fall substantially before the fifth carbon budget starts (in 2028) due to the announced phase-out of unabated coal-fired electricity generation:[25]

- **Natural gas.** Under our baseline scenario, where no action is taken on climate change, demand for natural gas is expected to rise out to 2030. Given that UK production is expected to decline over the same period, increasing imports would be required in order to satisfy UK demand. However, under our Central scenario demand for gas falls, meaning that the need for around 45% (425 TWh) of imported gas is avoided in 2030 (Figure 4.1).
  - DECC project UK natural gas production to decrease from 380 TWh in 2014 to 170 TWh in 2030 as North Sea supplies fall, a decline of 55%.
  - Under our Baseline projections, natural gas demand is expected to rise by 39% between 2014 and 2030 from 810 TWh to 1,130 TWh.

23 The UK's electricity system must be managed to meet the Government's reliability standard, which targets a loss-of-load expectation of no more than three hours per year. This represents the number of hours per year in which, over the long term, it is statistically expected that supply will not meet demand.

24 DECC (2015) *UKCS Oil and Gas Production Projections*. Available at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/414172/Production_prjections.pdf

25 DECC (2014) Government announces plans to close coal power stations by 2025, https://www.gov.uk/government/news/government-announces-plans-to-close-coal-power-stations-by-2025

- Under our Central scenario natural gas demand would decrease by 14% between 2014 and 2030 to 700 TWh, reflecting reduced gas consumption (primarily due to more efficient use in meeting demands for heat) as well as a contribution to the gas supply from biomethane.
- Therefore, net imports of 530 TWh in 2030 under the Central scenario are expected to be 45% lower than baseline net imports of 955 TWh.

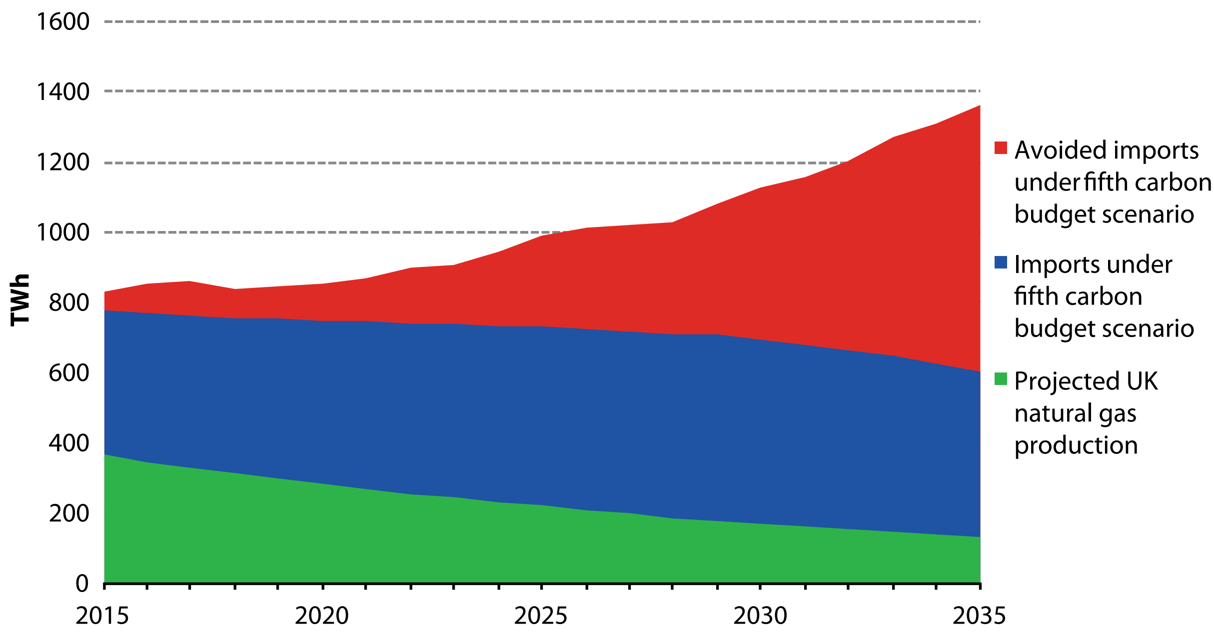
- **Oil.** Under our baseline scenario, where no action is taken on climate change, demand for liquid hydrocarbon fuels is expected to rise out to 2030. Given that UK domestic crude oil production is expected to decline over the same period, this means increasing imports would be required in order to satisfy UK demand. However, under our Central scenario demand for petroleum products falls, meaning that the need for 40% (270 TWh) of imports is avoided in 2030 (Figure 4.2).
  - UK petroleum product production is projected to decrease from 505 TWh in 2014 to 225 TWh in 2030, a decline of 56%.
  - Under our Baseline projections, petroleum product demand is expected to rise by 2% between 2014 and 2030 from 890 TWh to 905 TWh.
  - Under our Central scenario demand for petroleum products would decrease by 29% between 2014 and 2030, to 635 TWh, primarily reflecting progress in decarbonisation of surface transport.
  - Therefore, net imports of 410 TWh in 2030 under the Central scenario are expected to be 40% lower than baseline net imports of 680 TWh.

This analysis presents the UK's import dependency under the Central scenario for gas and oil demand, on the basis of Government projections of production within the UK. If assumed production were to be higher (e.g. due to a significant contribution from UK shale gas production), this would lead to a reduction in imports that is additional to those from decarbonisation.

Overall, the implication of our fifth carbon budget scenarios is that net oil and gas imports would be more than 40% lower compared to a world where no action is taken on climate change. This would reduce the proportion of UK oil and gas demand met by imports from 81% to 70% in 2030.

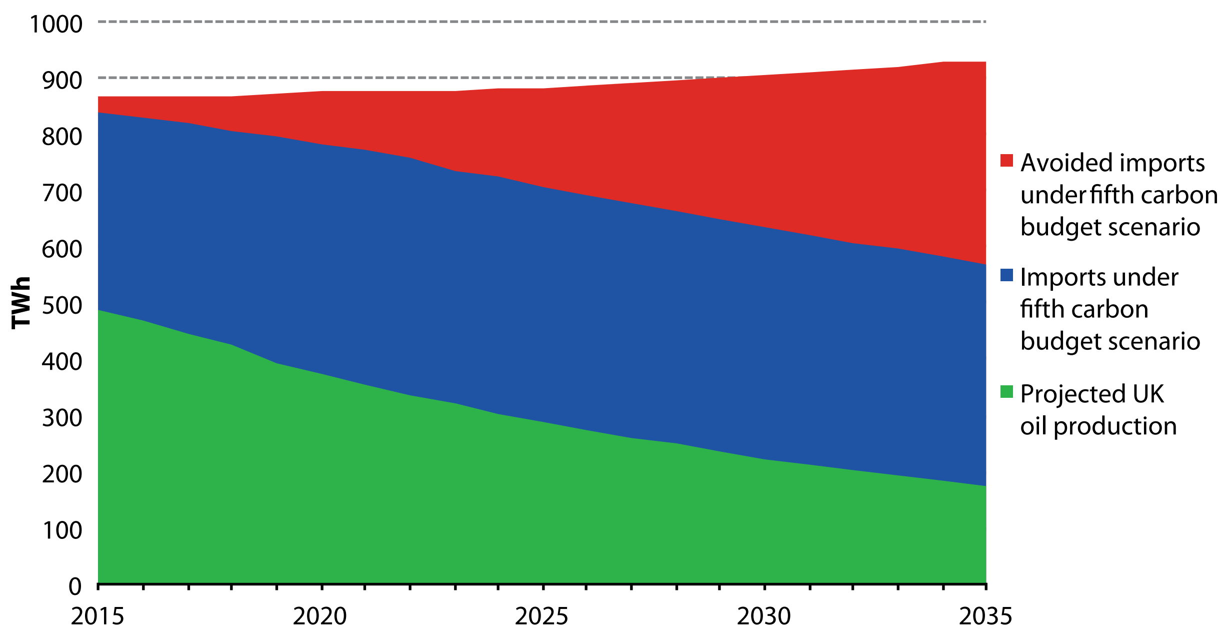
Summary: Our central fifth carbon budget scenario implies a reduction in imports of oil and gas across the UK economy of over 40%, compared to a world where no action is taken on climate change. This would therefore enhance the UK's energy sovereignty by reducing demand for imported fossil fuels, and also provide a hedge against price volatility and the associated risk of damaging economic impacts. Were it to turn out that fossil fuel prices remained low this would increase costs to the UK from its action – a cost we account for when presenting costs of meeting the fifth carbon budget (Chapter 6).

Figure 4.1: UK consumption and imports of natural gas under the CCC central scenario



Source: UK natural gas production from DECC (2015) *UKCS Oil and Gas Production Projections*, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/414172/Production_prjections.pdf.
Notes: Avoided gas consumption based on the difference between consumption under the fifth carbon budget scenario and DECC's baseline scenario. Fifth carbon budget scenario has lower consumption due to lower demand for gas and production of biomethane.

Figure 4.2: UK consumption and imports of oil and petroleum products under the CCC central scenario



Source: UK oil production from DECC (2015) *UKCS Oil and Gas Production Projections*, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/414172/Production_prjections.pdf.
Notes: Avoided petroleum product consumption based on the difference between petrol and diesel consumption under the fifth carbon budget scenario and DECC's baseline scenario.

5. Fiscal circumstances

In our previous advice on the fourth carbon budget we considered the most significant fiscal impacts, both positive and negative, likely to arise as a direct result of the policies used to pursue carbon budgets through the 2020s.

We concluded that fiscal impacts from meeting the fourth carbon budget are likely to be small and manageable relative to total revenues.

We have reconsidered these factors in light of developments since our previous advice and based on our new scenarios. We conclude that fiscal impacts are likely to remain manageable overall for the fifth carbon budget period, particularly given scope for fiscal rebalancing to maintain revenues in the period to 2030:

- **Revenues from EU ETS auctioning and carbon price floor.** UK revenues from auctioning of EU ETS allowances and the carbon price floor could decline slightly through the 2020s in real terms, from around £2.9 billion in 2020 to £2.6 billion in 2030 in a central price scenario. This reflects falling carbon price floor revenues which more than offset rising EU ETS auctioning receipts. Total revenues over the fifth carbon budget period could be around £13 billion, within a range of £8-18 billion.
  - **EU ETS auctioning.** EU countries have agreed the EU ETS cap will fall 27% between 2020 and 2030. Independent projections suggest allowance prices could double over the same period[26]. The combination of these means UK auctioning revenues are projected to rise through the 2020s, from £1.2 billion in 2020 to £1.8 billion in 2030. For indicative purposes, if there was a range of 50% around the carbon price then revenues could be £0.9-2.7 billion in 2030. Overall, total revenues over the fifth carbon budget period could therefore be £9 billion, within a range of £5-14 billion[27].
  - **Carbon price floor.** This is currently frozen at £18/tCO_2. We assume it remains at this level through the 2020s in real terms. Our central power sector scenario has emissions falling 55% between 2020 and 2030 (Chapter 3). The combination of these suggests carbon price floor revenues would fall, from around £1.6 billion in 2020 to £0.7 billion in 2030. Total revenues over the fifth carbon budget period would be around £4 billion in total. If the Government were to stick to its 'target trajectory' for the carbon price floor (reaching £78/tonne in 2030), revenues would be higher at around £2 billion in 2030.
- **Transport revenues.** Current fuel duty and vehicle excise duty (VED) receipts are around £27 billion and £6 billion respectively. With an unchanged fiscal regime, revenues from transport are likely to fall substantially in the future. However, changes to the duty bands and rates, or other measures, could be used to preserve revenues in line with the current taxation burden for drivers.
  - Fuel efficiency of vehicles will improve under a current policy baseline (e.g. the test-cycle CO_2 intensity of new cars will improve from 125 gCO_2/km in 2014 to 95 gCO_2/km in 2020, in line with the EU new car CO_2 target).
  - Our scenarios for meeting the fifth carbon budget would lead to a further incremental reduction in revenues, as conventional vehicles improve faster than the current policy baseline and electric vehicles come into the fleet. For example, under our central scenario in 2030 average new car test-cycle CO_2 intensity falls to around 50 gCO_2/km, with zero-emission vehicles representing around 8% of the fleet.

26 Rising to around £25/tCO_2 in 2030. Market price projection from Point Carbon Thomson Reuters (June 2015).

27 Our analysis assumes a neutral effect of the Market Stability Reserve. See Chapter 2, Box 2.2.

– Under our current policy baseline scenario, fuel duty revenues in 2030 could fall by up to around £4 billion below current levels. The incremental impact of our fifth carbon budget scenarios could be a further £7 billion reduction below the current policy scenario.

– The VED system was reformed in 2015 so that from 2017 only the first year charge is differentiated by CO_2 band. For the second year onwards vehicles pay the same rate[28], except zero-emission vehicles which are exempt. These changes limit the impact of improving fuel efficiency on VED receipts. Under a current policy baseline we estimate VED revenue could fall by around £1 billion by 2030 relative to current levels. The incremental impact of our fifth carbon budget scenarios could be a further reduction of around £0.5 billion. However, future VED impacts could be offset by adjusting banding as vehicle efficiency changes over time.

- **Low-carbon heat.** The low-carbon heat measures in our scenarios have relatively low resource costs of £1.1 billion in 2030, as they focus on the more cost-effective opportunities (e.g. in properties off the gas grid and new-build). Given that the current funding approach under the Renewable Heat Incentive is to fund measures from public spending rather than energy bills, we include this as a fiscal impact.

- **The Levy Control Framework.** Costs associated with supporting low-carbon generation in the power sector are capped under the Levy Control Framework (LCF), which is set to increase to £8 billion in 2020 based on existing and committed projects. Our power sector scenarios imply £9 billion of funding by 2025, which would then fall by the time of the fifth carbon budget. While the overall annual cap is set by the Government, the LCF is funded through energy bills (e.g. surcharges) rather than through public spending. We therefore consider the impact of the LCF in our assessment of fuel poverty above and in greater detail in Chapter 4 of our Power Sector Scenarios report[29].

- **Other impacts.** There is also a set of measures that will have smaller impacts on the fiscal balance, both positive (e.g. the Carbon Reduction Commitment) and negative (e.g. remaining support for plug-in vehicles). We do not assess these in detail, given their smaller size and/or uncertainty about policy design in the 2020s. As mentioned above, government has committed £500m for compensation of the indirect impacts of low-carbon policy to energy-intensive industries to 2020. This is likely to reduce to 2030 given increased action to implement low-carbon measures in other countries.

Overall, net fiscal impacts under our fifth carbon budget scenarios are likely to be manageable, particularly with scope for rebalancing in the period to 2030. There is time between 2016 and 2028 to make suitable adjustments to the fiscal framework. Changes to current duty rates and bands could be used to preserve tax revenue from road transport – whilst this would increase the rate of tax on each litre of fuel it would not increase the annual or per mile cost to drivers, given higher fuel efficiency of vehicles.

Summary: We have considered the main fiscal impacts likely to arise as a result of our fifth carbon budget scenarios, both positive (e.g. EU ETS auction receipts) and negative (e.g. lower fuel duty receipts as vehicle fuel efficiency improves). Our conclusion is that the overall net impacts are likely to be manageable, given the time available from now to the fifth carbon budget period to make adjustments.

28 other than a supplement for the most expensive cars

29 CCC (2015) *Power sector scenarios for the fifth carbon budget*. Available at https://www.theccc.org.uk/publication/power-sector-scenarios-for-the-fifth-carbon-budget

6. Wider health and environmental impacts

UK action to reduce greenhouse gas emissions is one part of wider global action to tackle climate change. International action will lead to less severe climate impacts on human health and the environment around the world, and less need for adaptation[30]. The value of this is captured implicitly in setting emissions targets and putting a consistent price on carbon emissions.

The UK must adapt to the impacts of inevitable future climate change. There are, however, limits to how much adaptation is technically and economically feasible, so this cannot be a substitute for mitigation (i.e. reducing emissions).

Changes included in our scenarios in Chapter 3 to reduce UK emissions can be implemented alongside adaptation to a changing climate. In taking forward policies and plans to meet the fifth carbon budget, the synergies, costs and benefits for both adaptation and mitigation should be considered:

- Buildings can be made more thermally efficient and more resilient to extreme weather conditions, such as heatwaves and flooding.
- Low-carbon infrastructure can be designed from the outset to be more resilient to extreme weather.
- Adopting more sustainable land management practices, particularly in the case of peatland habitats, will safeguard agricultural productivity and other benefits provided by the natural environment, as well as protecting important carbon stores.

There will be more local and immediate health and environmental impacts from the various changes assumed in our carbon budget scenarios. While the Climate Change Act does not specify these explicitly as factors to consider in setting carbon budgets, they are part of the broad requirement to consider economic and social circumstances.

For our 2013 review of the fourth carbon budget we commissioned a survey of the estimated impacts to 2030 on health and the environment[31]. It found significant benefits and some costs from low-carbon measures:

- **Improved air quality** results from a range of measures that reduce burning of fossil fuels. As well as harming the environment, air pollution currently reduces average life expectancy by at least six months, according to government estimates. Reducing vehicle emissions will be essential to meet air quality requirements in many UK cities. A switch away from unabated coal-fired power generation also provides considerable co-benefits. There are trade-offs between reducing GHG emissions and air quality in burning biomass, especially as a replacement for gas in heating, and coal with carbon capture and storage (CCS) for electricity. Overall, however, our scenarios show a substantial air quality benefit.
- **Reduced noise** is an additional benefit arising from measures such as improved glazing, electric vehicles and reduced traffic. As well as being a nuisance, noise can lead to more serious health issues through stress and impaired sleep and concentration.
- **More active lifestyles** result from greater levels of cycling and walking, significantly improving human health and wellbeing while also reducing emissions from vehicle transport.
- **Reduced congestion**, as a result of avoided travel by cars and HGVs, could offer a further economic benefit in the form of less wasted time for transport users.

30 CCC (2015) *The scientific and international context for the fifth carbon budget*

31 Ricardo-AEA (2013) Review of the impacts of carbon budget measures on human health and the environment; ApSimon and Oxley (2013) *Analysis of the air quality impacts of potential CCC scenarios*. Both available at https://www.theccc.org.uk/publication/fourth-carbon-budget-review

- **Potential costs** include increases in road accidents from more walking and cycling (although this is more than offset by reductions from less traffic in our scenario), the landscape effects of new installations (especially renewables) and hazardous waste and accident risk from increased nuclear power.

Overall, for the impacts that could be quantified, the review showed substantial net benefits from following our low-carbon scenario. They were estimated to total around 0.1-0.6% of GDP in 2030 when monetised using recommended government methods (the range largely reflecting uncertainty in the monetary value of years lost through ill-health, and the extent to which the time saved by reduced congestion should be included).

Further work reinforces this conclusion and shows that the benefits may be even greater:

- In 2015 the Lancet Commission on Health and Climate Change published its review of impacts of, and responses to, climate change. It found that tackling climate change could be the greatest global health opportunity this century. For the UK in particular, it notes the health benefits of decarbonising the power sector, using cleaner vehicles and more active travel, and from well-ventilated, more efficient buildings[32].
- Since our review new evidence suggests a stronger link between air pollution and impacts on health. Government has revised its damage costs upwards, particularly for oxides of nitrogen, in light of this new evidence[33]. Hence the air-quality benefits of a low-carbon path are likely to be greater than we estimated in 2013.

Where there are possible costs of low-carbon measures to other health or environmental goals, many of the impacts, such as potential road accidents from walking and cycling, or impacts of new power sources on the landscape and habitats, can be reduced through appropriate design and operation.

Summary: There are wider benefits from actions to meet carbon budgets, in addition to the long-term global benefit in mitigating climate change. These benefits, such as improved air quality, health and reduced noise, accrue immediately and directly to individuals, communities and habitats. Accounting for them strengthens the case for ambitious action to reduce emissions over the next two decades. At the same time, measures can be put in place to reduce local costs from action, including allowing communities to choose which approaches meet their particular priorities. In taking forward policies and plans to meet the fifth carbon budget, the synergies, costs and benefits for both adaptation and mitigation should be considered.

32 Watts et al. (2015) *Health and climate change: policy responses to protect public health, The Lancet Commissions*

33 https://www.gov.uk/guidance/air-quality-economic-analysis