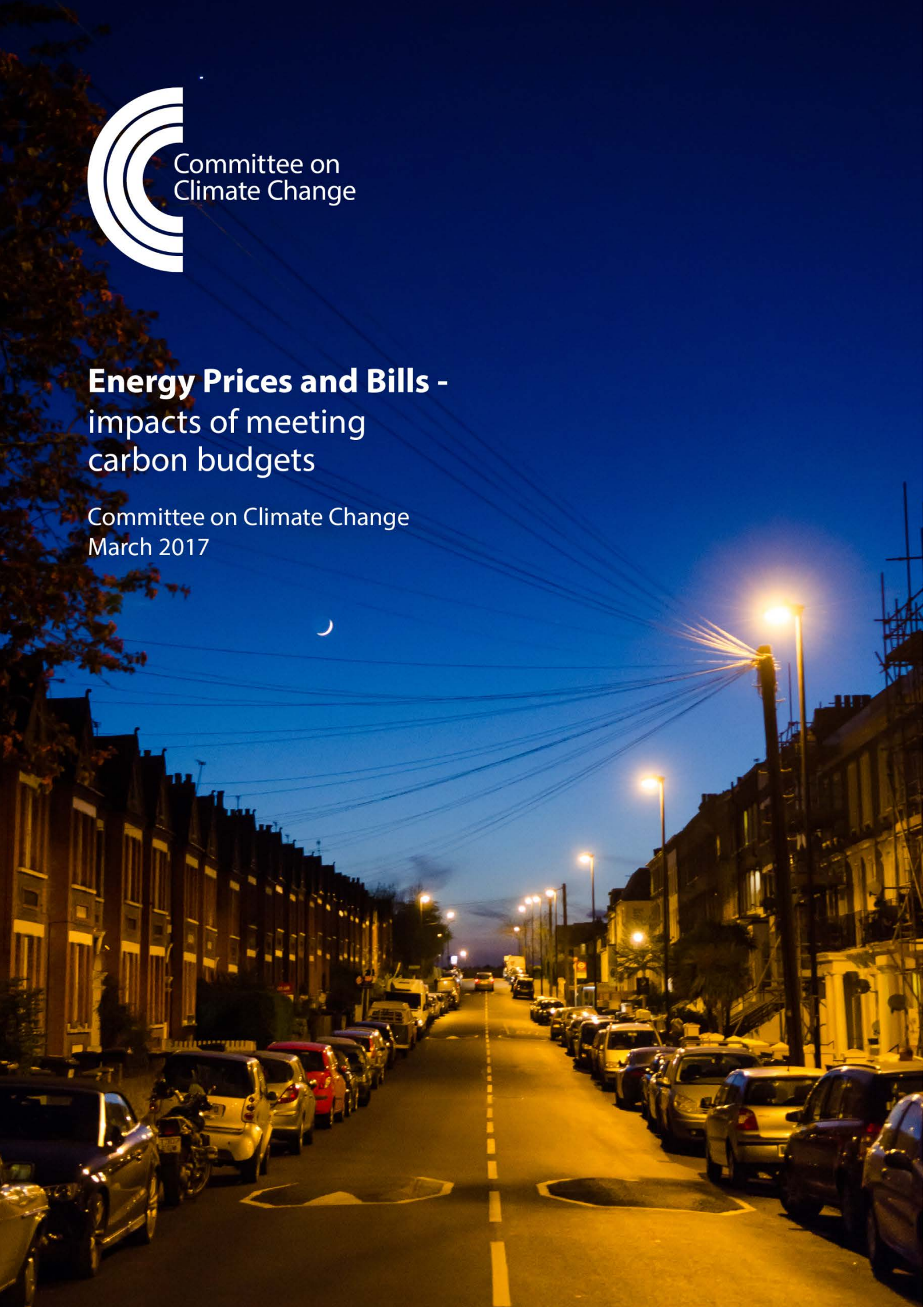




Committee on  
Climate Change

# **Energy Prices and Bills - impacts of meeting carbon budgets**

Committee on Climate Change  
March 2017



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## Acknowledgements

The Committee would like to thank:

**The team that prepared the analysis for this report:** Matthew Bell, Adrian Gault, Taro Hallworth, Mike Hemsley, Eric Ling, Mike Thompson and Emma Vause.

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## The Committee



### **The Rt. Hon John Gummer, Lord Deben, Chairman**

The Rt. Hon John Gummer, Lord Deben, was the Minister for Agriculture, Fisheries and Food between 1989 and 1993 and the longest serving Secretary of State for the Environment the UK has ever had. His sixteen years of top-level ministerial experience also include Minister for London, Employment Minister and Paymaster General in HM Treasury. He has consistently championed an identity between environmental concerns and business sense. To that end, he set up and now runs Sancroft, a Corporate Responsibility consultancy working with blue-chip companies around the world on environmental, social and ethical issues. Lord Deben is Chairman of the Committee on Climate Change, Valpak Limited, and the Association of Professional Financial Advisors.



### **Professor Nick Chater**

Professor Nick Chater FBA is Professor of Behavioural Science at Warwick Business School, having previously held chairs in Psychology at Warwick and University College London (UCL). He is particularly interested in the cognitive and social foundations of rationality, and in applying behavioural insights to public policy and business. He has served as Associate Editor for the journals *Cognitive Science*, *Psychological Review*, *Psychological Science* and *Management Science*. He co-founded and is a Director of the research consultancy Decision Technology Ltd.



### **Professor Sir Brian Hoskins**

Professor Sir Brian Hoskins CBE FRS is the Chair of the Grantham Institute for Climate Change and the Environment at Imperial College London and Professor of Meteorology at the University of Reading. His research expertise is in weather and climate processes. He is a member of the scientific academies of the UK, USA, and China. He has received the top awards of the American and UK Meteorological Societies, the inaugural Gold Medal of the International Union of Geodesy and Geophysics, and the Buys Ballot Medal of the Royal Netherlands Academy of Sciences and Arts which is awarded every 10 years.





### **Paul Johnson**

Paul is the Director of the Institute for Fiscal Studies and is a visiting professor at UCL. He is widely published on the economics of public policy including tax, welfare, inequality and poverty, pensions, education, climate change and public finances. He is also one of the authors of the “Mirrlees review” of tax system design. Paul has previously worked at the Financial Services Authority and has been Chief Economist at the Department for Education and Director of Public Spending in HM Treasury, as well as Deputy Head of the UK Government Economic Service. He is a member of the council and executive committee of the Royal Economic Society and a member of the banking standards board. Paul has previously served on the council of the Economic and Social Research Council. He was a founder council member of the Pensions Policy Institute and in 2010 he led a review of the policy of auto-enrolment into pensions for the new Government.



### **Baroness Brown of Cambridge**

Baroness Brown of Cambridge DBE FREng (Julia King) is an engineer, a crossbench member of the House of Lords, and Chair of the CCC’s Adaptation Sub-Committee. Energy and climate-related interests include being the UK’s Low Carbon Business Ambassador; membership of the World Economic Forum Global Agenda Council on Decarbonizing Energy; a non-executive director of the Green Investment Bank, and of the Offshore Renewable Energy Catapult. She is Chair of the Henry Royce Institute for Advanced Materials and of STEM Learning Ltd, a non-for-profit company providing continuing professional development for science teachers in UK schools. She is a former Vice Chancellor of Aston University, with an academic and industrial career at Cambridge University, Imperial College, London and Rolls-Royce plc where she held senior engineering and manufacturing posts.



### **Professor Corinne Le Quéré**

Professor Corinne Le Quéré FRS is Director of the Tyndall Centre for Climate Change Research and Professor of Climate Change Science and Policy at the University of East Anglia (UEA). She conducts research on the interactions between climate change and the carbon cycle. She has authored multiple assessment reports by the Intergovernmental Panel on Climate Change (IPCC), and is a member of the Scientific Committee of the Future Earth research platform for global sustainability.



### **Professor Jim Skea**

Professor Jim Skea has research interests in energy, climate change and technological innovation. He has been RCUK Energy Strategy Fellow since April 2012 and a Professor of Sustainable Energy at Imperial College since 2009. He was Research Director of the UK Energy Research Centre 2004-12 and Director of the Policy Studies Institute 1998-2004. He has operated at the interface between research, policy-making and business throughout his career. He is President of the Energy Institute and was elected co-Chair of IPCC Working Group III in 2015. He was awarded a CBE for services to sustainable energy in 2013 and an OBE for services to sustainable transport in 2004.

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## Executive Summary

Meeting energy demands from low-carbon sources is currently more expensive than burning fossil fuels without bearing the cost of releasing carbon dioxide. Shifting to low-carbon energy sources therefore involves additional expense, which under current policy is largely paid by households and businesses through their energy bills. Improvements to energy efficiency, in part driven by climate policies, help to reduce energy bills by reducing the amount of energy needed to light and heat the UK's buildings, to run our appliances, and to produce goods and services. Overall, the evidence suggests that total energy bills for households have been stable over the past few years and competitiveness impacts on business limited.

This report sets out the Committee's latest, independent analysis of how the UK's carbon budgets and related policies affect energy bills for households and businesses. It also describes implications for fuel poverty and competitiveness, which the Committee has a legal duty to consider. In addition we identify the size of the low-carbon economy and areas where the UK is well placed to benefit from a growing global market.

Our findings, based on the approach set out in Box 1, are:

- **Household energy bills.**

- **Current bills.** Household bills in 2016 were below 2008 levels as higher prices resulting from low-carbon policies and network costs were more than offset by reductions in energy use (Figure 1):
  - For the 85% of UK households that are dual-fuel (i.e. using gas for heating and hot water and electricity for lights and appliances) the average annual energy bill was around £1,160 in 2016.
  - Bills are about £115 lower in real terms since the Climate Change Act was passed in 2008, having risen around £370 from 2004 to 2008 as international gas prices rose.
  - The majority of the bill reflects wholesale and network costs unrelated to climate policy. Around £105 (9%) of the 2016 bill resulted from the shift towards a UK-based low-carbon electricity supply and support for energy efficiency improvements in homes.
  - Gas and electricity use have been cut by 23% and 17% respectively since 2008, saving the average household £290 a year. Average household size was constant over this period and we have corrected for the recent mild winters. Improved appliance, lighting and boiler efficiency driven through minimum standards have substantially reduced energy consumption without significant up-front costs.
- **Future bills.** The bill impact of shifting to low-carbon electricity will continue to increase slowly, but is likely to be more than offset by continued improvements in energy efficiency (Figure 2).
  - Meeting the fifth carbon budget, including sourcing 75% of UK generation from low-carbon sources by 2030, will add around a further £85-120 to the annual bill (£95 in our central estimate). Added to the impact on current bills, this implies that low-carbon policies will add £190-225 in total to the average annual bill in 2030 (£200 in our central estimate). This is consistent with the Committee's previous assessments from 2012, 2014 and 2015, which estimated a total impact in 2030 of £155-215.

- Households could more than offset this bill impact from energy efficiency improvements between 2016 and 2030, which would save around £150 on average if prices remain at current levels. The majority (85%) of this saving is available from replacing appliances, lights and boilers at the end of their lives with the latest equivalent models.
  - However, other factors, particularly rising wholesale gas prices, are expected to add over £200 to bills, increasing the typical bill in real terms to around £1,350 by 2030 in a central case (within a range of £1,220-£1,410). If wholesale prices do rise, the saving from improving energy efficiency would be even larger.
- **Competition.** Individual households switching from standard variable tariffs to the lowest available tariff could save about £200-300 per year. Switching and wider issues, such as the effectiveness of the wholesale market and the size of supplier margins, are considered by Ofgem and the Competition and Markets Authority.
- **Fuel poverty.** If the insulation and low-carbon heat installations required to meet the carbon budgets can be successfully targeted at the fuel poor then around three-quarters can be lifted out of fuel poverty by 2030. However, meeting the Government's goal of improving fuel poor homes to efficiency band C by 2030 would require roughly doubling the funding currently provided under the Energy Company Obligation.
- **Business energy bills** (Table 1).
  - **Current bills.** Low-carbon policies increase energy prices for businesses, but have only a limited impact on the total costs of production for the majority of businesses.
    - **Sector averages.** In 2016, energy costs made up an average of 0.9% of operating costs for firms in the commercial sector, 2.0% for manufacturing and 3.8% for the fifth of manufacturing defined as energy-intensive. The costs associated with low-carbon policies made up 0.2%, 0.4% and 0.7% of operating costs in the respective sectors, without accounting for any benefits resulting from energy efficiency policies.
    - **Energy-intensive industry.** Energy use varies significantly across businesses, as do energy prices and the impact of climate policies. For the most energy-intensive products, energy costs are a much larger proportion of total costs, but these firms are considered for compensations and exemptions from policy costs. Firm-level data is not available to make a full assessment of the overall impact.
    - **International comparison.** UK industrial gas prices are low by European standards but electricity prices are high. Differences in low-carbon policies cannot explain the difference in electricity prices, which stem primarily from higher wholesale and network costs. It is not clear why these costs are higher in the UK than in many comparable economies. This should be considered further in the review of business energy costs announced in the Government's consultation on the industrial strategy.
  - **Future bills.** The costs associated with low-carbon policies are expected to rise to about 0.5% of operating costs for the commercial sector, 1.0% for manufacturing and 1.6% for energy-intensive sectors by 2030. Total energy costs will depend on future fossil fuel prices. Current central estimates suggest total costs could rise to 1.3%, 3.3% and 5.9% of operating costs respectively. Firms could cut these costs by improving energy efficiency, for example the Committee's scenarios to meet the fifth carbon budget involve measures to reduce business electricity use by around 15%.



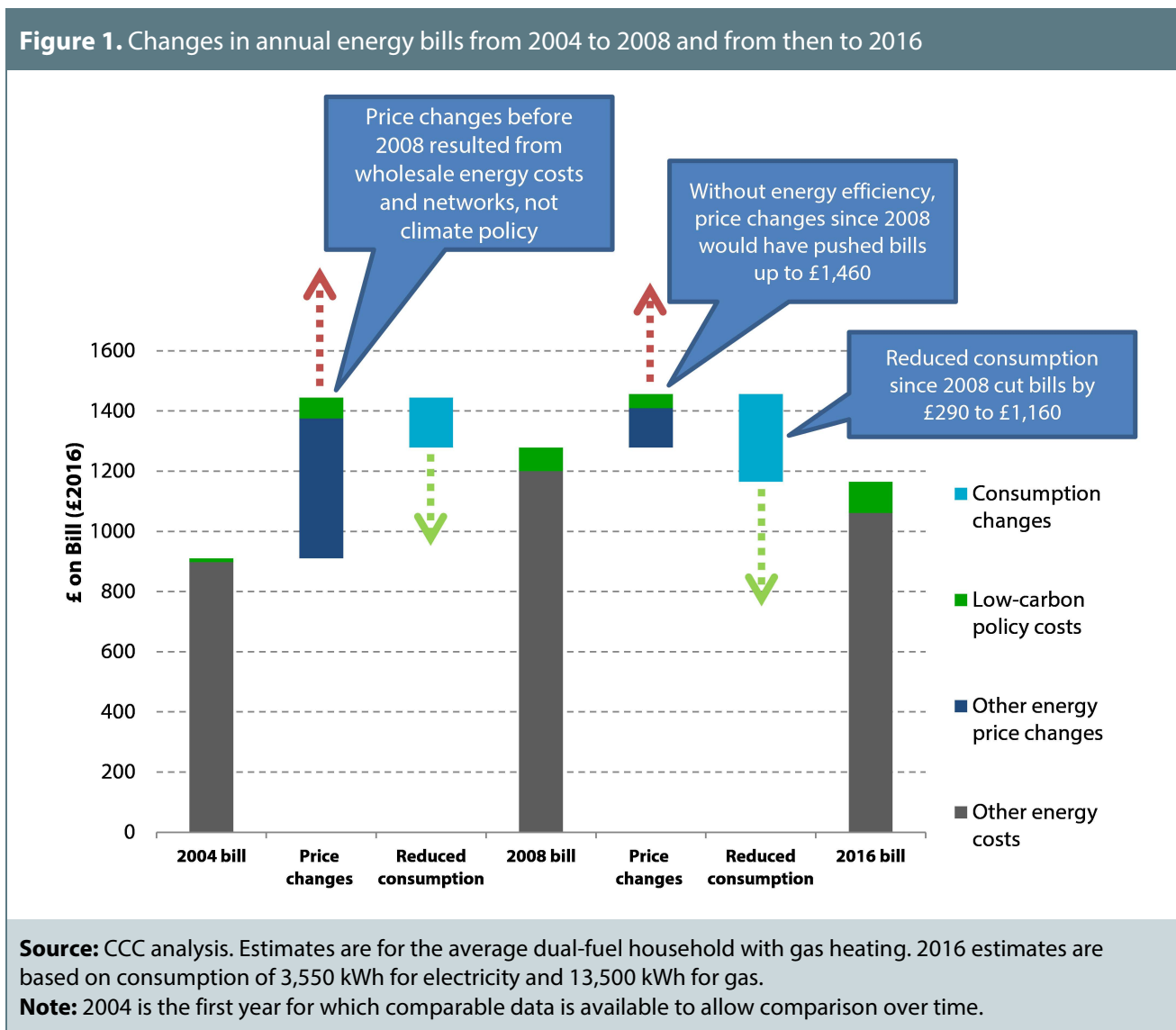
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- **Impact on prices of consumer products.** If all of the costs of low-carbon policies were passed on to consumers through higher product prices this would add 3 pence to an average £10 basket of goods and services in 2016 and would add 6 pence by 2030. Where firms can cut costs through energy efficiency or other measures, price impacts will be reduced.
  - **Competitiveness.** Low-carbon policies have not had a major impact on the competitiveness of UK manufacturing to date. To ensure that remains the case the Government should ensure compensations and exemptions for firms at risk of carbon leakage are predictable and reliable.
    - **Past impacts.** There are at least three reasons to think that competitiveness effects of UK carbon budgets have been low:
      - **Output trends.** With the exception of the financial crisis, the UK's manufacturing output has shown fairly steady slow growth since 1990, despite strengthening low-carbon policies since the early 2000s.
      - **Emissions drivers.** Outside the financial crisis, falls in UK industrial emissions largely reflect shifts to lower-carbon fuels, improved energy productivity and structural changes towards less carbon-intensive manufacturing.
      - **Impact of low-carbon policy on prices.** Following some delays in introduction, industrial sectors deemed by the Government 'at most risk of carbon leakage' now receive compensations and exemptions from the costs of low-carbon policies. These can reduce low-carbon policy costs on electricity by up to 80%. For these firms low-carbon policy adds less than 10% to the electricity price, which adds less than 2% to operating costs in the case of steel.
    - **Future policy.** Cost compensation and exemptions should remain so long as there are differences in low-carbon policy costs between the UK and international competitors. The Government should ensure businesses can plan on the basis that this will be the case, while keeping the precise coverage, level and conditionality of the compensation and exemptions under review. Longer term, the Government should consider policies to ensure a level playing field with other countries while encouraging action to reduce emissions. That could be based on more consistent international approaches or border tariff adjustments that put a charge on imports based on their carbon content.
  - **Opportunities and the low-carbon economy.** The UK economy will need to adapt as the UK continues to reduce emissions and as low-carbon products replace high-carbon products internationally. That transition is already underway and presents opportunities for UK businesses, including those currently producing high-carbon products. It must be integral to the Government's new industrial strategy.
    - The UK low-carbon economy is already estimated to employ hundreds of thousands of people and contribute around 2-3% of GDP, which is a comparable size to energy-intensive manufacturing. It has been growing faster than the rest of the economy.
    - Following the Paris Agreement, global demand for low-carbon goods and services is set to expand many times over to 2030 and then again to 2050. UK businesses must adapt to meet this need in place of the declining demand for high-carbon goods and services.

- The UK is particularly well-placed to take advantage of growing global markets for low emission vehicles; low-carbon finance, insurance and consulting; low-carbon electricity; smart grids and energy efficient products.
- Reducing emissions also brings important co-benefits, particularly for health, resulting from improved air quality, better housing, reduced noise and more active transport (e.g. walking and cycling).

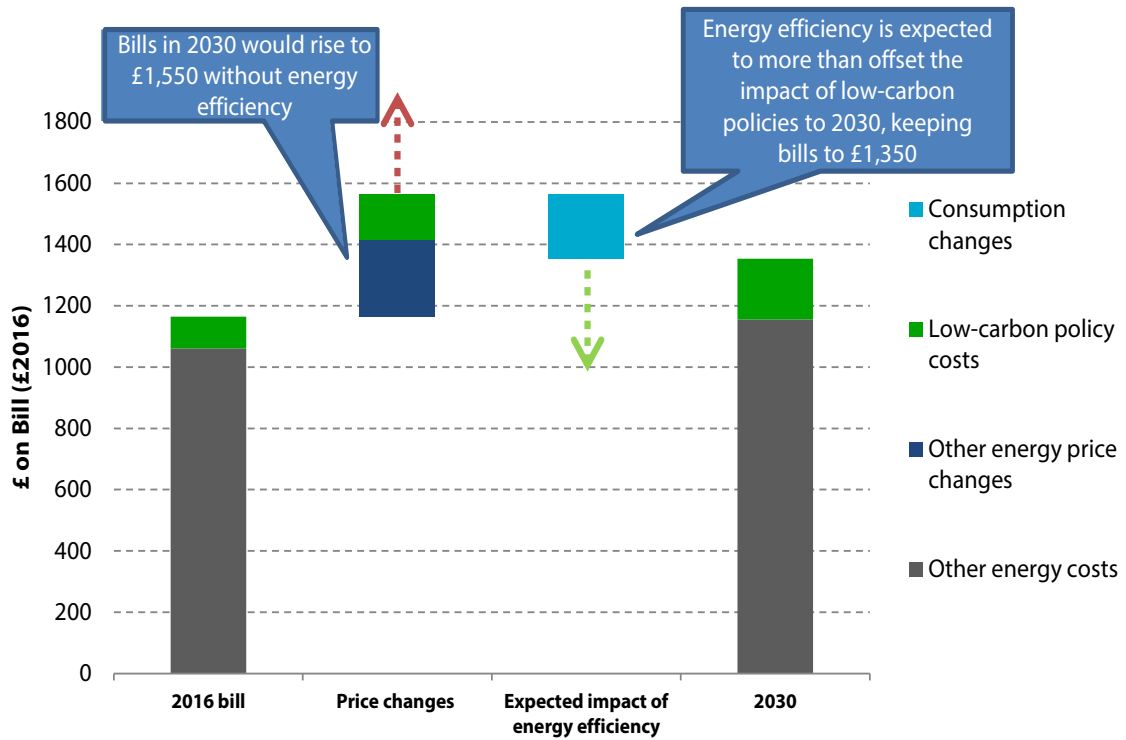
We set out our analysis and further findings in three chapters:

1. Household energy bills
2. Business energy prices and bills
3. Maintaining competitiveness in a low-carbon economy

We have also published detailed assumptions and results in a Technical Annex on our website.



**Figure 2.** Central estimates for changes in annual household energy bill from 2016 to 2030



**Source:** CCC analysis. Estimates are for the average dual-fuel household with gas heating.

**Table 1.** Energy and low-carbon policy costs as a proportion of total operating costs for the commercial, manufacturing and energy-intensive sectors (£2016)

	Commercial sector (58% of UK GVA)		Manufacturing sector (10% of UK GVA)		Energy-intensive sectors (2% of UK GVA)	
	Energy	Low-carbon policies	Energy	Low-carbon policies	Energy	Low-carbon policies
<b>2004</b>	0.5%	0.1%	1.2%	0.1%	2.4%	0.2%
<b>2016</b>	0.9%	0.2%	2.0%	0.4%	3.8%	0.7%
<b>2020</b>	1.0%	0.3%	2.3%	0.6%	4.2%	1.0%
<b>2030</b>	1.3%	0.5%	3.3%	1.0%	5.9%	1.6%

**Source:** CCC analysis. Figures as a share of GVA are also reported in Chapter 2.

**Notes:** Energy-intensive sectors have energy costs that are greater than 10% of their GVA (gross value added): paper & paper products, refineries, chemicals, rubber & plastics, minerals and basic metals (SIC 17, 19-20, 22-24).

### Box 1. Approach to estimating the impact of carbon budgets on energy bills

The Committee has based the estimates in this report on the actions included in the Central scenario from the Committee's 2015 advice on *The Fifth Carbon Budget*. This scenario involves emissions in 2030 that are 57% below 1990 levels and develops technologies and markets required for the 2050 target to reduce emissions by at least 80% relative to 1990. The fifth carbon budget, requiring a 57% reduction in emissions, was accepted by the Government and legislated by Parliament in July 2016.

The approach assumes a broad continuation of current policy choices where:

- The cost of shifting to low-carbon electricity generation is paid by electricity consumers. This includes support paid directly to generators and additional costs imposed on the electricity system and networks.
- Carbon taxes raise funds for the Exchequer (£2.3 billion in 2015, and £2.1 billion in 2030 under our central assumptions) but increase household energy bills. Carbon taxation contributed £30 of the around £105 that low-carbon policies added to bills in 2016.
- The costs of shifting to low-carbon heating are paid from the Exchequer, as are some payments to cut costs for the most intensive users of energy (combined spend of £0.6 billion in 2015, due to rise to around £2 billion in 2030 under our central assumptions).

For households, the report uses the mean level of electricity and gas consumption rather than the median, which is lower and often reported elsewhere, for example by Ofgem. Using the mean ensures that the total spend summed across households matches the total spend on low-carbon policies, but implies that over 50% of dual-fuel households will face bills lower than the averages in this report.

Whilst the summary above focuses on the bill for the average dual-fuel household and sector averages, the analysis in the full report also considers the wider distribution of households and firms:

- Electrically-heated homes are on average smaller (e.g. urban flats) and therefore face lower energy bills. However, low-carbon policies make up a higher proportion of their bills: 18% rather than 9%. This is set to increase to 2030.
- Oil-heated homes currently face similar average bills to gas-heated homes, but bills are more variable due to world oil price volatility. They pay the lowest share of low-carbon policy costs (8%) since whilst they can benefit from funding to improve energy efficiency they do not pay towards it in their oil costs.
- Some households in the devolved nations face higher energy prices (particularly in the North of Scotland), have higher energy demand (Scotland) and/or have lower rates of connection to the gas grid (especially Northern Ireland). Fuel poverty is a devolved matter, with different treatment by the different nations and a higher prevalence in Scotland, Wales and Northern Ireland than in England.
- Businesses face different wholesale, network and policy costs. The report presents up to five sets of representative prices, differentiated by energy consumption and policy coverage. The report also includes 'deep dive' assessments for steel, cement and aluminium. The assessment does not suggest that UK low-carbon policy was a primary cause of declines in these sectors.

We do not analyse the period beyond 2030, but we note that low-carbon policy costs would be expected to fall as payments to existing low-carbon generation begins to expire and new capacity can be added at reduced cost. In contrast if the electricity sector does not shift to low-carbon sources, prices would continue to rise beyond 2030 with ongoing rises expected for carbon prices.



# Chapter 1: Household energy bills





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In this chapter, we consider the energy bills faced by households across the UK. In particular, we assess the impact of support for low-carbon policies on bills and the potential for improved energy efficiency to mitigate bill increases.

We set out the current (2016) picture for energy prices and bills, the drivers of changes since 2004<sup>1</sup> and the outlook for prices and bills to 2020 and 2030, assuming measures are put in place to meet carbon budgets.

We focus primarily on the energy bills of the 85% of UK households that are dual-fuel (i.e. using gas for heating and hot water and electricity for lighting and appliances). In addition, we consider the impacts for different household types (e.g. those using electric or oil heating), those in fuel poverty and households in devolved administrations.

### Key messages:

- **Improved energy efficiency** has been effective in mitigating the majority of bill increases that would have occurred due to price rises from 2004 to 2016 (Figure 1.1). Reductions in household energy use since 2004 save typical dual-fuel households<sup>2</sup> around £490 per year. Improved appliance, lighting and boiler efficiency driven through minimum efficiency standards have significantly reduced energy consumption and bills across most households, without significant up-front costs. Looking towards 2030, bill savings through energy efficiency opportunities continue to offer significant savings and are capable of more than offsetting the bill impact of low-carbon policy costs that are levied on energy prices.
- **Current bills:** The annual bill for a typical dual-fuel household in 2016 was around £1,160, of which £615 was for gas use and £545 was for electricity. Around £105 (9%) of the bill is the result of low-carbon policies. Low-carbon policy costs comprise: the carbon price, support for renewable electricity generation and costs associated with improving energy efficiency for carbon reduction; the majority are levied on electricity.
- **Changes in bills:** Total bills have risen around 28% in real terms<sup>3</sup> since 2004. Bills rose rapidly from 2004 to 2008, since when they have fluctuated around the current level. This has been against a backdrop of generally increasing prices and large reductions in energy consumption, made possible by energy efficiency improvements. Price pressures have largely been driven by higher wholesale energy prices, but the costs of low-carbon policies have also increased by £90 since 2004. Gas consumption for a typical dual-fuel household fell 37% between 2004 and 2015, while electricity consumption fell 18%. If households consumed the same amount of gas and electricity as they did in 2004 average bills in 2016 would be £490 higher due to price rises.
- **Outlook for future energy bills:** Based on current policy we expect low-carbon policies to add an additional £95 to bills by 2030 (on central assumptions, i.e. £200 in total). On the other hand we expect consumption to continue to fall as energy efficiency continues to improve. Opportunities to improve energy efficiency to 2030 would save a typical dual-fuel household around an extra £150 annually if prices remain at current levels. Additionally, our central estimate<sup>4</sup> is that wholesale prices will rise, implying household energy bills will

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<sup>1</sup> 2004 is the earliest year a full dataset is available for our analysis.

<sup>2</sup> A typical dual-fuel household is taken to be a gas-heated household with average energy consumption – see Box 1.1.

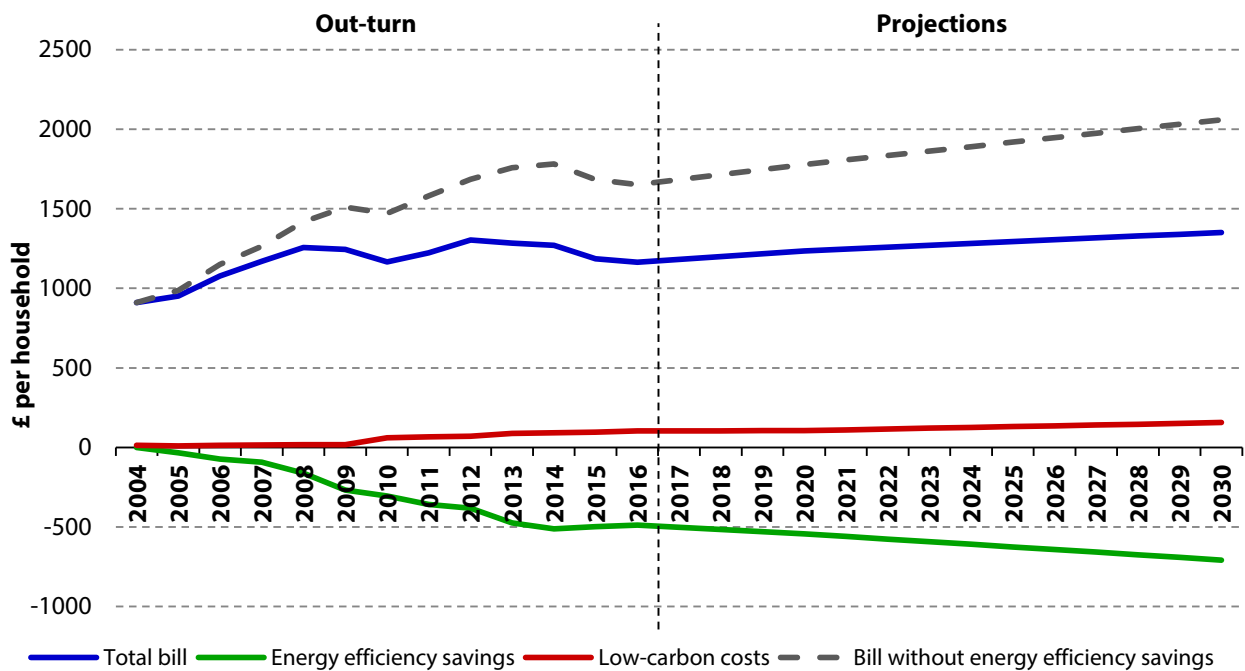
<sup>3</sup> All bills are in real 2016 prices unless otherwise stated. The adjustment is based on the government's GDP deflator. <sup>4</sup> Based on BEIS (2016) *Fossil Fuel Price Assumptions*. Available at: [www.gov.uk](http://www.gov.uk).

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increase 16% to £1,350 by 2030, with a range of £1,220 to £1,410 depending on future fossil fuel prices and implying that energy efficiency savings will be even more valuable.

- **Households without gas heating:** Around 6% of UK households use electricity as the main source for heating. These homes are typically smaller properties, so have lower total energy consumption and lower bills, but face a high share of low-carbon policy costs (18% in 2016) since these are levied more heavily on electricity than gas. Around 4% of households use oil for heating. Oil heating is typically more expensive than gas heating and bills are subject to significant uncertainty due to fluctuations in world crude oil prices. Since no low-carbon policy costs are paid on oil, low-carbon policy costs make up a smaller share of oil-heated household bills (8% in 2016).
- **Fuel poverty:** Energy prices are a key driver of fuel poverty, along with high energy usage and low incomes. In principle, improved energy efficiency and low-carbon heat measures included in our carbon budget scenarios can more than offset increases in bills due to low-carbon policy costs, but this will require more funding than is currently allocated.
- **Energy bills in the devolved administrations:** Many households in the devolved administrations (particularly in the North of Scotland) face higher energy prices, have higher energy demand and have lower rates of connection to the gas grid. In Northern Ireland the majority of households use oil heating, which has tended to mean higher bills in the past. Fuel poverty rates are correspondingly higher in the devolved administrations than England. Most devolved administrations have additional policies to tackle fuel poverty, including area-based schemes to deliver energy efficiency improvements in deprived areas with local authorities, and additional support to vulnerable households.

**Figure 1.1.** Annual energy bills, low-carbon costs and energy savings (2004-2030)



**Source:** CCC analysis. Estimates for the average dual-fuel household.

**Notes:** Figures to 2016 are out-turn data and the energy efficiency savings represent the cumulative reduction in energy consumption since 2004. Some of this change may be due to other factors such as households' response to changing prices or due to changing habits, as well as energy efficiency improvements. Beyond 2016 the figures are our estimates of bills, low-carbon costs and energy efficiency savings, based on central fossil fuel price projections and energy efficiency measures included in the Central scenario from the CCC's advice on the fifth carbon budget.

We set out our analysis that underpins these messages in six sections:

- Overview of energy use in the residential sector
- Historical changes in household energy bills
- Future household energy bills
- Bills for households without gas heating
- Energy bills in Scotland, Wales and Northern Ireland
- Fuel poverty

## (a) Overview of energy use in the residential sector

Households use 36% of UK electricity and 60% of UK gas. The rest is used by businesses, which we consider in Chapter 2.

85% of households in the UK are 'dual-fuel' households that use gas for heating and hot water and some cooking and use electricity for lighting and appliances. Most of the analysis in this chapter focuses on the energy bills for the typical user within this category (Box 1.1).

The remaining 15% of households use different fuels for heating, mainly electricity or oil (Figure 1.2). We set out the implications of carbon budgets for these households' energy bills in section (d).

### Box 1.1. CCC assumptions on the typical dual-fuel household

Dual-fuel households are connected to the gas grid and use gas for space heating and hot water and use electricity for most other uses e.g. lighting and appliances. We model the typical dual-fuel household as having average consumption:

- **Gas consumption:** We use an average gas consumption of 13,500 kWh per year for the typical dual-fuel household. This is based on total domestic gas consumption in 2015 after adjustment for external temperatures,<sup>5</sup> divided by the estimated number of dual-fuel households.
- **Electricity consumption:** We assume a typical electricity consumption of 3,550 kWh per year. This is an average based on the 2015 total electricity consumption of all households less electricity used for heating electrically-heated homes divided by the total number of households. It is higher than the median estimate (3,100 kWh) reported by Ofgem, implying that over 50% of households will have a lower demand. Using the mean ensures that the sum of bills across households matches the total cost of low-carbon measures.

In practice energy consumption varies significantly across households (Box 1.2). However, the average consumption used for our typical household is representative of many commonly found household types. For example, it can be characterised as a 3 bedroom, semi-detached house with 2 adults.

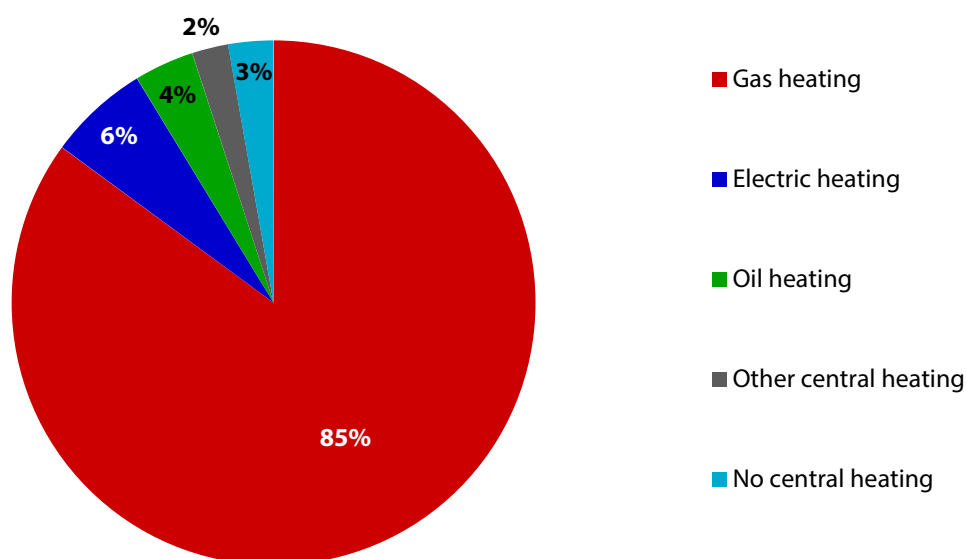
We assume that the typical household is not eligible to claim Warm Home Discount and so does not receive bill reductions from this. The Warm Home Discount, which is paid for through energy prices by all households, is used to protect certain households and in aggregate its cost is returned to consumers through bill reductions. Warm Home Discount is targeted to pensioners and currently saves eligible households £140 off their electricity bill.

The Committee's scenarios for meeting carbon budgets imply that many households will buy electric vehicles in the period to 2030. Those households will face a higher electricity bill, but will make larger savings elsewhere from cutting their spending on petrol and diesel. We do not cover that effect in our analysis, although we do include the increased costs implied for strengthening the electricity network to accommodate a larger number of electric vehicles, since these costs are currently spread over all households. We take the same approach to take-up of electric heat pumps, which in the period to 2030 we expect to be mostly deployed off the gas grid and in new homes (see Box 1.6).

**Source:** Total gas and electricity consumption, number of households and share of households using different heating fuels are taken from BEIS (November 2016), Energy Consumption in the UK.

<sup>5</sup> Consumption is adjusted to the external temperatures to ensure that the data is not skewed by a relatively cold or mild weather compared to other years.

**Figure 1.2.** Proportion of UK households by heating fuel (2014)



**Source:** BEIS (2016) *Energy Consumption in the UK*. Available at: [www.gov.uk](http://www.gov.uk).

**Notes:** Data is for 2014. Other central heating and no central heating will include fuels such as coal, biomass and LPG.

The typical dual-fuel household in 2016 paid an energy bill of around £1,160. The majority of dual-fuel energy consumption is gas, but electricity use also has a significant bill impact due to its relatively higher price (Figure 1.3).

- Around 80% of energy consumption for the average dual-fuel household is gas used for heating and hot water and some cooking, but due to the higher relative price of electricity, gas use makes up around 58% of bills.
- Electricity is used for cooking, lighting, fridges and freezers, laundry and other electronics (e.g. TVs) and some space and water heating.

Bills vary considerably across households depending on a range of factors:

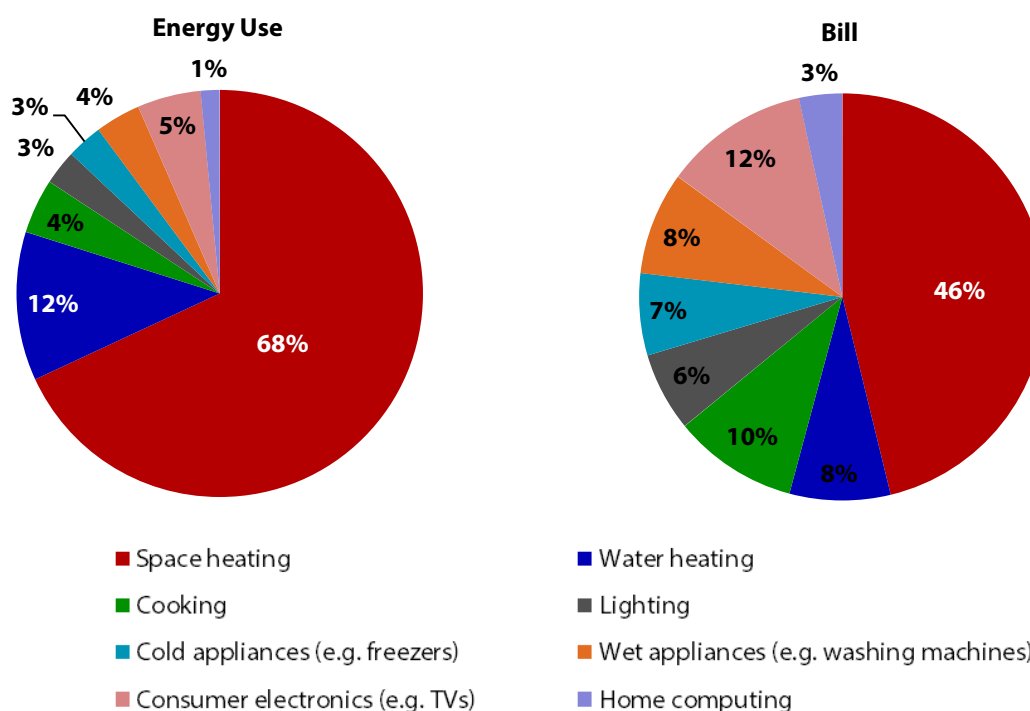
- Bills tend to be higher for large homes with more occupants, old and poorly insulated properties, homes with inefficient heating systems and households with high consumption patterns such as warming their homes above average, or using more technology such as tumble driers (Box 1.2).
- Annual gas bills in 2016 varied from around £370 for low consumption households to £770 for high consumption households, relative to a £615 gas bill for the typical dual-fuel household.<sup>6</sup>

<sup>6</sup> Consumption assumptions are taken from NEED data for 2014. The lower quartile (8,100 kWh) has been used as a low-consumption household and the upper quartile (16,800 kWh) has been used as a high-consumption household.



- Even for households with the same consumption, bills can vary considerably depending on their supplier, tariff and payment method. Consumers on a 'standard variable tariff' pay around £200 to £300 more than those on the cheapest tariffs.<sup>7</sup>

**Figure 1.3.** How UK households use their energy and how this translates into bills (2016)



**Source:** BEIS (2016) *Energy Consumption in the UK*, and CCC analysis. Available at: [www.gov.uk](http://www.gov.uk).

**Notes:** Consumption data is for 2015. In estimating bills, our 2016 prices have been applied to 2015 consumption

### Box 1.2. Variation in energy consumption and bills across households

There is a wide variation in gas and electricity consumption across households, with some very high users (Figure B1.2a). While the National Energy Efficiency Data-Framework (NEED) shows a median gas consumption of 12,000 kWh in 2014, the mean is somewhat higher at 13,100 kWh, since this is affected by high consumption from relatively few households. We use mean consumption in this report – a slightly higher value of 13,500 kWh (see Box 1.1).

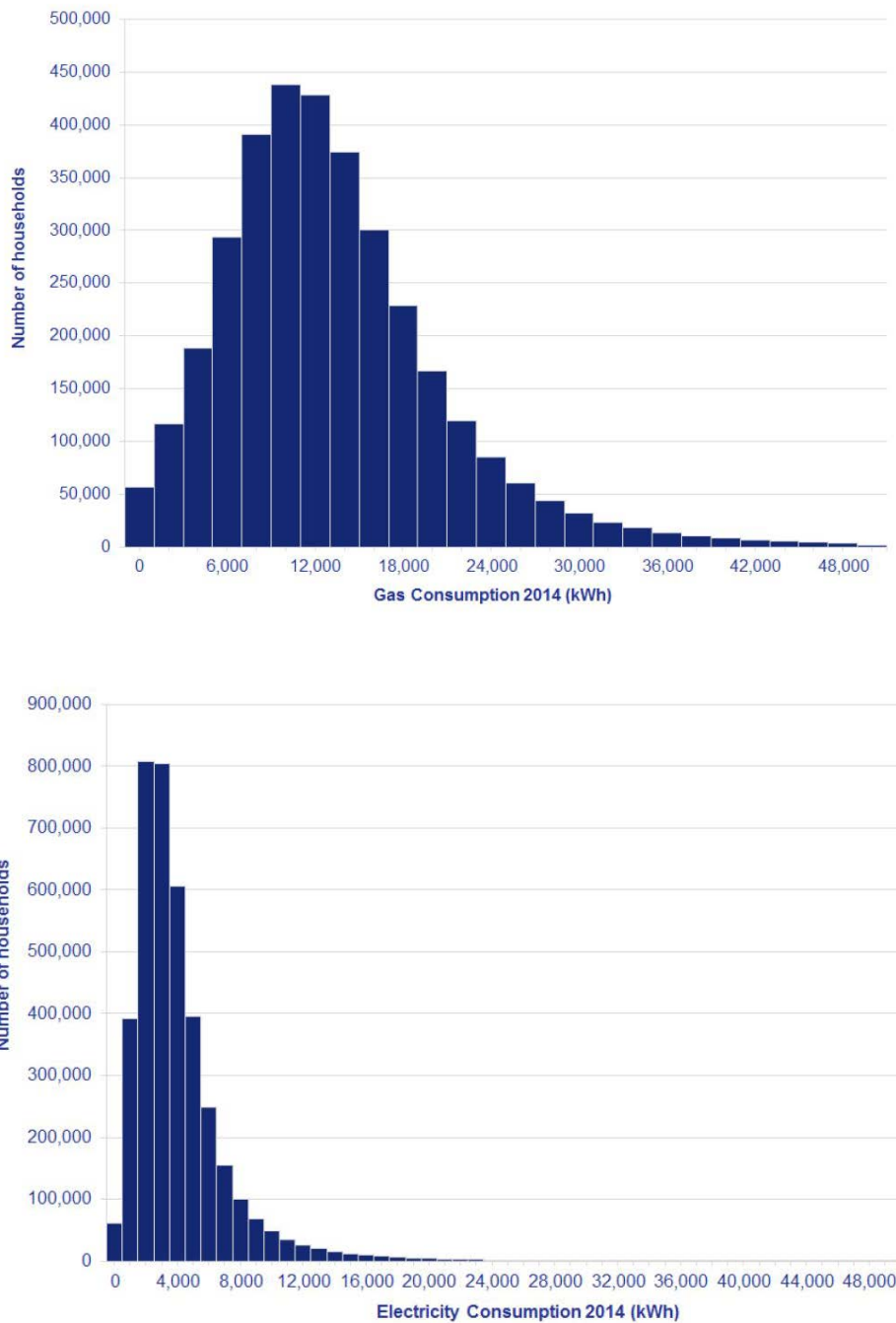
The dispersion is greater for electricity consumption than gas consumption, given the wide range of uses of electricity and particularly whether homes use electricity for heating.

Gas consumption tends to increase with larger properties, more bedrooms and more occupants. There is also a wide range of consumption across homes with similar characteristics. For example, the lowest consuming detached houses can use less gas than the highest consuming flats or mid-terrace houses (Figure B1.2b).

<sup>7</sup> Ofgem (2016) *Retail Energy Markets in 2016*. Available at: [www.ofgem.gov.uk](http://www.ofgem.gov.uk); CMA (2016) *Energy Market Investigation*. Available at: [www.gov.uk](http://www.gov.uk); Ofgem (2017) *Infographic: Bills, prices and profits*. Available at: [www.ofgem.gov.uk](http://www.ofgem.gov.uk); DECC (2014) *Variation in tariff types and energy bills*. Available at: [www.gov.uk](http://www.gov.uk)

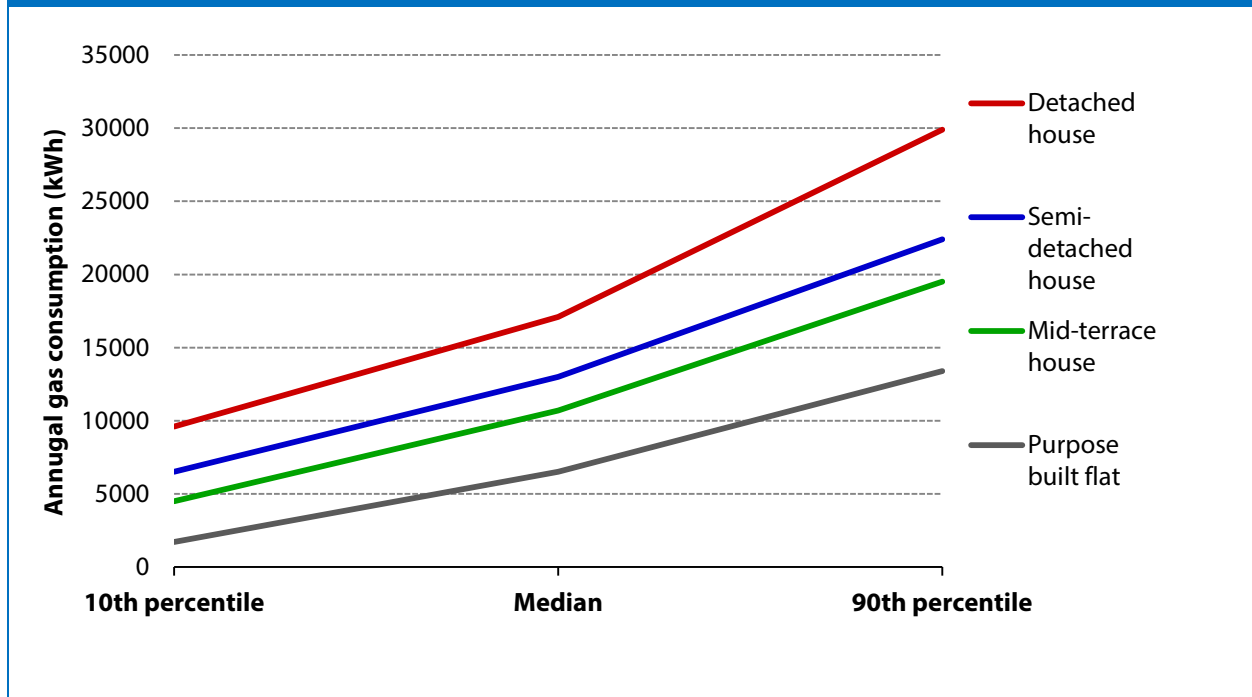
**Box 1.2.** Variation in energy consumption and bills across households

**Figure B1.2a.** Distribution of household gas and electricity consumption (2014)



## Box 1.2. Variation in energy consumption and bills across households

Figure B1.2b. Variation in gas consumption across property types (2014)



**Source:** DECC (2016) *National Energy Efficiency Data-Framework: Summary of analysis using the National Energy Efficiency Data-Framework (NEED)*. CCC analysis based on DECC (2016) *National Energy Efficiency Data-Framework: Additional tables: Summary Consumption Statistics*. Available at: [www.gov.uk](http://www.gov.uk).

### (b) Historical changes in household energy bills

Household energy bills rose rapidly from 2004 to 2008, and have since fallen slightly after peaking in 2012. This reflects energy use that has generally fallen and energy prices that generally rose until 2014 (Figure 1.4). As a result, bills for the typical dual-fuel household in 2016 were £1,160, which is a £250 real terms increase on 2004 and a cut of £115 on 2008.<sup>8</sup>

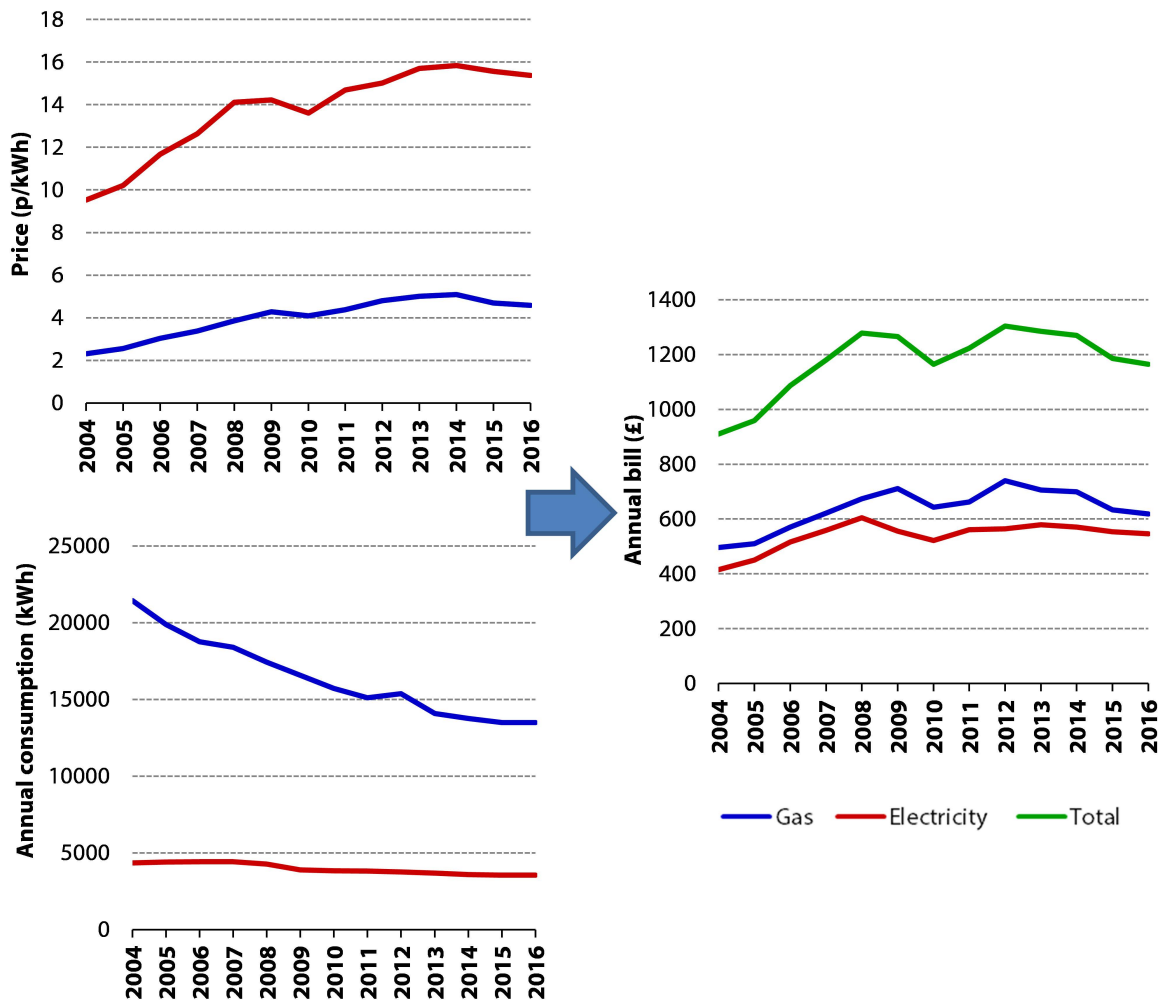
Energy bills rose as a share of household total expenditure between 2004 and 2009, increasing from 3.4% to 5.5%. They have since fluctuated around that level (Figure 1.5). Energy bills make up a far higher share of total expenditure for lower income households<sup>9</sup>, more than 10% in 2014.

The rest of this section explores energy prices and energy use in turn, focusing on how they have been affected by policies aimed at reducing carbon emissions. We find that higher prices resulting from low-carbon policies have increased the average annual bill in 2016 by £90 since 2004 (up from £15, to £105), whilst bills are around £490 lower than they would otherwise have been due a reduction in energy use (Figure 1.6), much of which has resulted from low-carbon policies.

<sup>8</sup> Real prices for 2016, based on the government's GDP deflator.

<sup>9</sup> Lower income households are defined here as those in the lowest income quintile, i.e. the 20% of households with lowest income.

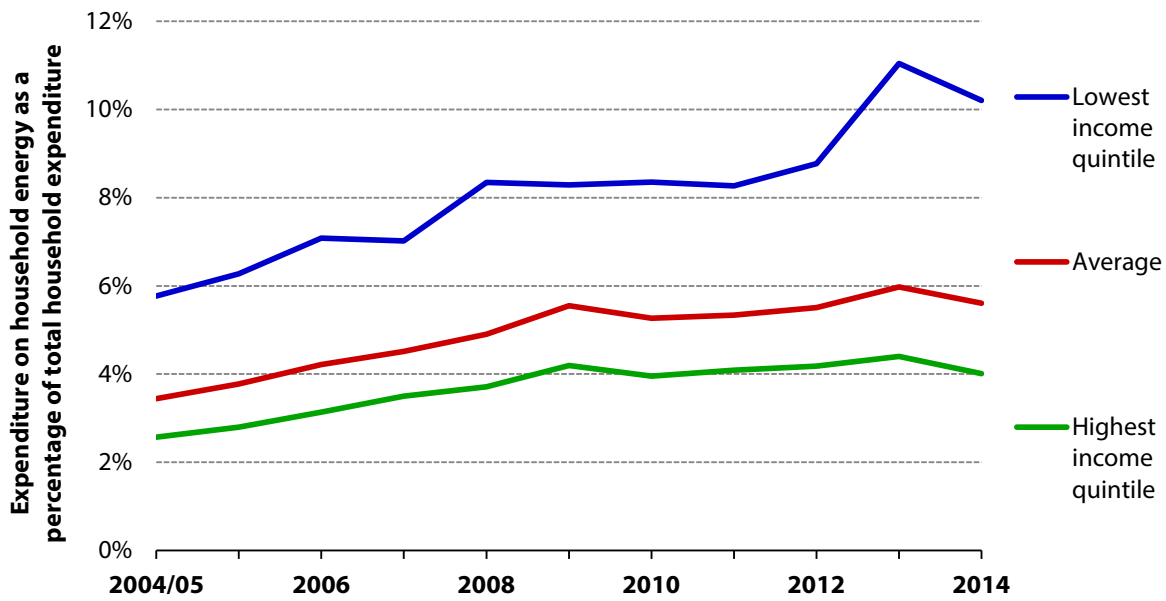
**Figure 1.4.** Historical changes in average dual-fuel household energy bills (2004- 2016)



**Source:** BEIS (2016) *Energy Consumption in the UK*; BEIS (September 2016) *Quarterly Energy Prices*. Available at: [www.gov.uk](http://www.gov.uk) and CCC analysis.

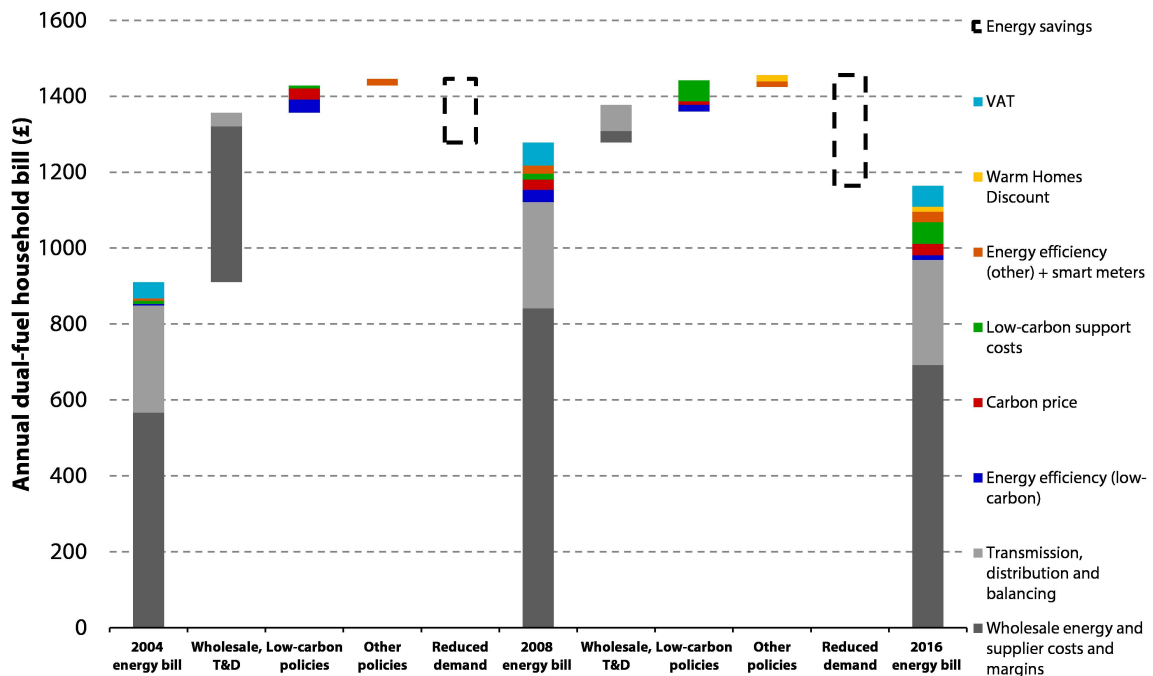
**Notes:** 2016 consumption held at 2015 value as data for 2016 is not yet available.

**Figure 1.5.** Household expenditure on home energy as a share of total expenditure (2004-2014)



Source: ONS (2016) *Household Budget Survey*. Available at: [www.gov.uk](http://www.gov.uk).

**Figure 1.6.** Changes in household bills (2004-2008-2016)



Source: CCC analysis.

Notes: Energy efficiency (low-carbon) costs fall slightly between 2008 and 2016.



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Charts showing the change in gas and electricity bills separately between 2004-2008-2016 are available in the Annex.

### **(i) Changes in household energy prices**

Electricity prices rose 61% between 2004 and 2016; of this increase, around half (31 percentage points) was due to a rise in wholesale and network costs, 7 percentage points to the impact of non-climate policies levied on consumers, and 25 percentage points to the impact of climate policies (Figure 1.7):

- Wholesale prices rose by 1.9 p/kWh between 2004 and 2016, while transmission and distribution costs rose 0.5 p/kWh and 0.6 p/kWh, respectively. Supplier costs and margins and balancing costs remained relatively stable over this period.
- The non-climate policy costs (Warm Homes Discount, energy efficiency policies aimed at addressing fuel poverty<sup>10</sup>, smart meters and VAT) together added around 0.6 p/kWh.
- Of the climate policy costs, price support for low-carbon generation added 1.6 p/kWh, while the impact of EU Emissions Trading System allowances and UK Carbon Price Support on the wholesale electricity price added 0.8 p/kWh. Other climate policy costs (energy efficiency policies aimed at reducing CO<sub>2</sub>, upgrades to transmission and distribution networks to accommodate renewable generation, heat pumps and electric vehicles and assumed costs of managing intermittency) added around 0.3 p/kWh combined. Climate policy cost increases were partially offset by the dampening effect of renewable generation on wholesale prices (the merit order effect), which reduced prices by 0.6 p/kWh<sup>11</sup>.

Gas prices rose 98% between 2004 and 2016; of this increase, the majority (84 percentage points) was due to a rise in wholesale, network and supplier costs, 11 percentage points to the impact of non-climate policies levied on consumers, and 3 percentage points to the impact of climate policies (Figure 1.8):

- Wholesale prices rose the most, by 1.2 p/kWh between 2004 and 2016, while supplier costs and margins rose 0.4 p/kWh and transmission and distribution costs rose 0.3 p/kWh combined.
- The non-climate policy costs (Warm Homes Discount, energy efficiency policies aimed at addressing fuel poverty, smart meters and VAT) together added around 0.3 p/kWh.
- Climate policy costs (energy efficiency policies aimed at reducing CO<sub>2</sub>, and reduced throughput through the gas grid) together added around 0.1 p/kWh.

Given these factors, in 2016 £105 (9%) of the typical dual-fuel energy bill was the result of policies to cut carbon emissions.

These low-carbon policies also bring a number of benefits:

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<sup>10</sup> Box 1.4 sets out our approach to allocating energy efficiency funding to climate or social policy.

<sup>11</sup> With sufficient deployment of low-carbon generation (e.g. renewables, nuclear), these sources increasingly set the wholesale price at times of high generation and/or low demand. The resulting reduction in wholesale prices due to the low variable cost of these sources is known as the merit order effect. Details on how we estimate the merit order effect and its impact on retail prices is set out in the Annex.

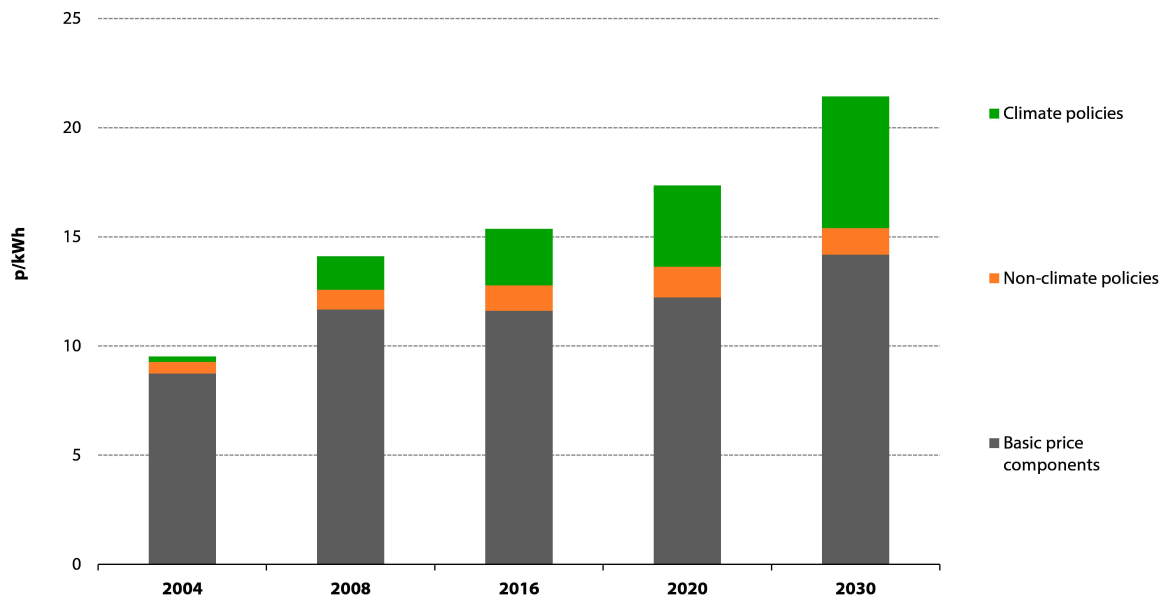
- 
- Carbon emissions fell 71 MtCO<sub>2</sub> from 2004 to 2015 in the UK power sector.
  - Approximately £2.3 billion of tax revenue was raised through the UK carbon price floor and auctioning of EU ETS permits in the power sector in 2015.
  - Improved air quality resulting from reduced burning of fossil fuels, avoiding health problems and premature deaths.
  - 50% of generation in 2015 (up from 28% in 2004) came from low-carbon sources that provide some insurance against volatile international fossil fuel prices. This has also driven down the cost of many of these technologies – for example the costs of offshore wind have reduced from £140/MWh for projects commissioning in 2014/15 to less than £100/MWh for projects coming online towards 2020<sup>12</sup>.
  - Energy efficiency policies contributed to the reductions in energy use set out in section (ii) below, serving to decrease bills overall.

Further details on price changes and their drivers can be found in the Annex.

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<sup>12</sup> Offshore Wind Programme Board (2017) *Cost Reduction Monitoring Framework 2016*. Available at: [ore.catapult.org.uk](http://ore.catapult.org.uk)

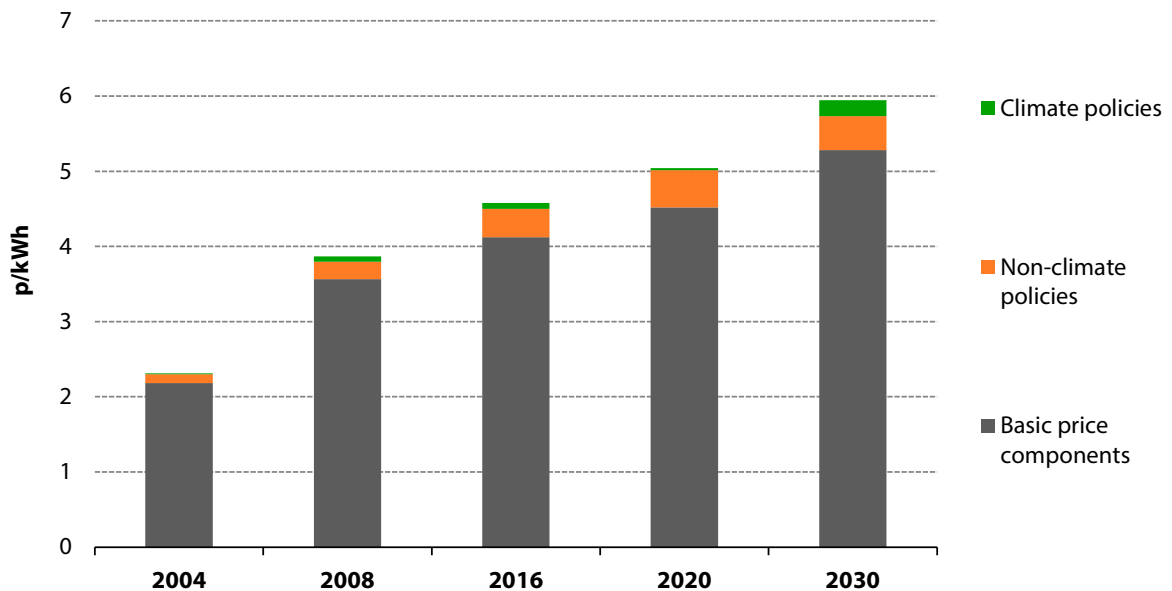
**Figure 1.7. Residential electricity price components (2004-2030)**



**Source:** CCC analysis.

**Notes:** 'Basic price components' include wholesale energy costs, supplier costs and the costs of transmission and distribution of electricity.

**Figure 1.8. Residential gas price components (2004-2030)**

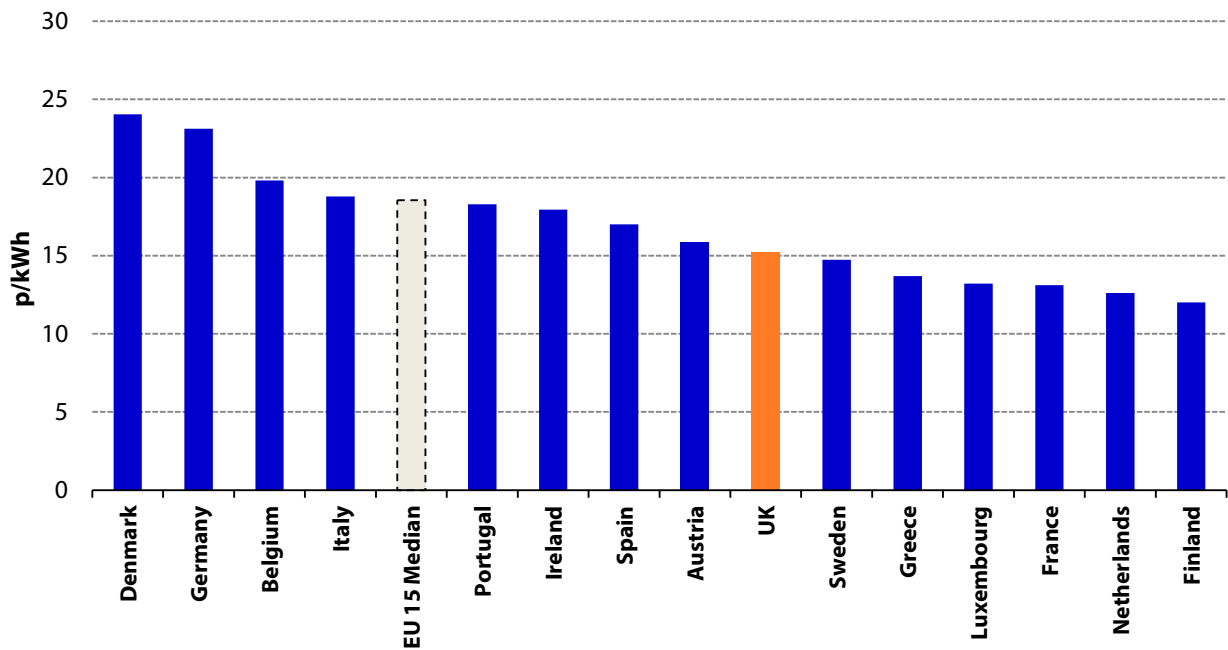


**Source:** CCC analysis.

**Notes:** 'Basic price components' include wholesale energy costs, supplier costs and the costs of gas distribution.

Residential electricity prices in the UK are below average prices across the EU-15. Prices are higher in Germany and Denmark (52-58%), and lower in the Netherlands and Finland (17%-21%) (Figure 1.9). Gas prices in the UK are the third lowest in the EU-15, slightly higher than those in Belgium and 18% higher than the lowest, in Luxembourg. The highest prices are in Sweden (104% higher than the UK) (Figure 1.10).

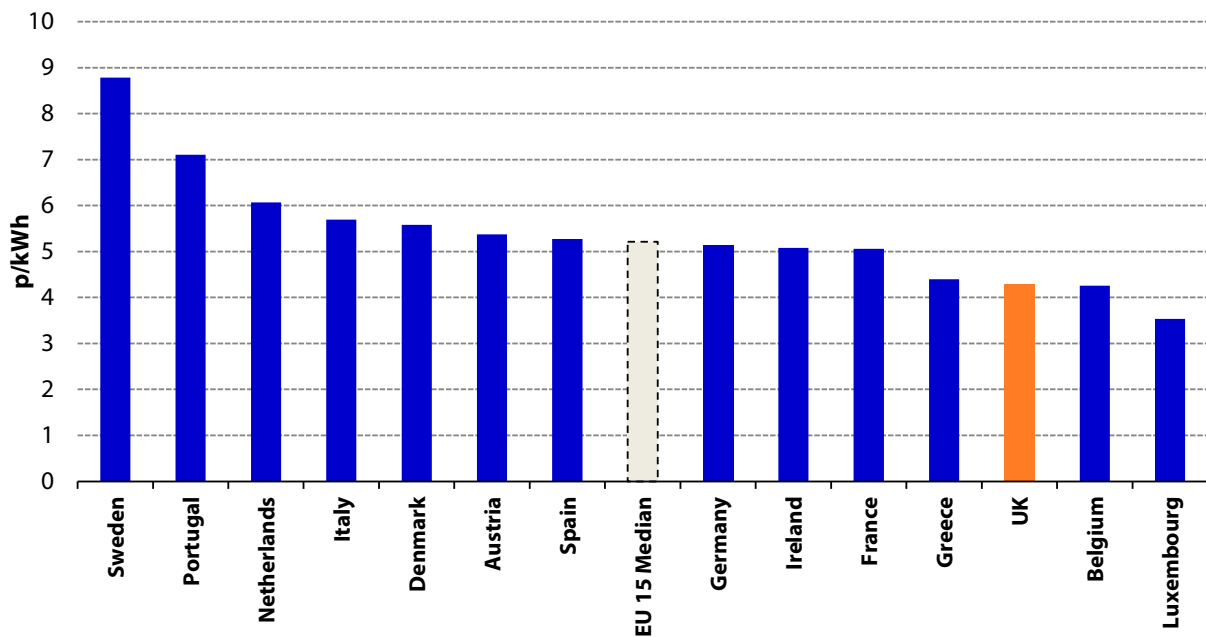
**Figure 1.9.** Residential electricity prices in EU-15 (2016)



**Source:** BEIS (2016) *International Domestic Energy Prices: Table 5.6.2*. Available at: [www.gov.uk](http://www.gov.uk).

**Notes:** Based on 'medium consumption' profile of 2,500 – 4,999 kWh per annum. Including taxes and levies.

**Figure 1.10.** Residential gas prices in EU-15 (2016)



**Source:** BEIS (2016) *International Domestic Energy Prices: Table 5.10.2*. Available at: [www.gov.uk](http://www.gov.uk).

**Notes:** Based on 'medium consumption' profile of 5,557 – 55,557 kWh per annum. Including taxes and levies. No data is available for Finland.

## (ii) Changes in household energy use

Household energy use has fallen despite increased use of appliances and devices that require electricity:

- A higher proportion of households now have dishwashers, tumble dryers and home computers/laptops than in 2004 and the screen size of new TVs and capacity of new washing machines are typically larger.
- While appliances have tended to gain more functionality or capacity over time, this has been possible while using less energy, typically at no greater cost to consumers (Box 1.3).
- The average household size has remained at 2.4 people over the last decade.<sup>13</sup>

During the 1980s and 1990s there was a growing tendency for households to heat their homes to higher temperatures. However, average internal temperatures peaked in 2005 and have declined slightly since (Figure 1.11). We have adjusted energy consumption for cold and mild winters to ensure comparisons can be made between years.

<sup>13</sup> ONS (2016) *Statistical Bulletin: Families and households in the UK: 2016*. Available at: [www.gov.uk](http://www.gov.uk)



### Box 1.3. Appliance and lighting development

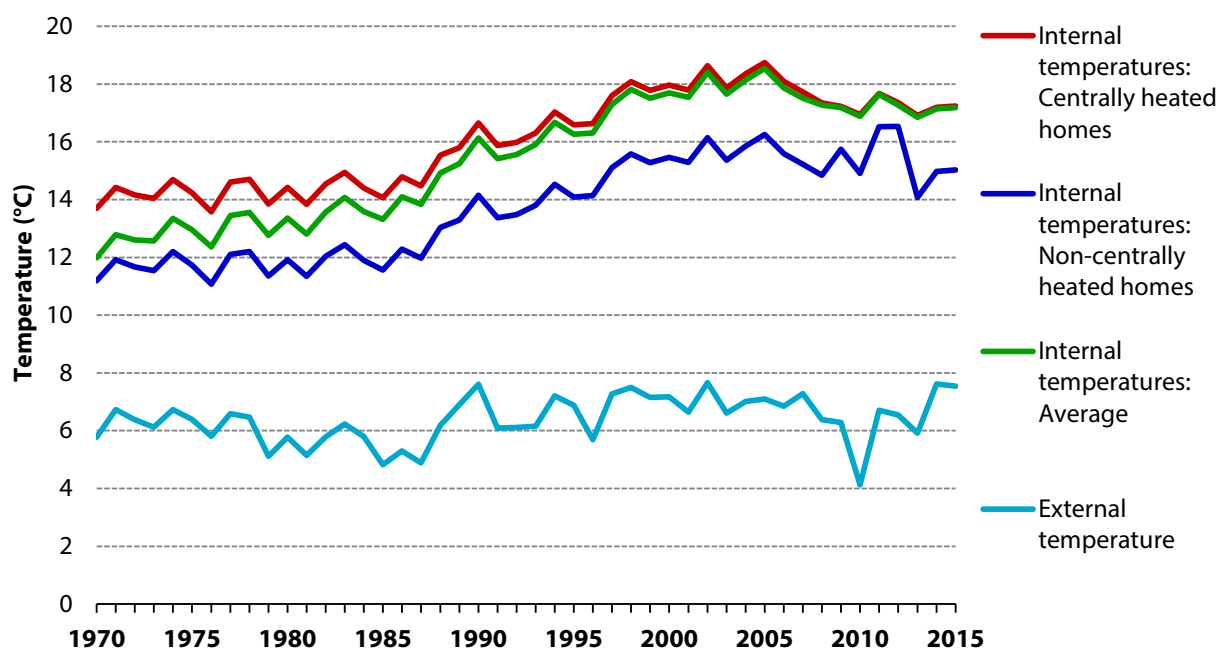
Significant reductions in the energy consumption of household appliances have been possible despite the increase in capacity and functionality of many appliances over time. For example, between 2004 and 2014 the average energy consumption of new refrigerators/freezers and washing machines sold in the EU has reduced by 25%, the average capacity of refrigerators/freezers has increased 3% and the proportion of washing machines with a capacity of over 6kg has increased from 3% to 60%.

At the same time as becoming more efficient, the prices of these products have fallen. The EU average real price for refrigerators decreased by 12.5% between 2004 and 2014 and for washing machines the average real price fell by 25%. Energy efficiency regulations appear to have had little long-term impact on purchase prices mainly due to changes in retail mark-ups, economies of scale in production and innovation by manufacturers.

Average energy consumption per household for lighting has reduced significantly too, with average EU consumption decreasing 18% between 2005 and 2013. This has been largely due to the phasing out of incandescent light bulbs in favour of more efficient CFLs and halogen lights. LEDs have a high luminous efficacy level (lumens per watt) and a long lifetime, but are currently relatively costly and so have a small market share. As LED technology and products mature its efficacy is expected to progressively increase and its price fall. In 2012, an average MV LED light had a rated luminous efficacy of 58 lm/W and a cost of 18.0 Euro. Projections for 2030 suggest that the luminous efficacy will reach 169 lm/W and the cost will fall to 2.5 Euro.

**Source:** Joint Research Centre, European Commission (2016) *Efficiency Trends of Energy-related Products and Energy Consumption in the EU-28*. Available at: [ec.europa.eu](http://ec.europa.eu). International Energy Agency (2016) *Achievements of appliance energy efficiency standards and labelling program*. Available at: [www.iea.org](http://www.iea.org).

**Figure 1.11.** Average UK home temperatures and external temperatures (1970 – 2015)



**Source:** BEIS (2016), *Energy Consumption in the UK*. Available at: [www.gov.uk](http://www.gov.uk). Cambridge Architectural Research (CAR) analysis using the Cambridge Housing Model (CHM).

**Notes:** Data to 2012 is from ECUK, data from 2013-2015 is modelled by CAR. There is a discontinuity in internal temperature in 2009 and again in 2013 due to changes in methods.

Falling energy consumption with increasing appliance use demonstrates significantly improving energy efficiency. This is also clear from available data on individual appliances:

- Condensing boilers, which are more efficient, have been required under building regulation since 2005. In 2014 around 60% of all UK boilers were condensing boilers.<sup>14</sup> On average boilers purchased during 2015 were 90.5% efficient.<sup>15</sup>
- In 2015, 55% of household lights were Compact Fluorescent Lamps (CFLs) (Figure 1.12). Using a more efficient CFL instead of a traditional incandescent bulb (which made up 70% of the stock in 2004) can save £5 a year or £70 over the lifetime of the bulb. The use of halogen bulbs has also been increasing over this period. Light Emitting Diodes (LEDs), which were only 0.6% of lights in 2015, have potential to be a more efficient replacement for both traditional bulbs and also halogen down-lighters. By replacing all halogen down-lighters in a home with LED alternatives, the household could save about £35 a year on their electricity bills.<sup>16</sup>
- There has been a significant improvement in the energy efficiency of appliances in UK homes. For example, by 2015 70% of fridges and freezers had an efficiency rating of A or better, an increase from only 9% in 2004 (Figure 1.13).

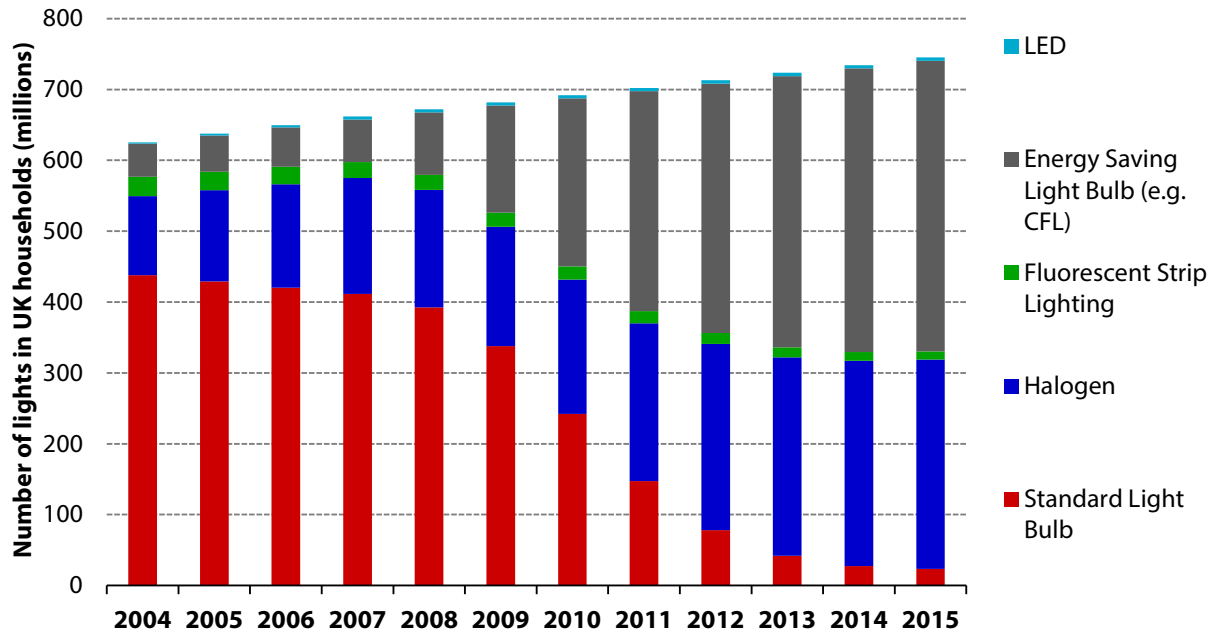
<sup>14</sup> BEIS (2016) *Energy Consumption in the UK*, Table 3.19. Available at: [www.gov.uk](http://www.gov.uk)

<sup>15</sup> Heating and Hotwater Industry Council (HHIC)

<sup>16</sup> Energy Saving Trust (EST)

- The fabric efficiency of homes has improved significantly. The average SAP rating of homes increased from 48.7 in 2004 to 60.9 in 2014,<sup>17</sup> equivalent to an improvement from an Energy Performance Certificate (EPC) band E to an EPC band D. By mid-2016 69% of cavity wall homes, 66% of lofts and 8% of solid wall homes had been insulated.<sup>18</sup>

**Figure 1.12.** Change in the type of lights used in UK homes (2004-2015)

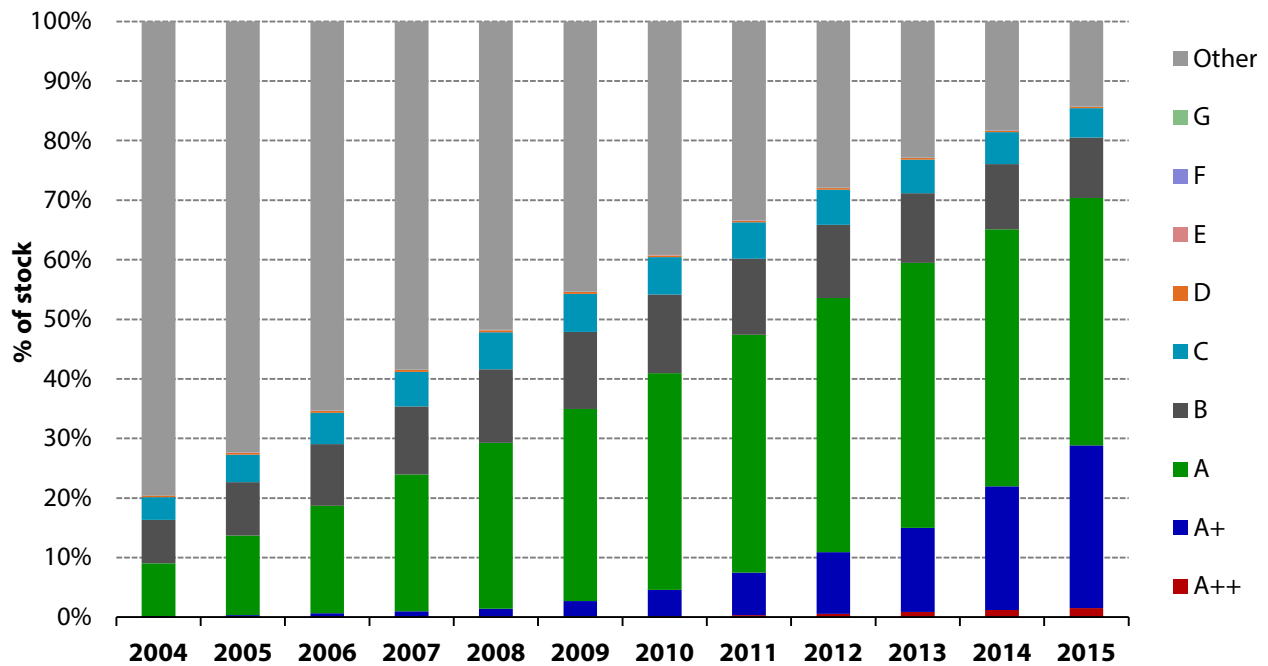


**Source:** BEIS (2016) *Energy Consumption in the UK*. Available at: [www.gov.uk](http://www.gov.uk).

<sup>17</sup> UK data, using the SAP 2012 methodology, source: BEIS (2016) *Energy Consumption in the UK*. Available at: [www.gov.uk](http://www.gov.uk). The Standard Assessment Procedure (SAP) is the methodology used by the Government to assess and compare the energy and environmental performance of dwellings, used in mandatory Energy Performance Certificates (EPCs).

<sup>18</sup> Great Britain data, source: BEIS (2016) *Household Energy Efficiency National Statistics*. Available at: [www.gov.uk](http://www.gov.uk).

**Figure 1.13.** Improved efficiency of refrigerators and freezers in UK homes (2004-2015)



**Source:** BEIS (2016) *Energy Consumption in the UK*. Available at: [www.gov.uk](http://www.gov.uk).

Some savings, mainly insulation measures, require active decisions by households and involve some disruption. However, most of these savings from improved energy efficiency occur without hassle or disruption to households. They occur through the natural replacement of household products accompanied by suitable standards for manufacturers.

It is not possible to identify how far these improvements would have occurred through technological progress in the absence of policies aiming to reduce emissions, but it is clear that policies have been an important factor:

- Boiler regulations were introduced in the UK in 2005. All gas-fired and oil-fired boilers fitted after 1st April 2005 have to be condensing boilers, which tend to be more efficient. This applies to both new installations and boiler replacements. Since 2010, all new boilers must be at least 88% energy efficient.
- The UK Market Transformation Programme (MTP), underpinned by EU-wide Eco Design and Energy Labelling Directives, has introduced minimum energy performance standards and energy labelling on energy-using products (e.g. TVs and lighting). Energy labels indicate the relative performance in terms of efficiency, steering consumers towards the most efficient models, while minimum energy performance standards progressively remove the least efficient products from the market.

Overall, reductions in household energy use since 2004 save dual-fuel households an average of £490 per year. It is likely that the overall effect of energy efficiency has been larger than this (given increased size and use of appliances), with low-carbon policy an important factor in this progress.

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## (c) Future household energy bills

### (i) Approach to projecting energy bills

Projecting future household energy bills is inevitably uncertain. In particular, projections of future fossil fuel prices have historically been inaccurate, while projections of future low-carbon policy costs are dependent on the scenario assumed and the way in which policy is designed to deliver those scenarios.

This report makes reasonable estimates of the likely future bill impacts of meeting carbon budgets taking these uncertainties into account:

- We focus on the impact of low-carbon policies more than total bills; the former are less sensitive to future fossil fuel prices. However, households are most interested in their total bill and we report potential future bills across the range of fossil fuel price projections.<sup>19</sup>
- We base our assessment on the scenarios from our fifth carbon budget report under which carbon intensity of the power sector falls from around 370 gCO<sub>2</sub>/kWh in 2015 to under 100 gCO<sub>2</sub>/kWh in 2030. We include the indirect impact of electric vehicles and low-carbon heating on electricity and gas costs (e.g. through required network strengthening), but do not include their direct costs (i.e. we do not include the costs of charging electric cars, or the saving on petrol/diesel costs).
- We assume that policies recover costs in line with their current designs under which the additional costs of low-carbon generation are met by electricity bill payers rather than general taxation.
- We identify wider costs and benefits not currently included in energy bills, such as impacts on the Exchequer.

We report the effect of key uncertainties on total bills and the impact of low-carbon policies in section c(v).

### (ii) Overview of projected energy bills

Under a central case for future wholesale gas prices, the total annual energy bill for a typical dual-fuel household would rise from £1,160 in 2016 to £1,240 in 2020 and then to around £1,350 by 2030 (Figure 1.14). The biggest drivers of bill increases to 2020 are higher wholesale gas prices and the costs of supporting low-carbon generation on electricity bills. From 2020 to 2030 the largest upwards pressure comes from wholesale gas prices and also renewables and wholesale electricity prices. A further breakdown of changes in gas and electricity bills is provided in the Annex.

The cost of low-carbon policies will increase as the share of generation supported by those policies increases to 2030. Under central assumptions, we estimate that by 2030, low-carbon policies will make up around £200 (15%) of the annual energy bill for a typical dual-fuel household, an increase of £95 since 2016. Offsetting this, improved energy efficiency could save households around an extra £150 annually by 2030 compared to today if prices remain at

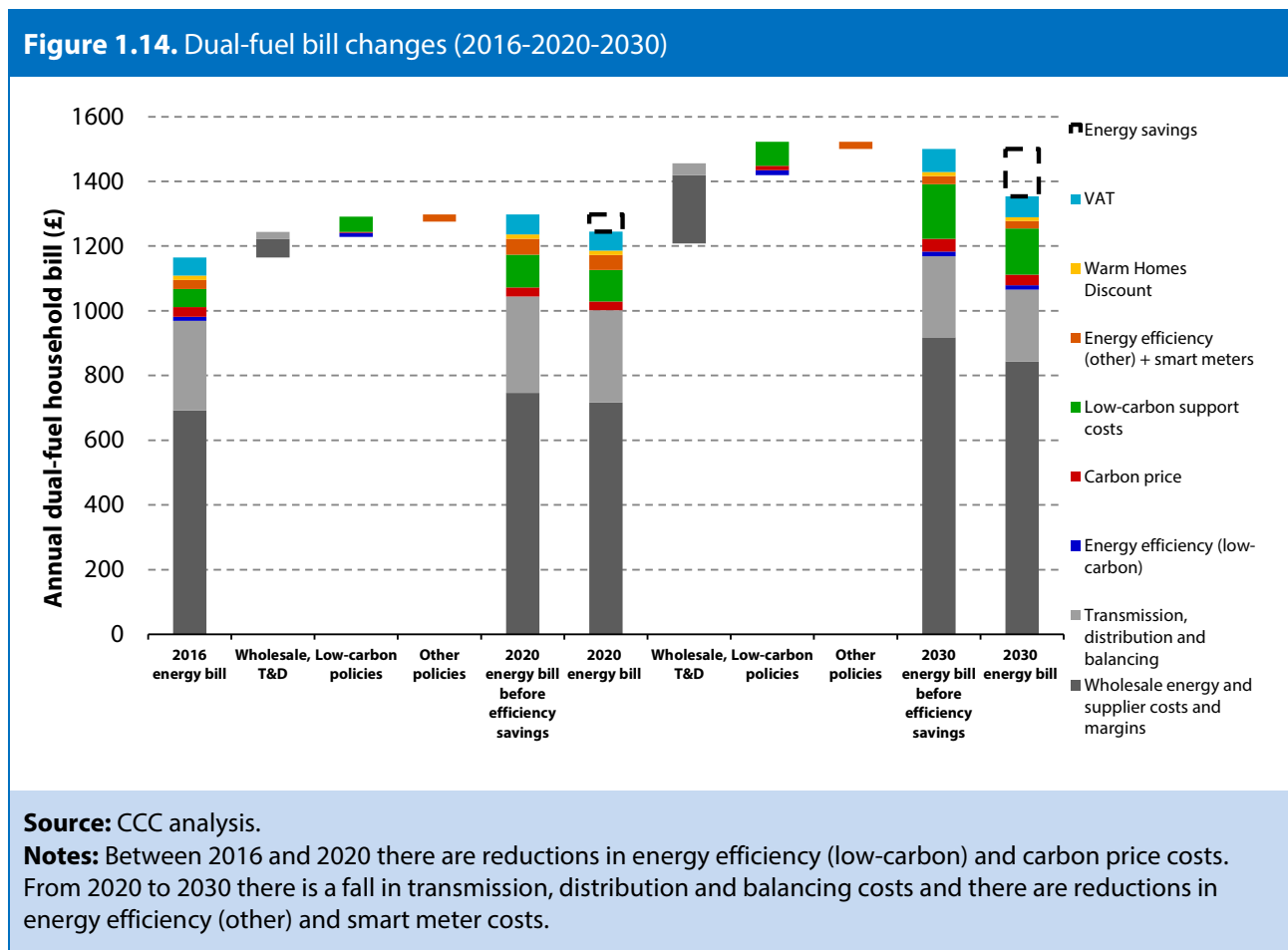
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<sup>19</sup> We use the range of fossil fuel prices published in BEIS (2016) *Fossil Fuel Price Assumptions*. The Central case involves a doubling of gas prices from 29 p/therm in 2016 to 62 p/therm in 2030, with a Low case of 38 p/therm in 2030 and a High of 72 p/therm.



current levels, given the opportunities to continue the historical trend of improving energy efficiency of lights, appliances and homes.

The central case for wholesale gas prices implies a rise in household energy bills of 16% in real terms from 2016 to 2030. However, there are significant uncertainties (see below) and bills could vary considerably with different gas prices or carbon prices. If prices do rise, then the potential saving from energy efficiency improvement would be even larger - £210 on central projections.



### (iii) Changes in household energy prices

Our central estimate is for electricity prices to rise a further 33% between 2016 and 2030, due in roughly equal measure to expected further rises in wholesale and network costs<sup>20</sup>, and climate policy costs. We estimate gas prices will rise a further 30%, almost entirely due to an assumed increase in wholesale energy costs.

In the short-term, our analysis suggests a 5% real-terms increase in a dual-fuel household's energy bill was to be expected between 2016 and 2017, with electricity prices rising by 4% due to increased costs of renewables support schemes, and gas prices rising 6% due to an increase in

<sup>20</sup> Network costs are the costs of the transmission and distribution of electricity, and the distribution of gas to consumers. Where additional network costs are a result of low-carbon policies, we include them as low-carbon support costs in our analysis.

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wholesale energy costs. Five of the big six energy providers have announced price rises this winter— Npower (9.6%), EDF Energy (8.4%), E.On (8.8%), SSE (6.9%) and Scottish Power (7.8%) — suggesting that rises in wholesale costs are having a larger effect, part of which may reflect the deterioration of sterling (increasing the cost of importing gas), as well as supplier-specific pricing and hedging strategies that we are unable to replicate in our analysis.

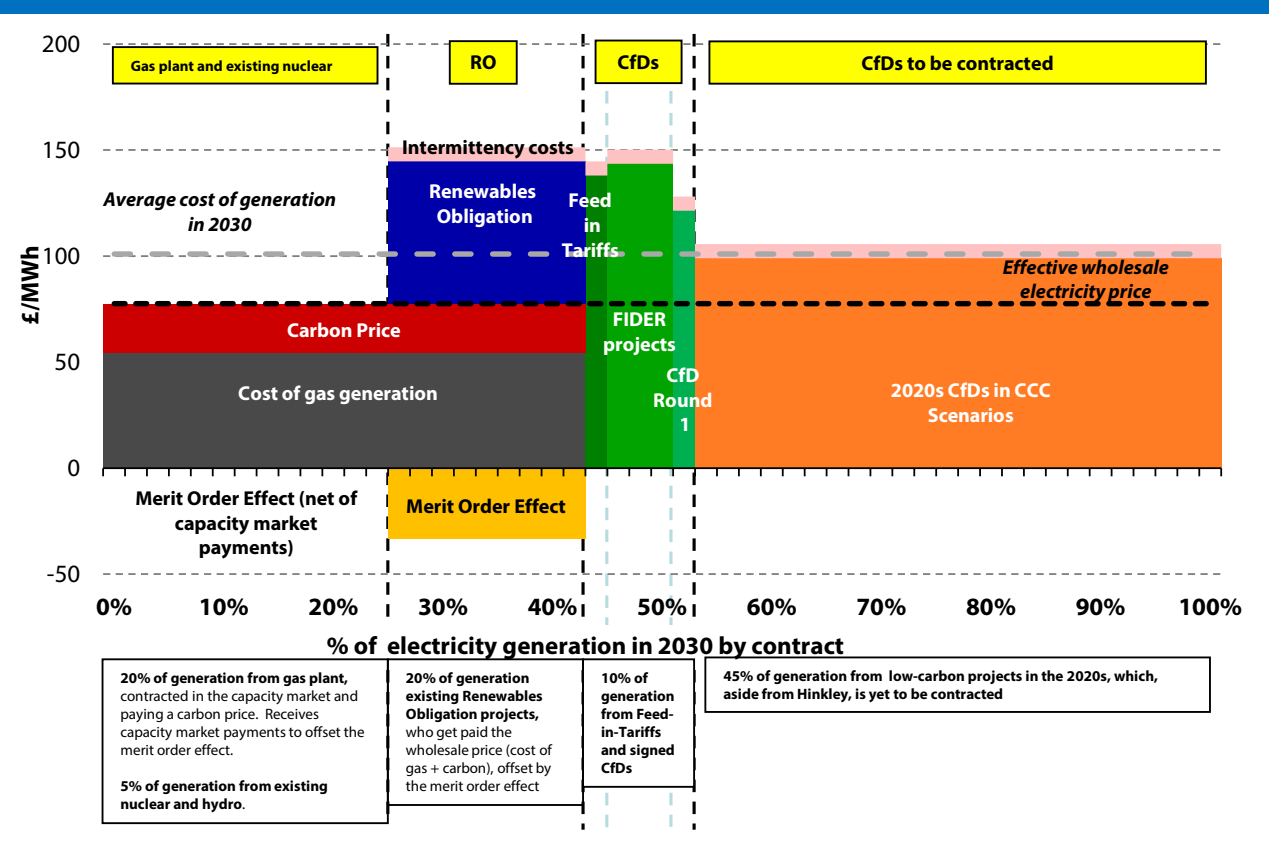
Climate policy costs largely reflect the cost of supporting an increasing share of generation from low-carbon sources. Although these are falling in unit cost, they remain more expensive sources of electricity than burning fossil fuels without bearing the cost of releasing CO<sub>2</sub> (Figure 1.15):

- The Committee’s scenarios for meeting carbon budgets require around 75% of generation to come from low-carbon sources in 2030. Given expected retirements and changing demand, most will need to come from new low-carbon sources.
  - 25% of generation is from current low-carbon sources that are still expected to be available in 2030. These are on average £67/MWh (i.e. 6.7 p/kWh) more expensive than generating electricity from gas and facing no cost for releasing CO<sub>2</sub>. Together these add £40 to an average annual bill.
  - A further 8% of generation has been contracted from low-carbon sources to 2020 at an average premium of £85/MWh.
  - A further 45% is needed during the 2020s, through a combination of renewables, nuclear and carbon capture and storage. These will on average involve a premium of around £43/MWh, including costs relating to grid connection, back-up capacity and managing intermittency.
    - Within this we assume a programme of offshore wind deployment in the 2020s would provide one-third of this generation, at an average premium of £52/MWh.
    - A commercialisation programme for Carbon Capture and Storage (CCS) would involve a premium of £51/MWh and provide around one-sixth of new low-carbon generation in the 2020s.
    - The remaining half of the new low-carbon generation in the 2020s from our Fifth Carbon Budget scenarios would come from mature low-carbon generation options (e.g. onshore wind, solar PV, nuclear power) at a premium of £36/MWh above the cost of gas generation.
- Further price increases are driven by the carbon price, which increases wholesale prices paid to gas generation and renewables receiving RO payments (see Annex for details). We estimate that the carbon price could increase average electricity prices by around £12/MWh in 2030, raising around £2 billion for the Exchequer.
- We estimate the merit-order effect could reduce wholesale prices by £15/MWh by 2030. This would erode the revenues available to gas and nuclear generation, and require compensation in the form of capacity payments; these could offset the overall merit order effect by £9/MWh, such that the net effect could be a reduction in wholesale prices of £6/MWh.
- In combination, these imply that average electricity prices in 2030 will be around £46/MWh higher as a result of these low-carbon policies. That compares to an estimated premium of £16/MWh in 2016 and £28/MWh in 2020.

- 
- Beyond 2030, electricity prices would be expected to fall as support contracts come to an end (e.g. offshore wind contracts that began in 2015 will end in 2030, but the supported projects are expected to continue producing power for 5-10 years). If low-carbon projects were not built in the 2020s, prices would still rise by £11/MWh to 2030 in line with increases in the carbon price (instead of by £18/MWh in the scenario described above). However, instead of then falling prices would continue to rise after 2030.
  - We expect other climate policy costs (energy efficiency policies aimed at reducing CO<sub>2</sub>, upgrades to transmission and distribution networks to accommodate renewable generation, heat pumps and electric vehicles and additional back-up capacity to manage intermittency) would add a further £5/MWh (i.e. 0.5 p/kWh) between 2016 and 2030.

Given the opportunity to reduce electricity demand by 21% to 2.8 MWh per dual-fuel household in 2030 through improved energy efficiency (see section iv), these costs of supporting low-carbon generation would add around £170 per household to the typical annual electricity bill for a dual-fuel household in 2030 (i.e. an increase of £80 from the £90 already paid in 2016).

**Figure 1.15.** Costs of electricity generation in 2030 in the CCC's Fifth Carbon Budget scenarios



**Source:** CCC analysis.

**Notes:** The chart shows the cost of electricity generation in 2030 of the CCC's 'High Renewables' scenario from *The Fifth Carbon Budget*. This includes generation from existing and contracted low-carbon generation under Feed-In-Tariffs, the Renewables Obligation and Contracts-for-Difference that we expect to remain online in 2030, additional low-carbon generation installed in the CCC's scenarios in the 2020s as well as gas generation and existing hydro and nuclear generation that we expect to remain online in 2030. The costs presented in this chart cover the costs of gas generation facing a carbon price (which we use as a proxy for the wholesale price before merit order effect and capacity payments), as well as support costs for low-carbon generation. Additional intermittency costs of £10/MWh for each unit of intermittent low-carbon generation have been added, as well as the additional costs of upgrading the transmission and distribution system to accommodate the low-carbon generation in our scenario. The analysis assumes a gas price of 62p/therm in 2030, and a carbon price of £65/tCO<sub>2</sub>, and presents electricity generation in 2030 in order to meet demand for electricity in our fifth carbon budget scenarios (i.e. pre-losses).

The remainder of the increase in electricity prices in our central estimates is largely due to a rise in wholesale and network costs, as well as small increases in the impact of non-climate policies levied on consumers:

- In our central case, wholesale prices rise by 2.1 p/kWh. Transmission and distribution costs and balancing costs could increase a further 0.5 p/kWh over this period. We assume supplier costs and margins remain at their 2011-15 (five-year) average.

- 
- Non-climate policy costs (energy efficiency policies aimed at addressing fuel poverty, smart meters and VAT) could together add a further 0.2 p/kWh.<sup>21</sup>
  - Overall, these price increases are equivalent to a further £75 per household.

Our central estimate is for gas prices to rise a further 30% between 2016 and 2030; this increase is due almost entirely (25 percentage points) to an assumed rise in wholesale prices. Reduced gas use resulting from energy efficiency policies will increase the costs each unit has to pay towards the gas grid, adding 0.1 p/kWh (2 percentage points). Taken together, low-carbon policies on gas bills are expected to add £25 to a dual-fuel household's gas bill in 2030.

We assume increased roll-out of renewable heat continues to be funded by taxation, e.g. the renewable heat incentive (RHI). The cost to the Exchequer of the RHI is less than the increased revenues paid from energy bills via the rising carbon price. We do not assume any carbon price is applied to residential gas consumption (Box 1.6).

#### **(iv) Changes in energy use**

Improved energy efficiency (in line with our fifth carbon budget central scenario) can significantly dampen the effect of increased energy prices. Projected typical bills for 2030 are 13% lower than they would have been without efficiency improvements (Table 1.1).

- Households purchasing more efficient electrical products (e.g. freezers, TVs, LEDs) as part of regular household decisions accounts for around 61% of the energy efficiency savings included in our analysis between 2016 and 2030. Savings from these sources should be available to most households.
- Boiler replacements also have a significant impact, making up 22% of the typical saving. This reflects larger savings for households that currently have inefficient boilers and high bills (around 40% of households), with smaller savings for households that already use an efficient boiler.
- The remaining 17% is from behaviour change and improvements to homes. The latter will not be available to all households, including some which are currently inefficient, but do not have easy opportunities to improve efficiency (e.g. because they have solid walls). Potential savings will differ across households dependent upon a range of factors including property characteristics (e.g. build form, age, current insulation) and household size and energy use. Illustrative savings from installing energy efficiency measures in two fairly common housing types (with relatively low efficiency before installing energy saving measures) are shown in Table 1.2.

It is very important that an effective policy package is in place to deliver these savings with strong product standards and strengthened energy efficiency policy to encourage insulation uptake. This is likely to require increased funding, which we include in our price estimates, as well as action to incentivise and facilitate the use of cost-effective measures (Box 1.4).

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<sup>21</sup> We treat smart meters as a non-climate policy as they have wider goals than reducing CO<sub>2</sub> and because in the longer term they allow overall reductions in the cost of the energy system whether or not it is decarbonised.

**Table 1.1.** Energy efficiency savings for an average dual-fuel household relative to 2016 bills

Energy efficiency measure	2020	2030
Efficient appliances (e.g. freezers, washing machines, ovens)	£5	£64
Efficient condensing boilers	£20	£46
Lighting (switch to CFLs and LEDs)	£3	£33
New televisions	£13	£31
Behaviour change (e.g. turning off lights, reducing shower flow, turning thermostats down 1 degree)	£5	£16
Net savings from cost-effective thermal measures	£5	£13
Solid wall insulation for fuel poor	£1	£6
<b>Total</b>	<b>£53</b>	<b>£210</b>

**Source:** CCC analysis, based on our central fifth carbon budget scenario.  
**Notes:** Totals may not add to due rounding. Values are in real 2016 prices. The approach to net savings for cost-effective thermal measures is explained in Box 1.4.

**Box 1.4.** Energy efficiency policy cost and savings assumptions

**Energy efficiency costs included in energy prices:**

The Government has stated its intention to reduce the funding available for ECO to £640m from 2017.<sup>22</sup> This will be targeted primarily at tackling fuel poverty, rather than carbon reduction, so we include its cost as a non-climate policy.

- In 2016, delivery costs of the ECO are estimated at £790m,<sup>23</sup> covering a mix of sub-obligations aimed at addressing fuel poverty and sub-obligations aiming to reduce emissions. Funds were split roughly equally between these two goals, so we attribute around half of its effect on bills in 2016 to climate policy.
- From 2017 the funding for ECO is being reduced, to £640m, and will be targeted primarily at the fuel poor. Although this will help cut emissions, it is primarily a social policy, so we attribute its costs to non-climate policy.

<sup>22</sup>2017 prices, BEIS (2016) *Energy Company Obligation (ECO): Help to Heat consultation document*. Available at: [www.gov.uk](http://www.gov.uk).

<sup>23</sup> 2013 prices, DECC (2014) *The Future of the Energy Company Obligation: Final Impact Assessment*. Available at: [www.gov.uk](http://www.gov.uk).



#### Box 1.4. Energy efficiency policy cost and savings assumptions

- £640m per year should be sufficient to cover the full upfront cost of solid wall insulation for fuel poor households.
  - Our Central scenario for our advice on the fifth carbon budget included 1 million installations of solid wall insulation to 2030 that involve a cost higher than the Government’s carbon values, on the basis that these were required under plans to tackle fuel poverty.
  - Our scenario implies an average annual installation rate of 70,000 per year, which at an average cost of around £7,000 would use around three quarters of the allocated funding.
- The remaining quarter of the funding could be used to pay for other efficiency improvements in fuel poor homes, even though many of these would result in bill savings over their lifetimes that are far above their initial installation cost.

Further funding of up to £250m may be needed to cover the costs of efficiency improvements for households that are not fuel poor for measures included in our scenario that do not payback in terms of bill savings (e.g. double glazing, floor insulation). We include this cost, around £10 per household, as a climate policy impact on bills.

#### Energy efficiency savings:

Although many of these efficiency measures still require a policy intervention if they are to be delivered, such policy could be delivered without imposing a cost on bills. For example, standards and labelling could improve efficiency of lights and appliances, while improved insulation could be incentivised through revenue neutral changes that apply at the point of sale or rental, such as through stamp duty, council tax or mortgage affordability calculations.

- A large share of energy savings come from updating boilers, appliances and lights to more efficient versions. We include the full energy savings from these and assume that the purchase cost to households is not significantly greater than it would have been for a less efficient product. We also include the full savings of behaviour change measures which have a negligible financial cost.
- The vast majority of the thermal energy efficiency measures in our scenarios (e.g. insulation) would result in bill savings that more than offset their upfront costs. We include the net savings of these when calculating average 2020 and 2030 energy bills. Net savings are estimated as the annual energy bill savings less the upfront capital cost of installation (spread over the lifetime of the measure and with 3.5% interest).
- We include the full savings of solid wall insulation delivered to fuel-poor homes that we assume is paid for through bills.

Our scenarios also include some measures, such as double glazing, that would not pay back across their lifetimes. These could be installed by households for their amenity value (i.e. improved comfort and reduced noise pollution). However, we assume that their additional cost, which we estimate at £250m per year on average, is recovered through energy bills, so that households are not left worse off when making these changes. We do not include the energy savings of these measures in estimating bills.

We spread the energy savings across households to give an average bill saving.

**Source:** BEIS (2016) *Energy Company Obligation (ECO): Help to Heat consultation document*; DECC (2014) *The Future of the Energy Company Obligation: Final Impact Assessment*. Available at: [www.gov.uk](http://www.gov.uk). CCC (2015) *The Fifth Carbon Budget*. Available at: [www.theccc.org.uk](http://www.theccc.org.uk).

**Table 1.2.** Potential savings for an individual household from their 2030 energy bill: Illustrative case studies with high savings potential

Measure	1950s 3 bed semi-detached home	Victorian 2 bed terraced home
Low energy lighting	£50	£35
Loft insulation	£105	£100
Cavity wall insulation	£115	N/A
New insulated external doors	£10	£20
Solid floor insulation	£45	-
New combi-condensing boiler and thermostatic radiator valves	£115	-
A rated glazing	£70	£90
Solid wall insulation	N/A	£105
<b>Total annual savings</b>	<b>£510</b>	<b>£350</b>
<b>Annual bill after savings</b>	<b>£1,330</b>	<b>£1,050</b>

**Source:** CCC analysis based on the EST Home Energy Check tool, which uses the SAP methodology.

**Notes:** The EST Home Energy Check tool estimates household energy bills and potential savings for specific household characteristics. Our analysis modifies the results from the tool to make them comparable to our bills analysis, since energy prices will be higher in 2030 and we expect household energy consumption to be lower than in the SAP method. In the illustrative case studies we assume the semi-detached home has cavity walls and the terraced home has solid walls and already has floor insulation and an efficient boiler.

## (v) Uncertainties in our projections

In the sections above we have presented our central estimates of the impact of climate policy on energy bills. These estimates reflect a range of underlying assumptions, including fossil fuel prices and carbon prices.

Low-carbon costs provide a hedge to fossil fuel prices (Table 1.3). Where fossil fuel prices are high, the cost of low-carbon policies is low and vice versa. The overall uncertainty for future energy bills is therefore reduced as a result of low-carbon support.

Unlike fossil fuel prices, which affect the energy costs as well as costs of low-carbon support, the impact of carbon prices is more limited. Using BEIS' low and high carbon price projections, we estimate that the costs of low-carbon policy could be £10 lower or £60 higher than our central

projection in 2030. Fiscal revenues would also differ, reaching around £4bn (rather than £2bn) if carbon prices are high.

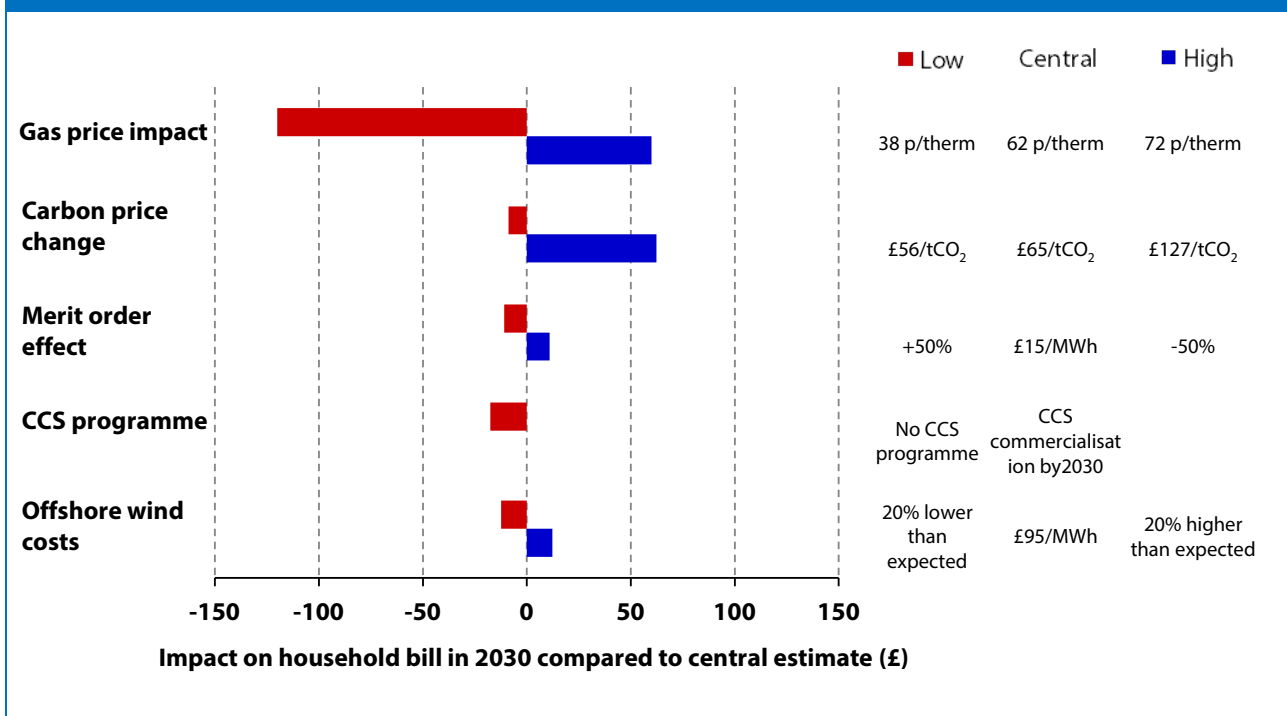
In addition to fossil fuel and carbon prices, a range of other factors could impact on energy bills to a smaller degree (Figure 1.16).

**Table 1.3.** Uncertainty in typical annual dual-fuel household bill estimates by fossil fuel price scenario

<b>2020 bill</b>	<b>Low</b>	<b>Central</b>	<b>High</b>
Bill	£1,180	£1,240	£1,370
Low-carbon policy cost	£130	£130	£125
Low-carbon policy cost as % of bill	11%	10%	9%
<b>2030 bill</b>	<b>Low</b>	<b>Central</b>	<b>High</b>
Bill	£1,220	£1,350	£1,410
Low-carbon policy cost	£225	£200	£190
Low-carbon policy cost as % of bill	18%	15%	13%

**Source:** CCC analysis.  
**Notes:** Assumptions on underlying gas prices in each scenario are taken from BEIS (2016) *Fossil Fuel Price Assumptions*. The impact on domestic retail prices for gas and electricity and the impact on household bills are modelled by the CCC.

**Figure 1.16.** Key drivers of uncertainty in projecting household bills (2030)



**Source:** CCC analysis.

**Notes:** Fossil fuel price assumptions for based on BEIS’s (2016) projections. Carbon price assumptions based on BEIS’s (2015) short-term values for modelling purposes, including the impact of the carbon price floor.

More detail on our assumptions and the price impacts of low-carbon policies are set out in the Annex.

## (d) Bills for households without gas heating

Around 6% of households use electricity as their main heating source and 4% use oil as their main heating source.

### (i) Electrically heated homes

Electric heating systems are found disproportionately in flats, and unlike other off-gas properties electrically heated homes are spread across rural and urban areas.<sup>24</sup> As many electrically heated homes are smaller properties we estimate typical energy bills to be lower than for a typical dual-fuel household.

- We estimate the typical annual bill for an electrically heated household was around £970 in 2016, of which £180 was the result of low-carbon policy costs.<sup>25</sup> This compares to a typical annual bill of £1,160 for a gas-heated household.

<sup>24</sup> Ofgem (2015) *Insights paper on households with electric and other non-gas heating*. Available at: [www.ofgem.gov.uk](http://www.ofgem.gov.uk)

<sup>25</sup> The estimate is based on annual consumption of 7,200 kWh per year, which is Ofgem’s high consumption for Profile 2 (multi-rate) electricity users in their Typical Domestic Consumption Values (TDCVs). We use the high consumption value which represents the upper quartile, as a conservative assumption and on the basis that the mean consumption is likely to exceed the median consumption (used for Ofgem’s medium TDCV). This energy

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- Low-carbon policy costs made up around 18% of bills for electrically heated homes in 2016 compared to 9% for a dual-fuel home.

Under our central assumptions, the bill for a typical electrically heated home is projected to rise to £1,090 by 2030, of which low-carbon policy costs make up £330 (30%). As for the electricity bill for dual-fuel households, the increase in bills is driven by increasing wholesale costs and low-carbon policy.

Low-carbon policy costs are applied more heavily to electricity meaning those that use electricity for heating as well as lighting and appliances are paying a greater share of their energy bill for low-carbon policy (Table 1.4). Low-carbon policy makes up a higher share of Economy 7 bills than a standard electricity tariff, since Economy 7 tariffs provide a discount on the wholesale cost of electricity, reducing bills overall. The higher impact of low-carbon policy costs on electricity bills reflects the current choice of policy (Box 1.5).

Energy efficiency opportunities are estimated to make bills for a typical electrically heated household around £230 (18%) lower than they otherwise would be in 2030. This is a proportionately larger saving than for dual-fuel households. A large share of efficiency savings come through the cost-effective insulation of solid walls included in our scenario for off-gas grid homes. Since lighting and appliance use make up a larger share of total consumption in electrically heated-homes and most lighting and appliance use occurs at peak time (when a higher price is paid compared to in dual-fuel households) appliance and lighting savings are also proportionately larger.

Given the higher impact of low-carbon policies on electrically-heated households, it will be important for the Government to consider mitigating policies for this group, particularly where they are vulnerable in other ways (e.g. low income groups and the fuel poor). That should include support for improving energy efficiency and shifting to low-carbon heating systems (e.g. heat pumps) – see Box 1.5. Other low-carbon technologies such as solar PV also present an opportunity for electrically heated homes to reduce their energy bills (Box 1.6).

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demand assumption implies electrically heated households use less than half the energy of our typical dual-fuel household. Even using this higher estimate, the total energy used by all electrically-heated households is considerably less than the total amount of electricity attributed to residential heating and hot water (11 TWh compared to 26 TWh). We spread the remaining demand over dual-fuel households, resulting in our mean consumption estimate of 3,550 kWh and implying that around 650 kWh of electricity is used for stand-alone electric heaters and hot water in dual-fuel households in addition to the 2,900 kWh attributed to lights and appliances.

**Table 1.4.** Low-carbon policy costs as a percentage of bill for different types of tariff

	2016	2020	2030
Electrically heated bill (Economy 7 tariff)	18%	23%	30%
Standard electricity tariff	17%	20%	28%
Dual fuel total bill	9%	10%	15%
Oil heated total bill	8%	9%	10%

**Source:** CCC analysis.

### Box 1.5. Low-carbon policy cost

The impact of carbon budgets on household bills reflects the cost of measures to reduce emissions and the choice of policy instrument to drive those measures.

- Low-carbon heat is currently paid for through taxation whereas low-carbon power is paid for through energy bills. The imbalance of low-carbon policy costs on electricity and lack of a carbon price on gas means that costs fall more heavily on electrically heated households and more subsidy is required to compensate consumers switching from gas to heat pumps.
- Households pay additional costs for low-carbon policies, as heavy industry is exempted from some policy costs.
- ECO adds to bills largely to support building efficiency, whereas appliance and lighting efficiency is mainly delivered through regulation.
- The carbon price increases bills and indirectly supports low-carbon power, while bringing revenue to the Exchequer.

We have assumed that the current policy choices broadly persist, but it is an option for Government seeking to shift bills impacts to change that balance.

We assume that low-carbon heat continues to be funded by taxation, e.g. the renewable heat incentive (RHI). The cost to the Exchequer of the RHI (£330m in 2015/16) is less than revenues paid to the Exchequer through the carbon price that is levied on electricity use (£2.3bn in 2015). The government has confirmed RHI funding of £1.15bn to 2020/21 and in our 2016 report *Next steps for UK heat policy* we estimated funding of at least £1.3bn was required by 2025 (and more if barriers to uptake are not fully addressed). We do not assume any carbon price is applied to residential gas consumption, though we estimate carbon price revenues to the Exchequer in 2025 of over £2bn. This is higher than payments under the RHI, and compensation paid to industry (around £2bn in total).

**Source:** Ofgem (2016) *Domestic & Non-Domestic Renewable Heat Incentive Annual reports*. Available at: [www.ofgem.gov.uk](http://www.ofgem.gov.uk); BEIS (2016) *The Renewable Heat Incentive: A reformed and refocused scheme*. Available at: [www.gov.uk](http://www.gov.uk); CCC (2016) *Next Steps on UK heat policy*. Available at: [www.gov.uk](http://www.gov.uk); CCC analysis.



## Box 1.6. Impact on household energy bills of installing low-carbon technology

### Heat pumps

Our fifth carbon budget analysis included installation of up to 2.5 million heat pumps in UK households by 2030, mostly off the gas grid and in new homes. Households installing heat pumps would see an increase in their electricity bills, which would need to be offset by a reduction in heating bills in order to be cost-effective. In our 2016 *Next steps for UK heat policy* report we estimated that heat pumps would be cost-effective for electrically-heated and oil-heated households, as well as new build houses by the mid-2020s. Heat pumps today cost around £5,700 for an air-source heat pump and £15,600 for a ground-source heat pump, and receive payments from the Government of between 8-19p/kWh for each unit of heat produced (for air-source and ground-source heat pumps respectively).

### Solar PV

Households with solar PV panels in the UK will face lower electricity bills, due to self-production of electricity. There are 900,000 small-scale solar PV installations in the UK (capacity of 4.8 GW), the majority of which are households who have installed solar panels under the Government's Feed-in-Tariff scheme. Our estimates suggest that households with a 4kW solar panel could meet around 50% of their annual electricity demand through self-generation, reducing electricity bills by around £300, as well as receiving export payments at times when their panels generate but the energy is not consumed in the home. If these households also install a battery storage system, we estimate they could meet around 60-80% of their electricity demand through self-generation, but would still rely on the electricity grid during winter periods. Government incentives continue to exist for households to install solar PV (which have an estimated installation cost of around £7,800 in 2015/16, for a 4kW panel), with Feed-in-Tariffs currently offering around 4p/kWh per unit of generation as well as 5p/kWh for each unit of exported electricity.

**Source:** CCC (2016) *Next steps for UK heat policy*. Available at: [www.theccc.org.uk](http://www.theccc.org.uk); BEIS (2016) *Solar PV Cost data*. Available at: [www.gov.uk](http://www.gov.uk); CCC analysis. Average installed heat pump costs based on BSRIA (2016) *UK Heat pumps, Report 59122/11*.

### (ii) Oil heated homes

An oil heated household with the same heating demand and electricity use as our typical dual-fuel household would have had a total bill of £1,180 in 2016, slightly higher than a gas-heated house. Until recently, energy bills for homes using oil heating were significantly higher than equivalent gas homes, but the price of domestic heating oil has almost halved in the period from 2010 to 2016 while the gas price has risen slightly. Under central assumptions on oil prices, the typical energy bill for an oil heated home would rise to £1,370 by 2020 and £1,650 by 2030, £300 higher than for typical dual-fuel households by 2030. There is a high level of uncertainty around future oil bills. The typical oil heated bill in 2030 could range between £1,380 and £2,060.

Energy saving opportunities are estimated to save households £170 off their energy bills in 2030 (on central projections), making them 9% lower than they otherwise would have been. This is a lower saving than for gas-heated households as we have not taken account of improvements in oil boiler efficiency that will be occurring. Savings come through appliance and lighting efficiency, behavioural changes and thermal insulation measures (e.g. solid wall insulation can be cost-effective if oil prices are high). Households installing low-carbon heat systems (e.g. heat pumps), would also cut bills in many cases, but are not included in our bill estimates.

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Oil heated households pay low-carbon policy costs on their electricity consumption for appliance and lighting use, but none is levied on oil, so oil households have the lowest share of low-carbon policy costs in their bills (Table 1.4).

### **(e) Energy bills in England, Scotland, Wales and Northern Ireland**

The majority of households in England (86%), Scotland (78%) and Wales (79%) use gas heating.

There is a higher share of electrically heated homes in Scotland (13%) than England (8%) and Wales (5%). Low-carbon costs represent a larger share of energy bills for electrically heated households, as most low-carbon policy costs are passed through electricity bills rather than gas bills.

The majority of households in Northern Ireland (68%) using heating oil face the lowest share of low-carbon costs on their bills, but a high degree of price uncertainty.

There are also variations in the prices faced for a given fuel and the average energy consumption of households across nations which make average bills higher in some devolved nations.

#### **(i) Variations in household energy prices**

Electricity prices vary across nations and have tended to be highest in the North of Scotland and Northern Ireland.<sup>26</sup>

- In Scotland standard electricity prices have been on average 5% higher and Economy 7 prices 9% higher than in England and Wales from 2004 to 2015. Prices have been higher in the North of Scotland in particular, which can partly be attributed to rurality and also to low levels (and less choice) of switching tariffs or suppliers.<sup>27</sup> For example, in 2015 the daytime price on Economy 7 was 18p/kWh against the UK average of 17p/kWh and the night price was 10p/kWh rather than 7p/kWh.
- In Northern Ireland standard electricity prices have been on average 14% higher and Economy 7 prices 6% higher than in England and Wales from 2005 to 2015.
- There has been less variation in gas prices across nations, with prices in Scotland averaging 1% lower than England and Wales from 2004 to 2014.<sup>28</sup>
- The price of domestic heating oil also varies across nations. Over the past year, prices in Northern Ireland (where there is highest usage) have tended to be below prices in England, Scotland and Wales.<sup>29</sup>

#### **(ii) Variations in energy consumption**

Sub national consumption data shows some wide variation in average consumption patterns across nations.<sup>30</sup>

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<sup>26</sup> BEIS (September 2016) *Quarterly Energy Prices*. Available at: [www.gov.uk](http://www.gov.uk).

<sup>27</sup> Ofgem (2015) *Insights paper on households with electric and other non-gas heating*. Available at: [www.gov.uk](http://www.gov.uk).

<sup>28</sup> Data is not available for the relatively small number of gas households in Northern Ireland.

<sup>29</sup> <https://www.boilerjuice.com>.

<sup>30</sup> BEIS (2016) *Sub-national consumption statistics for 2014*. We have used the mean household consumption data for 2014 from this source to estimate bills across nations. The mean annual gas consumption for metered households in Great Britain from this source is 13,246 kWh compared to our assumption of 13,500 kWh for a typical dual-fuel

- Despite having more efficient homes on average, gas consumption per metered household is higher in Scotland (13,870 kWh) than England (13,230 kWh) or Wales (12,500 kWh). This reflects colder outdoor temperatures and puts greater bill pressure on Scottish households.
- Average annual electricity consumption by households on standard tariffs (such as dual-fuel households) is highest in England (3,700 kWh) and lowest in Wales (3,510 kWh).
- There is a wide variation in the regional average annual electricity consumption for households on Economy 7 tariffs, with consumption the highest in Northern Ireland (8,100 kWh), followed by Wales (6,540 kWh) compared to 5,280 kWh in England. These differences might be partly due to the variety of homes that use electric heating in different nations.

### **(iii) Bill impacts**

Average bills vary, reflecting these differences in prices and consumption.<sup>31</sup>

- Average gas bills are higher in Scotland than other UK nations, due to higher consumption. However, there is regional variation and average gas bills in London exceed those in Scotland due to higher prices.
- The average bills for electricity consumption on a standard tariff are highest in the North of Scotland and South West of England.
- Average bills for electricity consumption on an Economy 7 tariff are higher in Scotland, Wales and Northern Ireland than in England, with the highest bills in the North of Scotland (due to high prices) and Northern Ireland (due to high consumption).

Bills in the North of Scotland are estimated to be some of the highest irrespective of fuel type.

## **(f) Fuel poverty**

The Climate Change Act requires us to consider the impact of carbon budgets on fuel poverty. Given that high energy prices are a key driver of fuel poverty, any policy that increases energy bills (without compensating measures) will have a negative impact on fuel poverty. However, low-carbon policies, such as improving energy efficiency, also have significant opportunities to reduce household bills and fuel poverty.

### **(i) Who are the fuel-poor?**

A household is considered to be fuel poor if they cannot afford to keep their home adequately warm at a reasonable cost, given their income. The exact definition of fuel poverty, which is a devolved matter, varies between England and the devolved administrations:

- England uses the Low Income High Cost (LIHC) definition. Households are considered to be fuel poor if they have required fuel costs above the national median and their income after

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household. The mean annual electricity consumption from this source is 3,954 kWh for standard meter consumers in Great Britain, compared to our assumption of 3,550 kWh.

<sup>31</sup> Bill estimates are based on average consumption for each fuel for England, Scotland, Wales and Northern Ireland (using sub-national consumption statistics for 2014) and fixed and variable charges for more specific regions for prices (using BEIS (September 2016) *Quarterly Energy Prices* for Q1-3 2016). The average consumption for a nation may not be fully reflective of the average consumption in specific regions.

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energy costs is below the official poverty line. In practice, this means that people living in efficient homes but with low income are unlikely to be considered fuel poor and neither are those with high fuel bills and high incomes.

- Scotland, Wales and Northern Ireland use the '10% definition'. A household is considered to be fuel poor if 10% or more of household income is required to be spent on fuel to maintain adequate warmth. Estimated levels of fuel poverty are higher under this definition and are significantly affected by energy prices.

The main factors in determining fuel poverty are: household energy requirements, energy prices and household income. The latest statistics for England show that 2.4 million or 10.6% of English households were fuel poor in 2014. The statistics imply that households off the gas grid are particularly vulnerable and that measures to improve home efficiency could greatly reduce fuel poverty.<sup>32</sup>

- Larger and older homes are associated with higher rates of fuel poverty.
- Households that use fuels other than gas for their central heating are more likely to be fuel poor (21% of households using solid fuel are fuel poor, 17% of oil heated households and 16% of electrically heated households compared to 10% of gas heated households). Households without any central heating are also more likely to be fuel poor.
- Households with no boiler or a non-condensing boiler have higher levels of fuel poverty compared to those with condensing boilers.
- Home efficiency is also a significant factor. Households with solid walls, or uninsulated lofts/cavity walls are more likely to be fuel poor.
- Fuel poverty rates are over 20% for properties with SAP ratings E-G (the least efficient) compared to just 2% for properties rated A-C (the most efficient).

In December 2014, the Government introduced a new statutory fuel poverty target for England. The target is to ensure that as many fuel poor homes as reasonably practicable achieve a minimum energy efficiency rating of a Band C, by 2030. There are also interim milestones to lift as many fuel poor homes in England as is reasonably practicable to Band E by 2020; and Band D by 2025.

Fuel poverty rates, targets and policies in the devolved administrations are discussed in section (iii).

## **(ii) Outlook for fuel poverty under carbon budgets**

As discussed above, bill increases in recent years have primarily been due to factors un-related to low-carbon policy. However, it is important to understand how low-carbon policy costs that are passed onto energy bills could affect fuel poverty in the future.

Analysis conducted for us by the Centre for Sustainable Energy (CSE) in 2014 assessed the potential impact of low-carbon policy on fuel poverty across the UK to 2030. This analysis used both fuel poverty definitions.<sup>33</sup>

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<sup>32</sup> DECC (2016) *Fuel Poverty Statistics*. Available at: [www.gov.uk](http://www.gov.uk).

<sup>33</sup> CSE (2014) *Research on fuel poverty: The implications of meeting the fourth carbon budget*. Available at: [www.theccc.org.uk](http://www.theccc.org.uk).

- In an illustrative scenario with costs passed onto energy bills, but no efficiency improvements, there was a predicted increase in fuel poverty from 2.9 million in 2013 to 3.1 million in 2030 under the LIHC definition and 5.6 million to 8 million under the 10% definition. The average fuel poverty gap (the amount needed to meet the fuel poverty threshold) was estimated to increase from £640 to £870 under the LIHC definition. Households particularly affected would be those with electric heating (many of which live in urban flats or rural areas) and those who are high energy users.
- In a case where insulation and low-carbon heat measures included in our scenarios are targeted towards LIHC fuel poor homes in each year of the scenario, fuel poverty levels (on the LIHC definition) are estimated to be significantly reduced:
  - Some 2.1 million (74%) of the 2.9 million fuel poor in 2013 would be lifted out of fuel poverty by 2030.
  - Around one quarter (26%) of the 2013 fuel poor would still be in fuel poverty in 2030.
  - Around 0.4 million households move from being non-fuel poor in 2013 to being in fuel poverty in 2030.

Successful targeting of measures is not easy (e.g. due to data availability, people moving in and out of fuel poverty, and households not always being willing or able to respond to offers), but could greatly help least-cost achievement of fuel poverty and carbon reduction targets:

- The Committee on Fuel Poverty have highlighted deficiencies in the targeting and level of current support, along with other challenges in meeting the fuel poverty milestones and target (Box 1.7).
- The Government consulted in February 2016 on proposals to increase data sharing, one aim of which would be to better enable local authorities and energy suppliers to identify fuel-poor households under such schemes.

The main policy currently in place to deliver efficiency improvements to fuel poor households (as well as other households) in Great Britain is the Energy Company Obligation (ECO). The Government has announced its intention to focus this more on fuel poverty in the future and has set out plans for the transitional period to September 2018. ECO funding has been reduced in recent years to £0.6bn for Great Britain which we expect to be inadequate to cover the energy efficiency improvements needed to move English fuel-poor households to a Band C by 2030. Our research suggests at least £1.2bn annual capital costs would be needed to meet this target.<sup>34</sup>

The prevalence of fuel poverty is high in the private rented sector. Private rented sector regulations require that from April 2018, landlords in England and Wales will need to ensure that their properties reach an EPC rating of at least E, or have installed those improvements that could be funded using available Green Deal finance or subsidies available to pay for them, before granting a tenancy to new or existing tenants. Given the Government is no longer funding the Green Deal, there have been calls to tighten these regulations to ensure improvements are made.

Devolved administrations have further fuel poverty policies (section (iii)).

<sup>34</sup> CSE for the CCC (2014) *Meeting the proposed fuel poverty targets: Modelling the implications of the proposed fuel poverty targets using the National Household Model*. Available at: [www.theccc.org.uk](http://www.theccc.org.uk).

### Box 1.7. Committee on Fuel Poverty findings

The Committee on Fuel Poverty set out its initial positions on Government's progress in meeting its fuel poverty milestones and target for England in its first report. This makes a number of observations and recommendations:

- There is a high risk that the 2020 milestone will be missed and even if there is no time slippage the work will be very back-loaded into 2018 and 2019.
- There are significant shortfalls in funding to meet the 2020 and 2025 milestones and 2030 household energy efficiency target. Further funding needs to be secured and existing funding should be used more effectively by improved targeting.
- The targeting of ECO, Warm Home Discount (WHD) and other support measures should be improved. For example, the WHD is focused on pensioners while this category makes up a small proportion of the current fuel poor under the LIHC definition. ECO should deliver energy efficiency improvements to fuel poor homes as its main objective and do so in the most cost effective way.
- Since knowing the addresses of those in fuel poverty is critical for targeting, high priority should be given to ensure that appropriate data sharing legislation is introduced.
- Government should continue to prioritise assistance to the most severely fuel poor and fuel poor households should receive help with bills while they await installation of energy efficiency measures.
- Regulations should be implemented to require private landlords to upgrade their properties to a Band E, up to a cap of £5,000 per property supplemented by ECO. A tax allowance on energy saving expenditure by landlords could be re-introduced.
- Tackling fuel poverty should be part of the devolved agenda and local authorities should be empowered to champion community-based energy efficiency initiatives.

**Source:** Committee on Fuel Poverty (2016) *Committee on Fuel Poverty: A report on initial positions*. Available at: [www.gov.uk](http://www.gov.uk).



### (iii) Fuel poverty in Scotland, Wales and Northern Ireland

Fuel poverty is a devolved matter and as set out in section (i) a different definition is used in England to Scotland, Wales and Northern Ireland. Fuel poverty rates are high in all devolved administrations (Table 1.5).

**Table 1.5.** Estimated fuel poverty rates across the UK

Country (year of data)	Low income high cost definition		10% definition	
	Number of fuel poor households	Proportion of households that are fuel poor	Number of fuel poor households	Proportion of households that are fuel poor
England (2014)	2,379,000	10.6%		
Scotland (2015)			748,000	31%
Wales (2016)			291,000	23%
Northern Ireland (2011)			294,000	42%

**Source:** England: BEIS (2016) *Fuel Poverty Detailed Tables 2014 data*, Scotland: Scottish Government (2015), *Scottish House Condition Survey: 2015 Key Findings*, Northern Ireland: BEIS (2016) *Annual Fuel Poverty Statistics Report*, Wales: Available at: [www.gov.wales](http://www.gov.wales).

**Notes:** LIHC is the official fuel poverty definition in England. For rough comparison purposes, BEIS estimate around 11.6% of English households would be fuel poor under a proxy estimate of the 10% definition. The 10% definition of fuel poverty is not measured the same way in all devolved administrations.

### Scotland

In Scotland a household is in fuel poverty if, in order to maintain a satisfactory heating regime<sup>35</sup>, it would be required to spend more than 10% of its income on all household fuel use. In 2015 31% (748,000) of households were fuel poor. Scotland had a target of eradicating fuel poverty as far as practically possible by November 2016.

Fuel poverty levels were the lowest in 2015 that they have been since 2008. In 2015 fuel poverty declined by about 4 percentage points, equivalent to around 97,000 fewer households living in fuel poverty compared to 2014. The Scottish Government estimate that just over half (2.3 percentage points) of the reduction in fuel poverty rates between 2014 and 2015 can be attributed to the drop in the price of domestic fuels over this period. Around a third (1.3 points)

<sup>35</sup> A satisfactory heating regime is defined as follows: For "vulnerable" households, 23°C in the living room (zone 1) and 18°C in other rooms (zone 2), for 16 hours in every 24. For other households, this is 21°C in the living room (zone 1) and 18°C in other rooms (zone 2) for 9 hours a day during the week and 16 hours a day during the weekend.

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can be attributed to improvements in the energy efficiency performance of the housing stock and the rest (0.6 points) can be explained by higher household incomes.<sup>36</sup>

Households using oil as the primary heating fuel have seen most improvement in fuel poverty levels in 2015, in large part due to the falling price of oil. Just over a quarter of them are now assessed as fuel poor (26%, down from 49% in 2014), which is comparable to the level of fuel poverty among those using mains gas (27%).

Rural fuel poverty is a particular problem in Scotland, with over half of rural and remote households living in fuel poverty. This reflects a combination of factors, including lower gas connection rates, colder temperatures and greater weather exposure, higher electricity prices and a lack of response from consumers in switching suppliers. An action plan has been developed by the Scottish Rural Fuel Poverty Task Force to tackle this issue.<sup>37</sup>

In addition to ECO, energy efficiency improvements have been delivered under Scotland's Home Energy Efficiency Programmes (HEEPs). Under HEEP's the Warmer Homes Scotland Scheme delivers heating and energy efficiency improvements to eligible households. EST estimate those who have qualified for the scheme have saved an average of £350 per year on their energy bills.<sup>38</sup> HEEP's also provide energy efficiency measures through local authorities in area-based schemes mainly installing solid wall insulation in areas with high levels of fuel poverty.

Going forward, Scotland's Energy Efficiency Programme (SEEP) will help local authorities to pilot new and innovative approaches to energy efficiency with community groups and businesses, helping reduce costs and improving energy efficiency across the economy. More than half a billion pounds are committed to SEEP over the next four years, part of a programme to run for 15 to 20 years.

## **Wales**

The Welsh Government has a target to ensure that, as far as is reasonably practicable, no household in Wales will be living in fuel poverty by 2018. Latest estimates suggest that around 23% of Welsh households remain fuel poor in 2016, compared to 26% in 2008 when the last housing survey was undertaken.

The Welsh Government has supplemented ECO with its own schemes to reduce fuel poverty, as well as the Welsh Housing Quality Standard to improve the minimum energy performance in social housing. The Nest scheme, running from 2011 to 2017 in Wales, has £120 million of funding to improve the energy efficiency of low income households and provides energy advice and support for any householder in Wales (the Welsh Government has consulted on a successor to Nest). Nest has been complemented by Arbed, an area-based scheme that funded the installation of energy efficiency measures being delivered in deprived communities across Wales by local authorities.

The Welsh Government are currently considering the future of a national energy efficiency scheme that provides fully funded improvement measures to low income households. The key objective of this scheme will be to reach the low income households that are more vulnerable than others to living in a cold home, both in terms of their likelihood of living in a cold home and

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<sup>36</sup> Scottish Government (2016) *Scottish House Condition Survey 2015 key findings*. Available at: [www.gov.scot](http://www.gov.scot).

<sup>37</sup> Scottish Government (2016) *An action plan to deliver affordable warmth in rural Scotland*. Available at: [www.gov.scot](http://www.gov.scot).

<sup>38</sup> EST (2017) *HEEPS: Warmer Homes Scotland Scheme*. Available at: [www.energysavingtrust.org.uk](http://www.energysavingtrust.org.uk).

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their susceptibility to the harmful effects. Research by CSE suggests a combination of options are considered by the Welsh Government for improving targeting of support, including using means tested benefits and a pre-approved third party referral system.<sup>39</sup>

### **Northern Ireland**

The latest data available for Northern Ireland is for 2011 and suggests 42% of households (294,000) were fuel poor. A fuel poverty strategy was released at that time including a number of schemes to improve energy efficiency and achieve affordable energy. Fuel poverty rates in Northern Ireland have tended to exceed the rest of the UK, due to high fuel prices and relatively lower incomes.

Fuel poverty rates in Northern Ireland are particularly sensitive to crude oil prices, with the majority of households reliant on heating oil. Heating oil prices were near their peak in 2011 and have fallen since.<sup>40</sup> Councils have introduced some bespoke approaches to help oil households given that a lower price on heating oil can be gained by buying in larger volumes. This includes oil saving stamps which encourage households to budget and save to buy less frequently and there are also some community bulk buying oil clubs.

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<sup>39</sup> CSE (2016) *Understanding the Characteristics of Low Income Households Most at Risk from Living in Cold Homes*. Available at: [www.cse.org.uk](http://www.cse.org.uk).

<sup>40</sup> For context, 34% of households were fuel poor in 2006 when heating oil prices were more comparable to today. Standard grade burning oil in the UK cost 30.5p/litre in 2016 compared to 33.7p/litre on average in 2006, while the average for 2011 was 58.2p/litre (all in current prices). Sources: BEIS (2016) *Quarterly Energy Prices*, Table 4.1.2. Available at: [www.gov.uk](http://www.gov.uk). Department for Communities (2011) *Warmer Healthier Homes - a new Fuel Poverty Strategy for Northern Ireland*. Available at: [www.communities-ni.gov.uk](http://www.communities-ni.gov.uk).



# Chapter 2: Business energy prices and bills



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This chapter focuses on the energy prices faced by businesses in the UK, from small commercial retail enterprises (such as local retail shops) through to large energy-intensive manufacturing businesses (such as blast furnace steelworks). The analysis in this chapter is also relevant to public sector organisations such as hospitals and schools, which face similar energy prices to businesses.

Businesses pay different energy prices depending on their size (e.g. bigger energy users can typically negotiate better prices) and the fuel type they consume. They also face different impacts from low-carbon policies depending on how they are covered by specific policies (e.g. the Climate Change Levy and the EU Emission Trading System) and whether they receive any exemptions or compensations for costs resulting from low-carbon policies.

For most businesses energy bills are a low proportion of their costs: they sell their goods and services within the UK and compete with other UK businesses that are subject to the same energy prices and so can pass through this cost to the consumer without any significant loss in sales. However, some products (e.g. steel) are very energy-intensive to make and so energy bills are a major cost to firms that produce them, they sell their product in price-competitive international markets and so may find it more difficult to pass on rising costs and maintain market share. Businesses that produce goods that are energy and trade-intensive are more sensitive to other countries' energy prices and energy policy, which can have an influence on investment decisions and even whether businesses continue operating.

The chapter presents analysis of energy prices and bills and the impact of low-carbon policy across the commercial and manufacturing sectors, and highlights sectors that are more sensitive to energy prices rises. In order to account for the range of energy costs that businesses face we present electricity prices for five illustrative types of business and gas prices for four illustrative types of business. We then present the impact of low-carbon policies upon these electricity and gas prices and the potential for energy bill savings through energy efficiency improvement. We then consider the impact on prices of consumer products. Most of the analysis is presented based on central assumptions for fossil fuel and carbon prices; the final section considers the impact of different prices.

Our analysis was not able to look at the impact on the most energy-intensive and price sensitive firms in each sector because there is limited published data on energy consumption, prices and government policy costs for individual energy-intensive firms. Nevertheless, we attempt to highlight the impact on businesses that are more energy-intensive than most, recognising that this does not represent the full range of possible energy costs faced by these firms. Sectors that compete with overseas firms are more likely to face competitiveness risks where energy costs are high, which we consider further in chapter 3.



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## Key messages:

- **Current bills.** Energy costs were around 0.9% of operating costs<sup>41</sup> across the commercial sector, 2.0% across manufacturing and 3.8% for more energy-intensive sectors (Table 1).<sup>42</sup> The costs from low-carbon policies were around 0.2% of operating costs for the commercial sector, 0.4% for manufacturing and 0.7% for the more energy-intensive sectors.
- **Change in bills since 2004.** Rising energy prices have increased energy costs as a proportion of operating costs by 0.4% across the commercial sector and 0.8% across manufacturing and 1.4% for the more energy-intensive sectors over 2004-2016. The costs from low-carbon policies increased energy costs as a proportion of operating costs by around 0.1% for the commercial sector, 0.3% for manufacturing and 0.5% for the more energy-intensive sectors. At least some of this energy cost increase will have been averted due to improvements in energy efficiency. The change in energy bills and the proportion of this that is due to low-carbon policies will have varied across different businesses depending on the mix of fuels that they used and the low-carbon policies that affected them.
- **Outlook to 2020 and 2030.** Our central projection suggests that to 2020, low-carbon policy costs could increase to 0.3% of operating costs for the commercial sector, 0.6% for manufacturing and 1.0% for more energy-intensive sectors due to low-carbon policies. To 2030 low-carbon policy costs as a proportion of operating costs could increase to 0.5% for the commercial sector, 1.0% for manufacturing and 1.6% for more energy-intensive sectors. For more energy-intensive sectors current low-carbon policy costs are equivalent to 10% of their gross operating surplus<sup>43</sup>, therefore increases in these costs could potentially have a greater impact on firms if they cannot pass these through to consumers, or if they do not receive compensation and exemptions from Government for these policy costs.
- **Impact on consumer prices.** Energy costs are a relatively small determinant of the final prices of consumer goods and services. We estimate that the costs of meeting carbon budgets will lead to a real-terms increase to 0.5% in commercial sector operating costs and 1.0% in manufacturing costs to 2030. For an average £10 basket of goods and services this could add around 6 pence, although this depends on market structures and competition.
- **Energy efficiency opportunities.** Energy efficiency provides opportunities for offsetting increasing energy prices. We estimate average potential savings of around 16% of annual electricity consumption and 5% of gas consumption for the commercial sector and 10%-15% for energy-intensive manufacturing by 2030. Examples of best practice suggest larger reductions are feasible in many instances.

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<sup>41</sup> For this analysis operating costs are defined as: intermediate purchase of goods & services and employment costs (from ONS Supply and Use Tables).

<sup>42</sup> Energy-intensive industries (EIs) are commonly defined as sectors where energy costs are 10% or more of Gross Value Added (GVA). For this analysis we have included the following sectors as EI: paper, refineries, rubber & plastics, chemicals, basic metals and minerals (cement, lime, glass, ceramics etc.).

<sup>43</sup> We use Gross Operating Surplus as a proxy for a business's profits.



**Table 2.1.** Energy and low-carbon policy costs as a proportion of operating costs (and Gross Value Added) for the commercial, manufacturing and energy-intensive sectors (£2016) (2004-2030)

	Commercial sector (58% of UK GVA)		Manufacturing sector (10% of UK GVA)		Energy-intensive sectors (2% of UK GVA)	
	Energy	Low-carbon policies	Energy	Low-carbon policies	Energy	Low-carbon policies
<b>2004</b>	0.5% (0.6%)	0.1% (0.1%)	1.2% (3.2%)	0.1% (0.2%)	2.4% (8.5%)	0.2% (0.6%)
<b>2016</b>	0.9% (1.1%)	0.2% (0.3%)	2.0% (5.4%)	0.4% (1.1%)	3.8% (14.4%)	0.7% (2.6%)
<b>2020</b>	1.0% (1.2%)	0.3% (0.4%)	2.3% (6.2%)	0.6% (1.6%)	4.2% (16.5%)	1.0% (3.8%)
<b>2030</b>	1.3% (1.7%)	0.5% (0.6%)	3.3% (9.0%)	1.0% (2.7%)	5.9% (25.2%)	1.6% (6.7%)

**Source:** CCC analysis based on BEIS (2016) *Digest of UK Energy Statistics*, BEIS (September 2016) *Quarterly Energy Prices* and ONS (2016) *Input-Output supply and use tables*. Available at: [www.gov.uk](http://www.gov.uk).

**Notes:** All figures are in 2016 price year, use (BEIS) *Digest of UK Energy Statistics* (DUKES) 2015 energy consumption and 2014 operating costs & gross value added (GVA) from ONS *Supply and Use Tables*. Energy prices for 2004 and 2016 are sector averages from (BEIS) *Quarterly Energy Prices* (2016). CCC analysis estimated 2020/2030 prices and low-carbon policy costs (see Annex). Commercial sector covers SIC codes 45-82 & 90-99, manufacturing sector here covers SIC codes 10-32 (excluding coal used for coke manufacturing). Energy-intensive sectors are defined as sectors having energy costs that are greater than 10% GVA and for this analysis included: paper & paper products, refineries, chemicals, rubber & plastics, minerals and basic metals (SIC 17, 19-20, 22-24). This does not include the potential cost or forgone revenue from surrendering EU ETS allowances for energy emissions.

We set out our analysis that underpins these messages in six sections:

- a) Current business energy prices and bills
- b) Changes in energy prices and bills since 2004
- c) Outlook for energy prices to 2020 and 2030
- d) Outlook for energy efficiency potential
- e) Outlook for energy bills and consumer prices
- f) Uncertainty around projections of future carbon and energy prices

## **(a) Current business energy prices and bills**

### **(i) Current business energy use and expenditure**

Commercial and manufacturing sectors use just over half of UK grid-electricity and nearly a third of the UK's natural gas used outside of the power sector; the remainder is used by households

(covered in Chapter 1) or the public sector.<sup>44</sup> Manufacturing sectors also directly use other fossil and bioenergy fuels in their processes or to generate their own electricity.

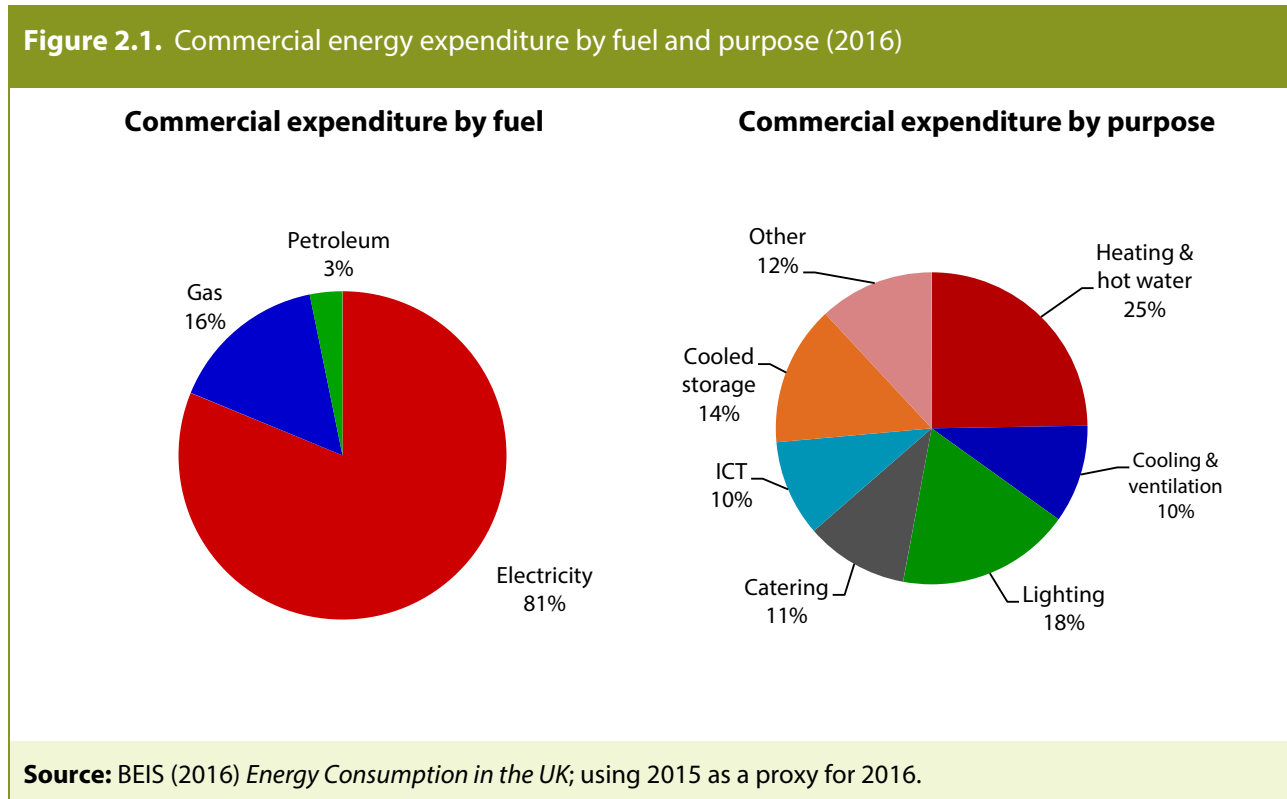
We consider energy costs within the commercial and manufacturing sectors separately.

### Commercial sector

The commercial sector is made up of businesses within the retail, hospitality, leisure and the wider service economy. Energy bills in the commercial sector are a small part of total costs and predominantly cover heating, lighting and cooling (Figure 2.1).

- The sector accounts for 58% of Gross Value Added (GVA)<sup>45</sup>, around 25% of total UK electricity consumption, and 12% of gas used outside of the power sector.
- In 2016, energy bills were on average around 0.9% of operating costs, while costs from low-carbon policies within this contribute around 0.2% of operating costs.
- Energy expenditure in the commercial sector is currently split between electricity (81%), gas (16%), and oil (3%).
- Across the commercial sector, the main energy costs are for heating and hot water (25%), lighting (18%) and cooled storage (14%).

Energy expenditure is determined by both consumption and current energy prices, which we consider in more detail in the following section.



<sup>44</sup> For this analysis manufacturing covers SIC codes 10-32, excluding coke manufacture.

<sup>45</sup> Gross Value Added is commonly used as a measure of contribution to the economy, and includes gross operating surplus, compensation for employees, plus taxes minus subsidies on production.

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## Manufacturing

The manufacturing sector is made up of a wide variety of businesses from the production of food to energy-intensive steel. Businesses within manufacturing are generally large energy users, though there is considerable variation between sub-sectors across the type of energy consumed, and the proportion of operating costs that energy costs represent (Figure 2.2-2.4).

- Manufacturing accounts for 10% of UK GVA, but around 28% of total UK electricity consumption through the grid, 18% of gas and 75% of coal used in the UK (outside of the power sector).
- Energy expenditure in manufacturing is currently split between electricity (76%), gas (16%), oil (3%), coal and manufactured fuels (5%).<sup>46</sup> There is great variation between sector's expenditure split depending on the process used to produce their product. For all sectors electricity consumption represents at least half the energy bill, due to electricity prices being five times the cost of gas prices. This is particularly apparent in sectors like minerals where electricity use is less than a fifth of total energy consumption, but still represents half the energy bill.
- Across the manufacturing sector, the largest energy costs are for motors (24%), low-grade heat (17%) and high-grade heat (14%).<sup>47</sup>
- Energy costs make up around 2% of operating costs and 5.4% of GVA across manufacturing. Costs from low-carbon policies make up around 0.4% of costs and 1.1% of GVA.
- For energy-intensive sectors energy costs on average make up around 3.8% of costs and 14.4% of GVA.<sup>48</sup> Costs from low-carbon policies contribute around 0.7% of costs on average and 2.6% for more energy-intensive sectors.

The Government estimates that around a sixth of manufacturing electricity is consumed by firms where electricity bills are 20% of their GVA, although there is significant variance in energy-intensity and the importance of energy costs both within and between sectors.<sup>49</sup> Annual Business Survey data from the Office of National Statistics estimate that energy costs as a proportion of operating costs can range between 1% and 8%, (Figure 2.4), although for certain products energy costs can be above 20% of operating costs. There is limited published energy consumption data to analyse the low-carbon element of energy costs within this.<sup>50</sup>

A key issue for energy-intensive firms is the extent to which increases in energy costs resulting from low-carbon policies result in reduced competitiveness for UK industries. We consider this in Chapter 3.

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<sup>46</sup> Electricity includes consumption from the national grid and autogeneration. Bioenergy is 5% of industrial energy, but there is limited data on consumption in manufacturing sectors or prices paid, although a proportion of this bioenergy will be included in the autogeneration assumptions used for this analysis.

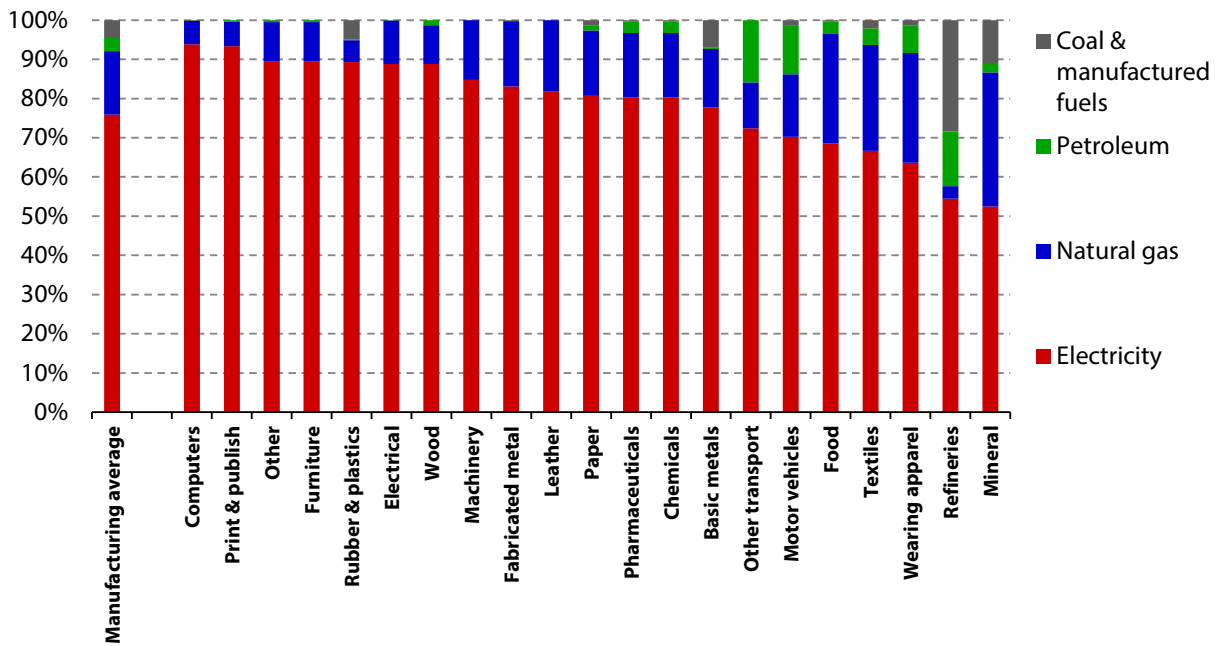
<sup>47</sup> The use of heat in industrial processes depends on its temperature. High-grade heat typically refers to heat at temperatures of 400°C or over, and low-grade heat at temperatures below this.

<sup>48</sup> Energy-intensive industries are defined as sectors where energy costs are 10% or more of Gross Value Added (GVA). For this analysis we have included: paper and paper products, refineries, rubber & plastics, chemicals, basic metals and minerals (cement, lime, glass, ceramics etc.).

<sup>49</sup> BEIS (2016) *Impact assessment for 'Moving from compensation to exemption from the costs of the Renewables Obligation and Feed In Tariff for energy intensive industries'*. Available at: [www.gov.uk](http://www.gov.uk)

<sup>50</sup> ONS (2016) *Annual Business Survey*. Available at: [www.ons.gov.uk](http://www.ons.gov.uk)

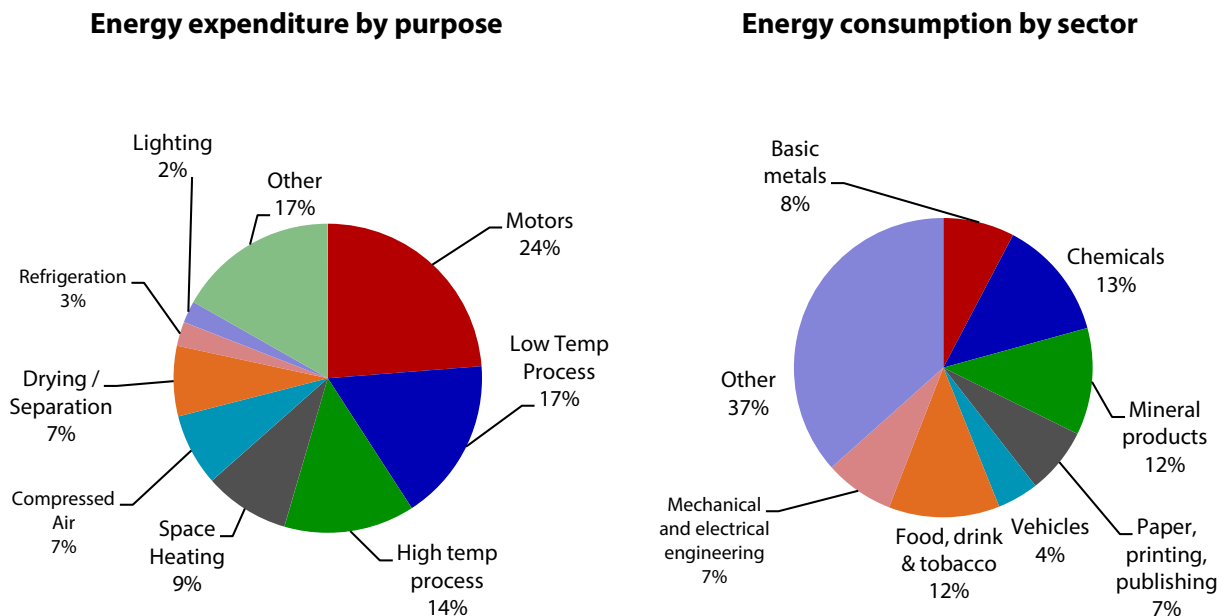
**Figure 2.2.** Manufacturing sector energy expenditure by fuel and by purpose (2016)



**Source:** BEIS (2016) *Energy Consumption in the UK*, using 2015 consumption as a proxy for 2016.

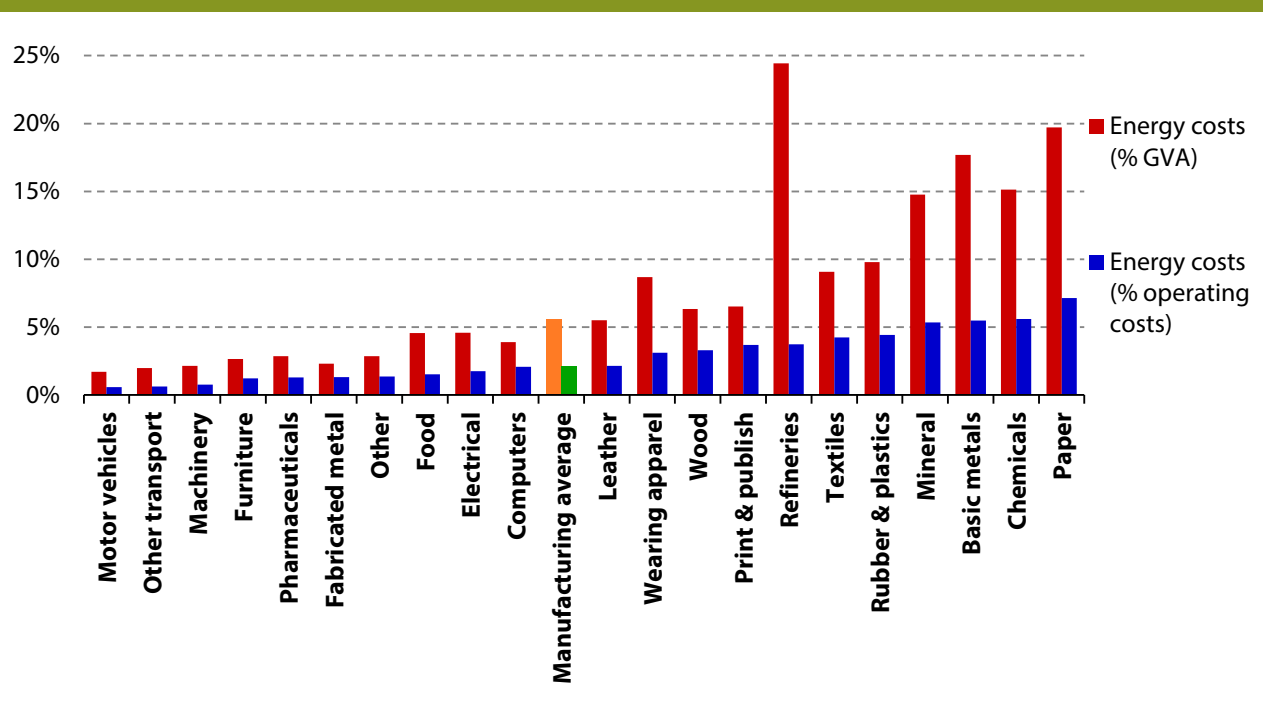
**Notes:** Excluding 5% of energy consumption that is waste/bioenergy due to insufficient price data.

**Figure 2.3.** Manufacturing energy expenditure by purpose and energy consumption by sector (2016)



**Source:** CCC analysis based on BEIS (2016). *Energy Consumption in the UK*. Available at: [www.gov.uk](http://www.gov.uk).

**Figure 2.4.** Energy costs as a % of total costs and GVA by manufacturing sector (2015)



**Source:** CCC analysis based on ONS (2016) *Annual Business Survey*. Available at: [www.ons.gov.uk](http://www.ons.gov.uk).

**Notes:** There is great variation on energy-intensity and importance of energy costs. ONS Annual Business Survey data suggests that for certain products energy costs can be 20% or more of operating costs.

## (ii) Current business energy prices

Given the variety and complexity of businesses, and range of energy prices and policy costs that businesses face (due to their consumption levels, and trade intensity) we cannot present the energy prices paid by every type of business energy consumer. Therefore, we set out how low-carbon policies impact on energy costs and show illustrative examples of prices that business may face (see Annex for further details).

### *Current electricity prices*

Electricity prices are lower for business consumers than for households, and vary depending on usage and type of connection to the network. Businesses also face a different mix of low-carbon policies to households.

We estimate that average electricity prices for the commercial sector and manufacturing sector were 11 p/kWh and 7.7 p/kWh respectively in 2016.

- Wholesale, supplier and network costs.** Wholesale costs for both commercial and manufacturing consumers are lower than for households. Larger business consumers of electricity may be able to negotiate lower prices through direct contracts with suppliers. Network costs may also be lower, by connecting directly to the transmission network and avoiding distribution costs. Businesses will also be cheaper to supply where their demand

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includes more off-peak energy, and is more flexible<sup>51</sup>. We estimate wholesale and network costs were on average 7.7 p/kWh for the commercial sector and 5.3 p/kWh for manufacturing in 2016, though this varies considerably depending on the quantity of electricity consumed by the firm.

- **Carbon price.** We estimate that the carbon price support mechanism and the purchasing of EU ETS allowances by businesses cost around 0.8 p/kWh in 2016. However, electricity-intensive firms in sectors deemed “most at risk” of carbon leakage received compensation up to 80% of this cost (Box 2.1).<sup>52</sup>
- **Support for low-carbon investment**<sup>53</sup>. Policies to support roll-out of low-carbon generation increased the electricity price faced by businesses by 1.5 p/kWh, except for certain electricity-intensive firms that receive compensation for some of this cost.
  - Renewables Obligation (RO), micro-generation Feed-in Tariffs (FiTs) and Contracts for Difference (CfDs) contributed 1.8 p/kWh. Electricity-intensive firms in sectors deemed “most at risk” of carbon leakage received compensation of up to 85% of these costs.<sup>54</sup>
  - Additional network costs from increased renewables deployment contributed 0.2 p/kWh, while our estimates suggest the merit order effect reduced wholesale energy costs by around 0.6 p/kWh.
- **Climate Change levy (CCL).** A tax on energy consumption which applies to all non-residential consumers, the CCL was 0.6 p/kWh in 2016, although the majority of manufacturing sectors have a Climate Change Agreement (CCA) and therefore receive a 90% discount from the levy, and metallurgical/mineralogical processes are exempt from CCL (around 15% of electricity consumption).
- **CRC Energy Efficiency scheme.** A mandatory carbon emissions reporting and pricing scheme for non-residential organisations that consume over 6 GWh of electricity annually and are not already covered by a CCA, the EU ETS or are metallurgical/mineralogical processes. Participants must purchase and surrender allowances for their emissions. We have estimated that the cost of the allowances for electricity were 0.7 p/kWh in 2016.<sup>55</sup>

To reflect the diversity of electricity costs and low-carbon policy impacts for businesses we focus on five illustrative types of electricity consumption to show a range of prices (Figure 2.5, Table 2.2). Inevitably these do not cover all possibilities and the variety and complexity of businesses may mean that different parts of operations are affected by different policies. However, they give a reasonable picture of the most important differences.

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<sup>51</sup> We have not assumed any changes in the relative negotiating power of industry, commercial firms or households over time. We note, however, that the importance of flexibility in demand is likely to increase in future as the share of intermittent generation (e.g. wind) increases; all sectors have opportunities to increase the flexibility of their demand.

<sup>52</sup> BEIS (2015) *Compensation for the indirect costs of EU Emission Trading Scheme and the Carbon Price Support mechanism from 2015*. Available at: [www.gov.uk](http://www.gov.uk). Carbon leakage is the situation in which, as a result of stringent climate policies, companies move their production abroad to countries with less ambitious climate measures.

<sup>53</sup> For further explanation of these components see Annex.

<sup>54</sup> BEIS (2016) *Compensation for the indirect Renewables Obligation and Feed-In-Tariffs*. Available at: [www.gov.uk](http://www.gov.uk)

<sup>55</sup> This is using the ‘Compliance Sale Price’ average for 2016 which is the price of permits at the end of the year, although participants have the opportunity to purchase allowances at the beginning of the year for a lower price. <https://www.gov.uk/government/collections/crc-energy-efficiency-scheme>

- **Small commercial** pays the full amount of CCL, consume too little to be in the CRC and pay the full costs of the carbon price and support for low-carbon generation. Overall, around a quarter of the electricity price paid is due to low-carbon policies.
- **Medium commercial.** In addition to the low-carbon costs that small commercial consumers pay, medium commercial consumers are within the CRC Energy Efficiency Scheme, so the cost of low-carbon policies is a third of the electricity price paid.
- **Large manufacturing**<sup>56</sup>. Most manufacturing sectors have a CCA and therefore pay a reduced rate of CCL and are not included in the CRC. However, as larger consumers of electricity pay a lower wholesale and network cost for electricity, low-carbon policy costs still make up just under a third of the electricity price paid.
- **Large manufacturing (low-carbon support compensation).**<sup>57</sup> This covers consumers that pay the reduced rate of CCL and receive compensation for the majority of the cost of supporting low-carbon generation. This compensated electricity user still receives the benefit of the merit order effect, reducing its energy bill. Firms that receive compensation are seen as 'at most risk' from carbon leakage and so their low-carbon policy costs are lower and constitute 15% of the electricity price paid.<sup>58</sup>
- **Extra-large manufacturing (low-carbon support and carbon price compensation).**<sup>59</sup> These consumers are considered the most at risk of carbon leakage and receive all available discounts and compensation: no CCL is paid and compensation is received for the majority of low-carbon support and carbon price costs while this user still receives the benefit of the merit order effect, reducing its energy bill. As a result, less than a tenth of the electricity price paid is due to low-carbon policies.<sup>60</sup>

Generation of electricity on site (autogeneration) is not exposed to the same costs of electricity bought through a supplier and delivered through the national grid. In particular, autogeneration avoids transmission, distribution and metering costs, as well as the costs of supporting low-carbon generation (which are paid via electricity suppliers). Currently, primary energy price data is not available to make a robust estimate of this cost of electricity (Box 2.2), but we have considered the different low-carbon costs as part of our analysis of total energy bills.

<sup>56</sup> For this analysis large equates to 'moderately large' consumption in BEIS price statistics.

<sup>57</sup> The illustrative example presented here most represents electricity consumption in sectors like cement, glass and fertilizers due to size of consumption (moderately large), relief on CCL and eligibility to claim compensation for low-carbon support (which includes costs for the Renewables Obligation, Feed-in-Tariffs and Contracts-for-Difference).

<sup>58</sup> The illustrative example here most represents electricity consumption in refining, cement, glass, ceramics sectors etc., see Box 2.1.

<sup>59</sup> The illustrative example here most represents electricity consumption in parts of basic metals such as steel due to size of consumption, eligibility to claim compensation for low-carbon support and carbon costs, plus assumed exemption from CCL.

<sup>60</sup> Include manufacturing firms in steel, aluminium, paper and some parts of chemical/textile sectors etc., see Box 2.1.



### Box 2.1. Support for low-carbon generation compensation policy framework

Following advice from the Committee, the UK Government recognised competitiveness risks to some specific industries and put in place plans for support arrangements for electro-intensive sectors. In the 2015 Autumn Statement the Chancellor went further and exempted 'at risk' sectors from costs associated with action to tackle climate change.

These sectors currently receive:

- **Compensation for the EU ETS and Carbon Price Support** impact of rising electricity prices for electro-intensive and trade-intensive industries (e.g. steel). Successful applicants need to show that their electricity consumption is for products on the eligibility list (Table B2.1) and the carbon cost of electricity is at least 5% of their GVA. In return successful applicants receive up to 80% compensation of the carbon cost against an electricity energy efficiency benchmark (around 80%).
- **Compensation for the Renewables Obligation and small-scale Feed-in-Tariff** impact of rising electricity prices for electro-intensive and trade-intensive industries (e.g. steel). Successful applicants need to show that their electricity consumption is for products on the eligibility list (Table B2.1) and that electricity costs are at least 20% of their GVA. In return successful applicants receive 85% of the additional cost of RO/FiTs.

In future, these sectors are expected to continue to receive compensation for carbon price costs and receive exemptions for low-carbon support costs:

- **Exemption for the Renewables Obligation, small-scale Feed-in-Tariff and Contracts for Difference scheme.** Instead of compensation, the government intends to move to a scheme whereby electro-intensive applicants that pass the threshold described above, are exempted from 85% of the costs of these policies. This is subject to State Aid approval.

For the sectors that qualify, these plans should offset up to around 80% of the costs to support low-carbon electricity sector investment through to 2019-20.

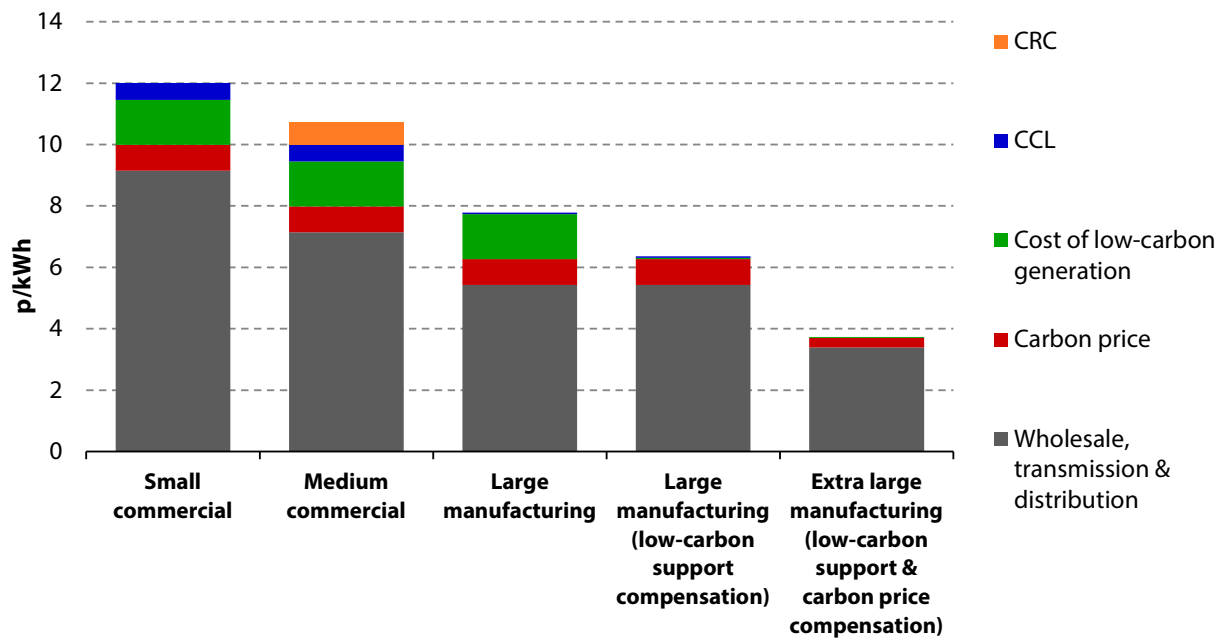
**Table B2.1.** Example energy-intensive sectors eligible for compensation

	EU ETS and Carbon Price Support	
	Eligible for compensation	Not eligible for compensation
Eligible for compensation for Renewables Obligation & Feed-in-Tariff	Steel, aluminium, paper, chemicals (fertilizers, inorganic, etc.), other metals and parts of textiles etc.	Refining, chemicals (industrial gases etc.), cement, lime, plastics, glass, ceramics (bricks, tiles etc.), textiles etc.

**Notes:** This is not the exhaustive list of products that are eligible for compensation. The European Commission has provided framework guidance to European Member States, setting out which sectors and sub-sectors can be eligible for compensation for the indirect costs of EU ETS and support for low-carbon generation.

**Source:** BEIS (2015) *Compensation for the indirect costs of EU Emission Trading Scheme and the Carbon Price Support mechanism from 2015*. BEIS (2016) *Compensation for the indirect Renewables Obligation and Feed-In-Tariffs*. BEIS (2016) *Consultation on implementing an exemption for Energy Intensive Industries from the indirect costs of the Renewables Obligation and Feed-in Tariff Schemes*. BEIS (2016) *Ells – Exemption from the indirect costs of Contracts for Difference*. Available at: [www.gov.uk](http://www.gov.uk).

**Figure 2.5** Five illustrative electricity prices in the business sector (2016)



**Source:** CCC analysis based on BEIS (September 2016) *Quarterly Energy Prices*. Available at: [www.gov.uk](http://www.gov.uk).

**Notes:** 'Cost of low-carbon generation' is the net cost of policies to support low-carbon generation, which include costs under the RO, FITs and CfDs and intermittency costs, offset by the merit order effect (which reduces the wholesale price, but is considered as a low-carbon policy benefit). 'Large manufacturing' is defined as 'moderately large' in BEIS (2016) *Quarterly Energy Prices*.

**Table 2.2.** Five illustrative electricity prices in the business sector (2016)

	<b>Total price (p/kWh)</b>	<b>Low-carbon policy cost (p/kWh)</b>	<b>% low-carbon policies</b>
<b>Small commercial</b>	12.0	2.9	24%
<b>Medium commercial</b>	10.7	3.6	33%
<b>Large manufacturing</b>	7.8	2.4	30%
<b>Large manufacturing (low-carbon support compensation)</b>	6.4	0.9	15%
<b>Extra-large manufacturing (low- carbon support &amp; carbon price compensation)</b>	3.7	0.3	9%

**Source:** CCC analysis.

**Notes:** 'Low-carbon policy cost' includes the CCL, CRC, plus support and additional network costs for low-carbon generation, offset by the merit order effect.

### Box 2.2. Autogeneration of electricity

Autogeneration is defined as the generation of electricity by a company whose main business is not electricity generation, with the electricity being produced mainly for that company's own use.

In 2015, 9 TWh of electricity was consumed on site (out of a total of 11 TWh generated through autogeneration) with the remainder being sold back to the grid. Hydro-electricity, solid/gaseous renewables and waste make up the majority of fuels used for autogeneration (65%), with the majority of the remainder coming from natural gas (32%).

The decision to use autogeneration depends upon the availability of low-cost fuel, efficiency of the unit and the cost of the alternative (grid-supplied electricity). There is therefore a risk of increased emissions if higher electricity prices for grid-supplied electricity provide an incentive to shift towards autogeneration with a higher carbon intensity.

**Source:** BEIS (2016) *Digest of UK Energy Statistics*. Available at: [www.gov.uk](http://www.gov.uk).

### Current gas prices

Gas prices in 2016 were lower for business consumers than for households, and vary depending on quantity consumed (see Annex). Businesses also face a different mix of low-carbon policies to households. We estimate that average gas prices for the commercial sector and manufacturing sector were 2.6 p/kWh and 1.6 p/kWh respectively in 2016.

- **Wholesale, supplier and gas distribution costs.** Wholesale gas costs for both commercial and manufacturing consumers are lower than for households, as larger gas business consumers may be able to negotiate lower prices through direct contracts with suppliers,

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and costs of supply may be lower. We estimate an average gas price of 2.3 p/kWh for the commercial sector and 1.6 p/kWh for the manufacturing sector in 2016, though this varies depending on the quantity of gas consumed (Figure 2.6).

- **CCL.** The full gas CCL rate was 0.2 p/kWh in 2016. Those with a CCA, which is the majority of manufacturing sectors, receive a 65% discount from the levy. Metallurgical/mineralogical processes are exempt.
- **CRC.** We estimate that the cost of CRC allowances for gas were 0.3 p/kWh.<sup>61</sup>
- **EU ETS.** Although many manufacturing sectors are covered by the EU ETS, they currently receive a proportion of their allowances for free. Even free allowances hold value for firms (through revenue in selling) and surrendering them for energy consumption is an additional marginal cost to the firm. Therefore we have included EU ETS allowances as a cost in the marginal consumption of energy (which we estimate at 0.1 p/kWh in 2016, for firms covered by the EU ETS), but not in the average energy bills analysis. Chapter 3 considers the potential monetary cost of EU ETS allowances for different sectors.

As with electricity, given the varied base cost and low-carbon policy framework we have chosen four illustrative types of business gas consumption to show a range of prices (Figure 2.6 and Table 2.3). Whilst these may not cover all possibilities, they give a reasonable picture of the most important differences.

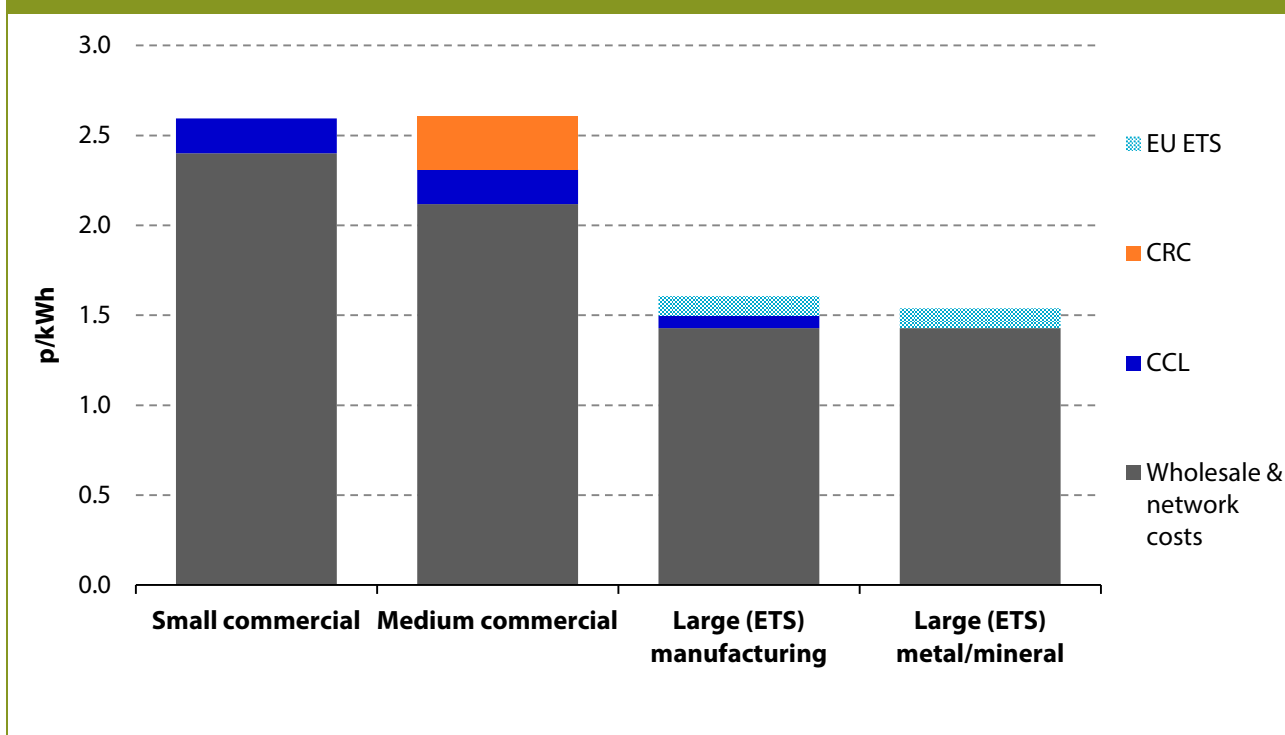
- **Small commercial.** Pay the full amount of CCL, therefore under a tenth of the gas price is due to low-carbon policies.
- **Medium commercial.** Pays the full CCL and the CRC cost on gas, and so a fifth of the gas price is due to low-carbon policies.
- **Large manufacturing (in ETS).** Most manufacturing sectors have a CCA and therefore pay a reduced rate of CCL and are not included in the CRC. The marginal cost of the EU ETS is 0.1p/KWh, and in total a tenth of the gas price is due to low-carbon policies.
- **Large metallurgical/mineralogical manufacturing (in ETS).** Are exempt from the CCL and CRC, so the only low-carbon policy cost is the EU ETS (0.1 p/KWh), which is 7% of the gas price.

Overall, this implies a significantly lower impact of low-carbon policies on gas prices compared to electricity, which risks incentivising a shift in fuel from electricity to gas. This is contrary to the direction set out in our decarbonisation scenarios, which, involves a shift in demand from hydrocarbon energy to low-carbon electricity for most non-energy intensive industries.

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<sup>61</sup> This is using the 'Compliance Sale Price' average for 2016 which is the price of permits at the end of the year, although participants have the opportunity to purchase allowances at the beginning of the year for a lower price. <https://www.gov.uk/government/collections/crc-energy-efficiency-scheme>

**Figure 2.6.** Four illustrative gas prices in the business sector (2016)



**Source:** CCC analysis based on BEIS (September 2016) *Quarterly Energy Prices*. Available at: [www.gov.uk](http://www.gov.uk).

**Notes:** We have included EU ETS allowances as a cost in the marginal consumption of energy.

**Table 2.3.** Four illustrative gas prices in the business sector (2016)

	Total price (p/kWh)	Low-carbon policies (p/kWh)	% low-carbon policies
<b>Small commercial</b>	2.6	0.2	7%
<b>Medium commercial</b>	2.6	0.5	19%
<b>Large manufacturing (ETS)</b>	1.6	0.2	11%
<b>Large (metal/mineral) manufacturing (ETS)</b>	1.5	0.1	7%

**Source:** CCC analysis based on BEIS (September 2016) *Quarterly Energy Prices*. Available at: [www.gov.uk](http://www.gov.uk).

## Current prices for other fuels

Manufacturing sectors also consume a range of other petroleum, solid and manufactured fuels, which we estimate prices for (Table 2.4).

- **Wholesale costs.** Average 0.7 p/kWh for coal and 2.9 p/kWh for petroleum products in the manufacturing sector.<sup>62</sup>
- **CCL.** The full coal CCL rate was 0.2 p/kWh, those with a CCA receive a 65% discount from the levy, and metallurgical/mineralogical processes are exempt. Due to existing hydrocarbon excise duties, CCL is not imposed on petroleum products.
- **EU ETS.** The potential marginal cost of EU ETS permits was 0.2 p/kWh for coal and 0.2 p/kWh for petroleum.

**Table 2.4.** Average (non-road fuel) petroleum products and coal prices (2016)

	Total price (p/kWh)	Low-carbon policies (p/kWh)	% low-carbon policies
<b>Coal</b>	0.8	0.1	10%
<b>Coal (in ETS)</b>	1.0	0.3	28%
<b>Petroleum</b>	2.9	0.0	0%
<b>Petroleum (in ETS)</b>	3.1	0.2	5%

**Source:** CCC analysis, using 'gas oil' as a proxy cost for petroleum.

## (b) Changes in business energy prices and bills since 2004

### (i) Change in business energy prices

Energy prices have generally increased since 2004, although they have fallen slightly from their 2012-2014 peak. The largest driver of increase has been the wholesale price of natural gas, with policy costs increasingly important for electricity in recent years.

#### *Change in electricity prices since 2004*

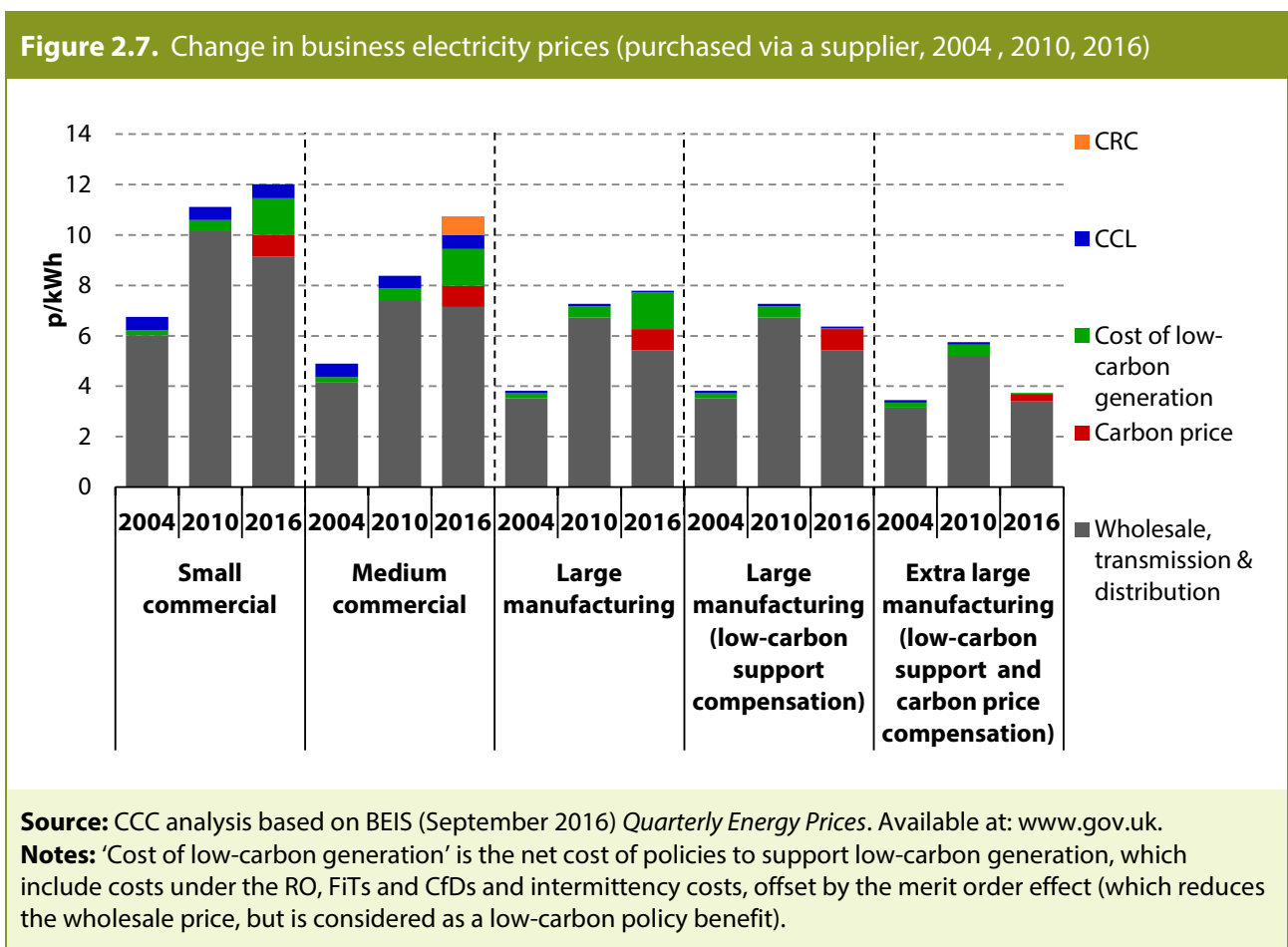
From 2004 to 2010 electricity prices rose primarily due to the rise in wholesale gas prices, before falling between 2010 to 2016 as the wholesale cost of electricity decreased, which was partially offset by an increase in costs from low-carbon policies (Figure 2.7 and Table 2.5).

- **Small commercial.** Electricity prices increased by 78% over 2004-2016 largely due to increases in wholesale energy costs, though an increase in low-carbon policy costs from the carbon price and support for low-carbon generation were responsible for two-fifths of the price increase.

<sup>62</sup> BEIS (2016) *Prices of fuels purchased by manufacturing industry*. Gas oil used as a proxy for petroleum products.

- **Medium commercial.** Electricity price increased by 119%, with half of this rise due to low-carbon policies. The low-carbon policy cost increase was greater for medium-sized commercial electricity consumers due to the introduction of the CRC, in addition to increases in costs from carbon and support for low-carbon investment.
- **Large manufacturing.** Electricity prices increased by 104%, with half of this rise due to low-carbon policies. The rise in low-carbon policy cost was mainly due to the rise in support for low-carbon investment.
- **Large manufacturing (low-carbon support compensation).** Electricity prices increased by 66%, with a quarter of this rise due to low-carbon policies. The rise in low-carbon policy costs was partially offset through the introduction of compensation for RO/FiTs for firms classed as 'at risk' and the merit order effect.
- **Extra-large manufacturing (low-carbon support and carbon compensation).** Electricity prices increased by 8%, with 14% of this rise due to low-carbon policies. The rise in low-carbon policy costs was mostly offset by the introduction of compensation for RO/FiTs and carbon costs for firms classed as 'at risk' and the merit order effect.

Businesses have seen an increase in the proportion of the electricity cost that is due to low-carbon policies, although the impact was limited for those deemed "most at risk".





**Table 2.5.** Change in business electricity prices (purchased via a supplier, 2004 -2016)

	<b>% of 2004 price due to low-carbon policy</b>	<b>% change in total price (and proportion of change due to low-carbon policies)</b>	<b>% of 2016 price due to low-carbon policy</b>
<b>Small commercial</b>	11%	78% (41%)	24%
<b>Medium commercial</b>	15%	119% (49%)	33%
<b>Large manufacturing</b>	8%	104% (52%)	30%
<b>Large manufacturing (low-carbon support compensation)</b>	8%	66% (25%)	15%
<b>Extra-large manufacturing (Low-carbon support &amp; carbon price compensation)</b>	9%	8% (14%)	9%

**Source:** CCC analysis.

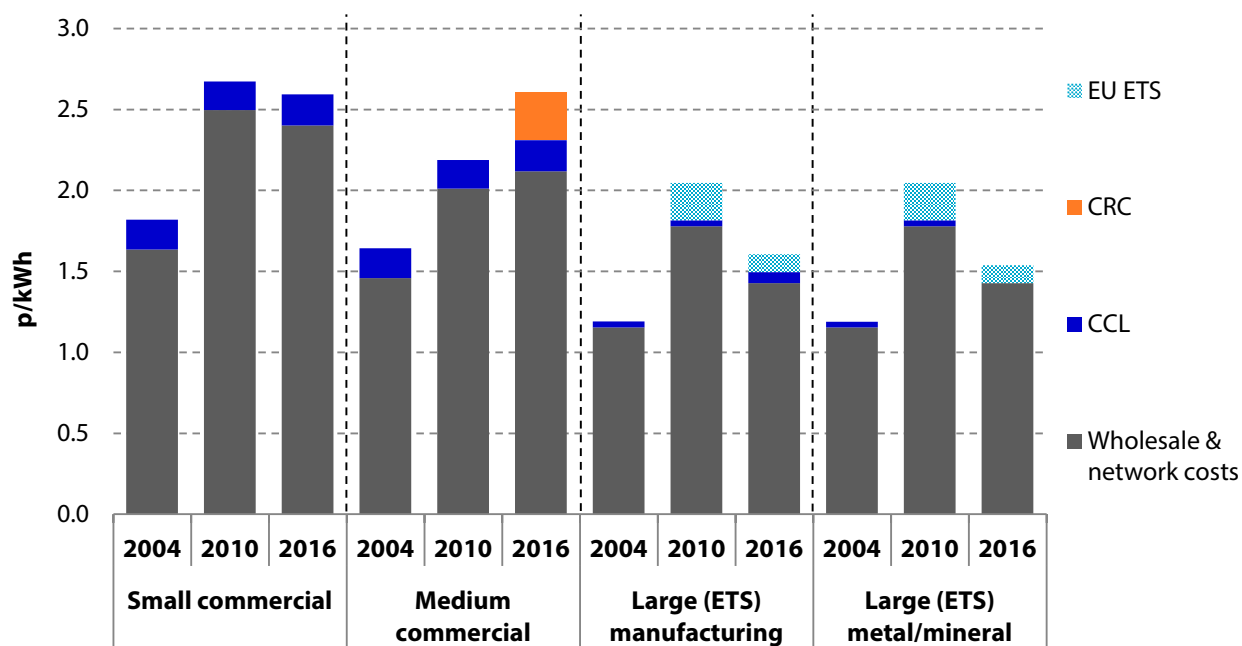
*Change in gas prices since 2004*

From 2004 to 2016 gas prices increased primarily due to the rise in wholesale prices (Figure 2.8 and Table 2.6).

- **Small commercial.** Gas prices increased by 43%, almost entirely due to the rise in the wholesale price. By 2016, the proportion of the gas price due to low-carbon policies fell to below a tenth of the total price.
- **Medium commercial.** Gas prices increased by 59%, with nearly a third of this increase due to the introduction of the CRC, meaning that by 2016 low-carbon policies represented almost a fifth of the total price.
- **Large manufacturing (in EU ETS).** Marginal gas costs increased by 35%, with nearly a third of this increase due to low-carbon policies, mainly from the introduction of the EU ETS. The low-carbon policy cost impact rose to around a tenth of the marginal cost by 2016.
- **Large metallurgical/mineralogical manufacturing (in EU ETS).** Marginal gas costs increased by 29%, with nearly a fifth of this increase due to low-carbon policies, mainly from the introduction of the EU ETS which was partially offset by the exemption to CCL. The low-carbon policy cost impact rose but to less than a tenth of the marginal cost by 2016.

Gas prices have risen since 2004, but with only medium-sized commercial users paying more due to low-carbon policy costs. For firms in the EU ETS, allocation of free allowances meant there was limited impact from the EU ETS on actual costs (see Chapter 3).

**Figure 2.8.** Change in illustrative business gas prices (2004 , 2010, 2016)



**Source:** CCC analysis based on BEIS (September 2016) *Quarterly Energy Prices*. Available at: [www.gov.uk](http://www.gov.uk).

**Notes:** We have included EU ETS allowances as a cost in the marginal consumption of energy.

**Table 2.6.** Proportion of illustrative gas prices due to low-carbon policies, change in gas price (and proportion of change in price due to low-carbon policies) (2004-2016)

	% of 2004 price due to low-carbon policy	% change in total price (and proportion of change due to low-carbon policies)	% of 2016 price due to low-carbon policy
<b>Small commercial</b>	10%	43% (1%)	7%
<b>Medium commercial</b>	11%	59% (31%)	19%
<b>Large manufacturing (ETS)</b>	14%	20% (n/a)	11%
<b>Large (metal/mineral) manufacturing (ETS)</b>	14%	15% (n/a)	7%

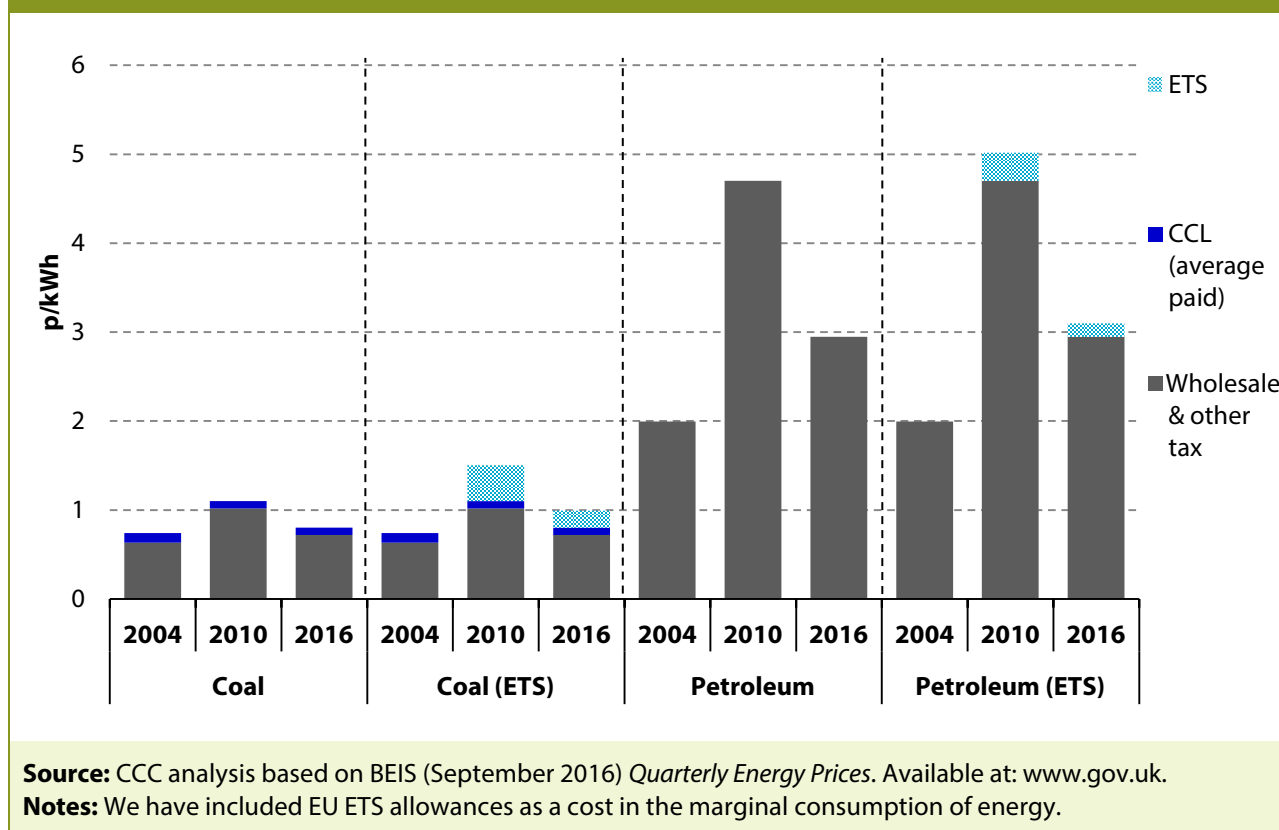
**Source:** CCC analysis.

**Notes:** We have included EU ETS allowances as a cost in the marginal consumption of energy.

## Change in prices for other fuels

Between 2004-2016, low-carbon policy costs only increased marginal prices for petroleum products and coal if consumption was covered by the EU ETS (Figure 2.9).

**Figure 2.9.** Change in average business petroleum and coal prices (2004, 2010, 2016)



## (ii) Change in business energy bills

Rises in energy prices have increased energy bills for firms over 2004-2016, though increases in energy prices may have been offset by energy efficiency improvements in the commercial sector and structural changes in the manufacturing sector.

To understand the impact of changing energy prices on bills we estimate what bills in 2016 would have been if energy prices had remained at 2004 levels. We then consider what energy productivity improvement there has been in the commercial and manufacturing sectors over 2004-2016.

### Commercial

The rise in energy prices has meant that energy costs in 2016 are 92% higher than they would have been 2004 with equivalent consumption. Two-fifths of this rise was due to low-carbon policies.

- Energy costs have risen as a proportion of commercial operating costs (and GVA) from around 0.5% (0.6%) in 2004 to 0.9% (1.1%) in 2016 (Table 2.7).
- The share of low-carbon policy costs as a proportion of commercial operating costs (and GVA) has risen from around 0.1% (0.1%) in 2004 to 0.2% (0.3%) in 2016.

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Both the change in energy costs and the proportion of this change that is due to low-carbon policies will have varied across different business types depending on the fuel types consumed and the low-carbon policies that firms were affected by.

This increase in energy costs will have partially been offset through improvements in energy efficiency. Indeed, despite growth in output of 30% over 2004-2016, commercial electricity consumption has remained broadly flat, falling by less than 1%. This reflects improving energy efficiency, alongside a growth in the number of appliances (Figure 2.10).

- The number of computers increased by 85% over the period, but a shift from desktops to laptops, together with an increase in more efficient models, led to a fall in electricity consumption of 22%.<sup>63</sup>
- Similarly, the total commercial lighting stock grew by 6% over the period whilst electricity consumption from lighting fell 26%.
- However, electricity demand from air conditioning systems increased 33%, and demand from printers rose 43%, suggesting that in certain cases efficiency improvement has been insufficient to offset growth in demand.

Comparison of gas consumption for specific years is not straightforward, because of the impact of changes in weather from year to year (i.e. heating requirements and gas consumption increase in years with cold winters). There was also a change in methodology to calculate statistics on natural gas energy consumption from 2008<sup>64</sup>. The statistics imply a general trend of declining gas consumption since 2004. Adjusting for variation in temperature and comparing before and after the statistical change, gas consumption fell 15% between 2004-2007, and then 20% over 2008-2015.

### *Manufacturing*

The rise in energy prices has meant that energy costs in 2016 are 58% higher than equivalent consumption would have been in 2004, with nearly half of this rise due to low-carbon policies (Table 2.7).

- The share of energy costs as a proportion of total costs (and GVA) in the manufacturing sector rose from around 1.2% (3.2%) in 2004 to 2.0% (5.4%) in 2016.
- The share of low-carbon policy costs increased from around 0.1% (0.2%) in 2004 to 0.4% (1.1%) in 2016.

Since 2004 energy consumption in the manufacturing sector has fallen by 30%. This has partly been due to structural changes towards less energy-intensive production following the 2008 financial crash. Over the 2004-2014 period there also appears to have been around a 7% improvement in energy productivity of production.<sup>65</sup> Chapter 3 provides a more detailed decomposition of industry emissions changes since 1990.

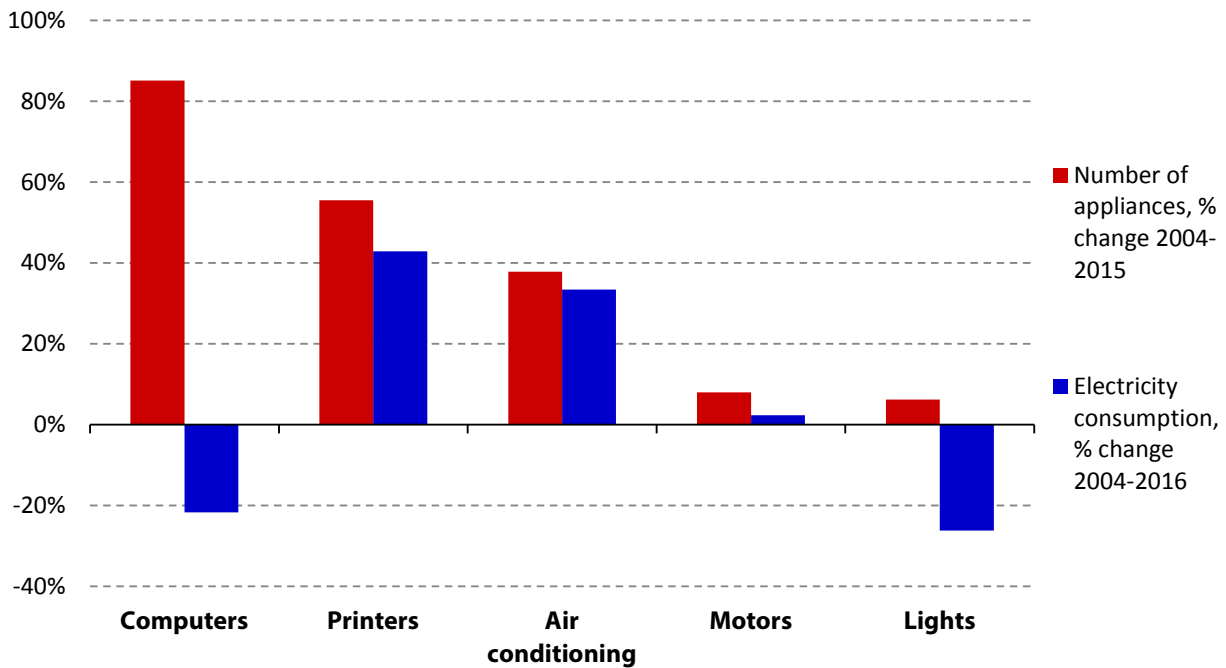
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<sup>63</sup> BEIS (2016) *Energy Consumption in the United Kingdom*. Available at: [www.gov.uk](http://www.gov.uk).

<sup>64</sup> There was a change in the methodology used in DUKES to calculate natural gas energy consumption from 2008. Further information about these changes in methodology can be accessed here: [https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/323499/Enhancements\\_to\\_ET\\_gas\\_tables.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/323499/Enhancements_to_ET_gas_tables.pdf)

<sup>65</sup> This improvement in energy intensity could be from improved energy efficiency, changes in product mix or plant utilisation.

**Figure 2.10.** Commercial sector change in non-domestic appliances and consumption (2004-2015)



**Source:** BEIS (2016) *Energy Consumption in the UK*. Available at: [www.gov.uk](http://www.gov.uk).

**Notes:** Slower (or negative) growth in electricity consumption compared to number of appliances, suggests improving energy efficiency.

**Table 2.7.** Energy and low-carbon policy costs as a proportion of operating costs (and Gross Value Added) for the commercial, manufacturing and energy-intensive sectors (2004, 2016)

	Commercial sector (58% of UK GVA)		Manufacturing sector (10% of UK GVA)		Energy-intensive sectors (2% of UK GVA)	
	Energy	Low-carbon policies	Energy	Low-carbon policies	Energy	Low-carbon policies
<b>2004</b>	0.5% (0.6%)	0.1% (0.1%)	1.2% (3.2%)	0.1% (0.2%)	2.4% (8.5%)	0.2% (0.6%)
<b>2016</b>	0.9% (1.1%)	0.2% (0.3%)	2.0% (5.4%)	0.4% (1.1%)	3.8% (14.4%)	0.7% (2.6%)

**Source:** CCC analysis based on BEIS (2016) *Digest of UK Energy Statistics*, BEIS (September 2016) *Quarterly Energy Prices And* ONS (2016) *Input-Output supply and use tables*. Available at: [www.gov.uk](http://www.gov.uk).

**Notes:** See Table 2.1.

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## (c) Outlook for business energy prices to 2020 and 2030

As set out in the Annex, drivers of future changes in electricity prices for businesses are similar to those affecting households regarding wholesale costs, network costs and policy costs. We assume the same impact as for households from the carbon price and support for low-carbon generation, with additional impacts from the CCL and CRC.

- **Carbon price.** Our projection for the impact of the carbon price remains flat at 0.8 p/kWh in real terms from 2016 to 2020, before rising to 1.2 p/kWh by 2030. Electricity-intensive firms in sectors deemed “most at risk” of carbon leakage will receive compensation for up to 80% of the carbon price in 2020, which we have assumed is maintained to 2030.
- **Support for low-carbon generation.** Continuing the shift to low-carbon power will increase support costs for low-carbon generation, increasing prices by 1.5 p/kWh in 2016, 2.8 p/kWh in 2020 and 4.4 p/kWh in 2030 for all consumers, except for certain energy-intensive firms in sectors deemed “most at risk” of carbon leakage which will receive compensation up to 85% of this cost.
- **CRC.** Our estimates assume the CRC will be abolished after the 2018/19 compliance year, in line with the 2016 Budget.
- **CCL.** We assume the CCL will be raised to make up for lost tax revenue with the closure of the CRC. We have assumed that CCAs and relief rates for CCL will continue to 2030.
  - **Electricity CCL:** The price impact rises from 0.6 p/kWh in 2016 to 0.8 p/kWh in 2020, and we assume it is maintained at this level in real terms. Firms with a CCA will see their 90% relief on CCL increase to 93% with the rise.
  - **Gas CCL:** The price impact rises from 0.2 p/kWh to 0.3 p/kWh by 2019, with relief for those with a CCA rising from 65% to 78%. At Budget 2016 it was also announced that it was the Government’s intention to have electricity/gas CCL parity by 2025, so we have assumed gas CCL rises to 0.8 p/kWh by 2025 and is maintained in real terms, with CCA relief rising to 93%.
- **Additional gas network costs.** Due to low-carbon policies reducing gas consumption across the economy (largely through improved energy efficiency), we assume that per unit gas network costs will rise as a result. This is assumed to add 0.1 p/kWh by 2030.

The rest of this section reports price estimates based on BEIS’s central case for fossil fuel prices. We consider the impacts of different wholesale and carbon prices in section 6.

### *Outlook for electricity prices*

Businesses supplied through the grid will face similar wholesale electricity price rises as in households, though the total price changes between 2016 and 2030 will vary due to the low-carbon policy costs a firm is facing (Figure 2.11 and Tables 2.8 and 2.9).

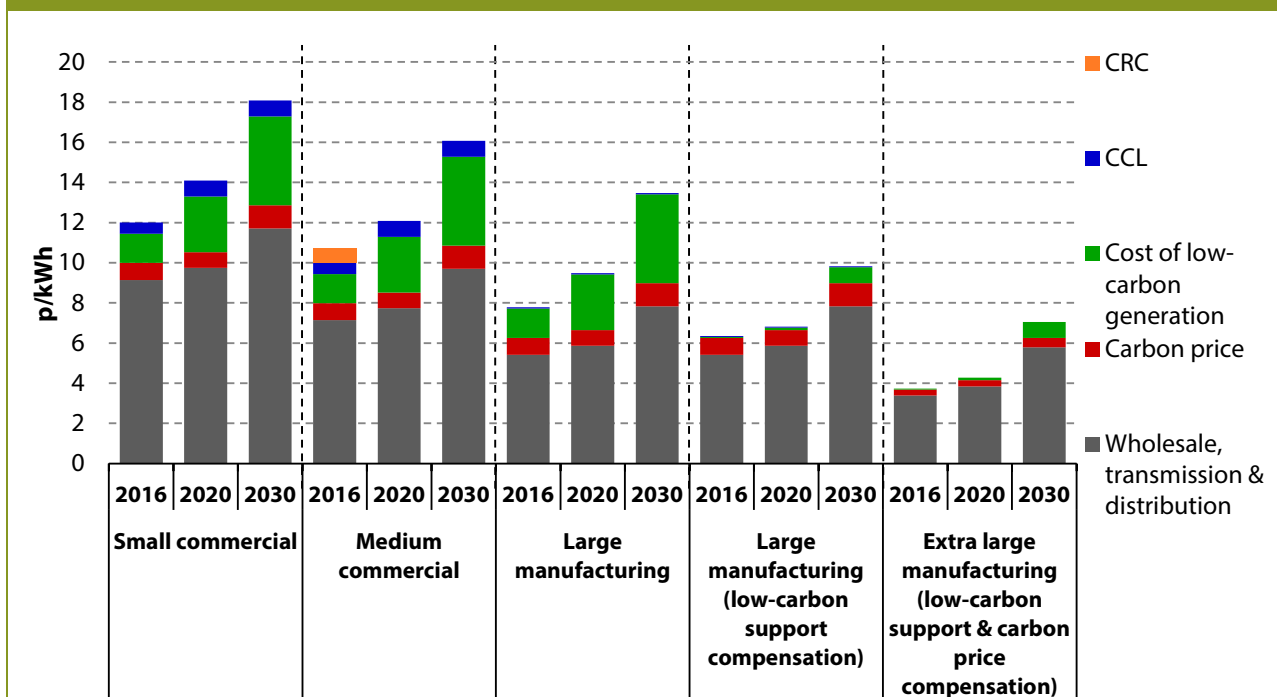
- **Small commercial.** Electricity prices are projected to increase by 17% to 2020 and 51% to 2030. Of this, low-carbon policy will be responsible for over two-thirds of the increase to 2020 and three-fifths of the total increase to 2030. The main increase in low-carbon policy costs comes from support for low-carbon generation, as well as an increase in the CCL in order to recoup revenue lost from scrapping the CRC for larger commercial electricity consumers.

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- **Medium-sized commercial.** Electricity prices are projected to increase by 13% to 2020 and 50% to 2030. Of this, low-carbon policy will be responsible for a half of the increase to 2020 and 2030. To 2020, the abolishment of the CRC means low-carbon policies do not have as large an impact on electricity prices as for smaller commercial electricity consumers, though low-carbon policy costs will increase to 2030, in line with an increase in support costs for low-carbon generation.
  - **Large manufacturing.** Electricity prices are projected to increase by 22% to 2020 and 73% to 2030. Of this, low-carbon policy will be responsible for three-quarters of the increase to 2020 and three-fifths of the total increase to 2030. All of the low-carbon policy cost increase is due to the rise in the carbon price and support for low-carbon generation, which are partially offset by the merit order effect.
  - **Large manufacturing (low carbon support costs compensation).** Electricity prices are projected to increase by 7% to 2020 and 55% to 2030. Of this, low-carbon policy will be responsible for less than a tenth of the increase to 2020 and a third of the total increase to 2030. Given compensation for support to low-carbon generation, this is due to a rise in the carbon price, the capacity market and additional network costs.
  - **Extra-large manufacturing (low carbon support costs and carbon compensation).** Electricity prices are projected to increase by 15% to 2020 and 89% to 2030. Of this, low-carbon policy will be responsible for a fifth of the increase to 2020 and a quarter of the total increase to 2030. For extra-large manufacturing low-carbon policy costs are relatively low because of compensations to firms in sectors deemed 'at risk', though they still make up 20% of their electricity costs, given the low overall price they pay (compared to other sectors).

While extra-large manufacturing electricity consumption will see the largest proportional rises in electricity prices to 2030, compared to other consumption brackets, they will also be subject to the smallest rise in low-carbon policy costs given the compensation/exemption policies.



**Figure 2.11.** Change in illustrative retail business electricity prices (purchased via a supplier, 2016, 2020, 2030)



**Source:** CCC analysis.

**Notes:** 'Cost of low-carbon generation' is the net cost of policies to support low-carbon generation, which include costs under the RO, FiTs and CfDs and intermittency costs, offset by the merit order effect (which reduces the wholesale price, but is considered as a low-carbon policy benefit).

**Table 2.8.** Electricity price % change from 2016 (and proportion of change in price due to low-carbon policies) (2020, 2030)

	2020	2030
<b>Small commercial</b>	17% (71%)	51% (58%)
<b>Medium commercial</b>	13% (55%)	50% (52%)
<b>Large manufacturing</b>	22% (74%)	73% (58%)
<b>Large manufacturing (low-carbon support compensation)</b>	7% (5%)	55% (31%)
<b>Extra-large manufacturing (low-carbon support &amp; carbon price compensation)</b>	15% (18%)	89% (28%)

**Source:** CCC analysis.

**Table 2.9.** Proportion of electricity price due to low-carbon policies (2016, 2020, 2030)

	2016	2020	2030
<b>Small commercial</b>	24%	31%	35%
<b>Medium commercial</b>	33%	36%	40%
<b>Large manufacturing</b>	30%	38%	42%
<b>Large manufacturing (low-carbon support compensation)</b>	15%	14%	20%
<b>Extra-large manufacturing (low-carbon support &amp; carbon price compensation)</b>	9%	10%	18%

**Source:** CCC analysis.

### *Outlook for gas prices*

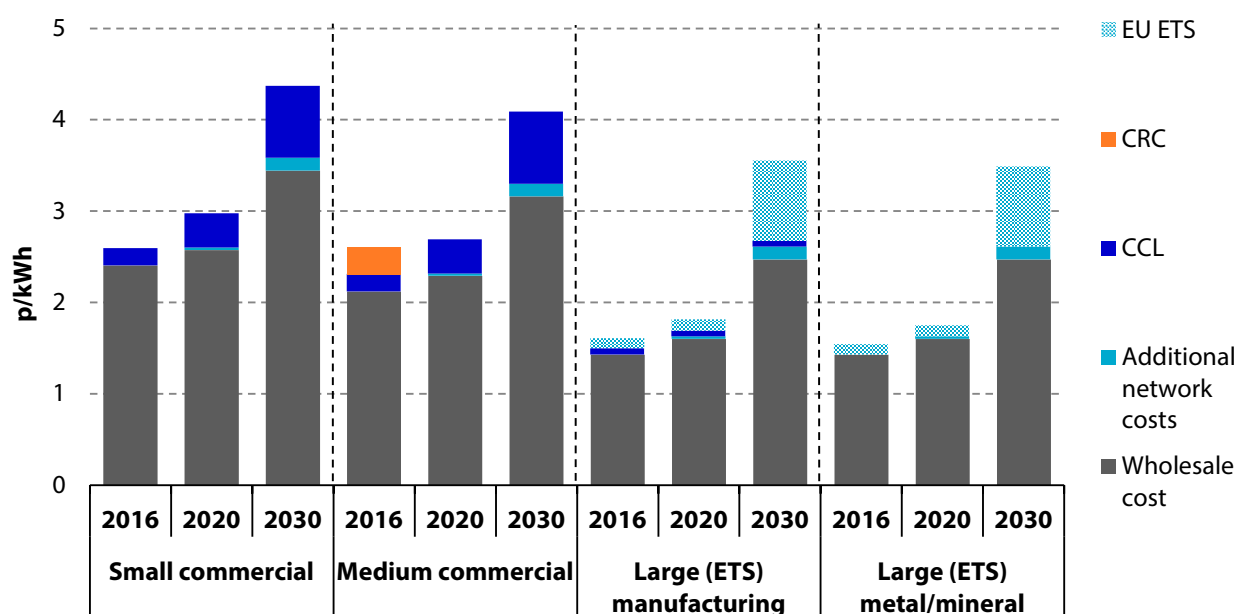
Firms will face similar wholesale price rises as for households, although those subject to the full CCL or in the EU ETS will face higher marginal price increases (Figure 2.12, Tables 2.10 and 2.11)

- **Small commercial.** Gas prices are projected to increase in real terms by 15% to 2020 and 69% to 2030. Of this, low-carbon policy will be responsible for over half of the increase to 2020 and two-fifths of the total increase to 2030. The main increase in low-carbon policy costs comes from an increase in the CCL in order to recoup revenue lost from scrapping the CRC for larger gas consumers, a rise in the CCL to match the electricity rate, and additional gas network costs.
- **Medium-sized commercial.** Gas prices are projected to increase by 3% to 2020 and 57% to 2030. Low-carbon policy costs are expected to fall to 2020 due to the scrapping of the CRC, but then increase to 2030 due to an increase in the CCL and additional gas network costs.
- **Large manufacturing (in EU ETS).** Gas prices are projected to increase by 13% to 2020 and 121% to 2030. Of this, low-carbon policy will be responsible for a fifth of the rise to 2020 and half of the rise to 2030, mainly from the marginal cost impact of ETS allowances (or loss in revenue of using free allocation) and additional gas network costs.
- **Large metallurgical/mineralogical manufacturing (in EU ETS).** Gas prices are projected to increase by 14% to 2020 and 127% to 2030. Of this, low-carbon policy will be responsible for a fifth of the rise to 2020 and half of the rise to 2030, mainly from the marginal cost impact of ETS allowances and additional gas network costs.

### *Outlook for other fuel prices*

To 2030, low-carbon policies will only increase marginal prices for petroleum products and coal if consumption is covered by the EU ETS (Figure 2.13). This could provide incentives for switching to lower-carbon energy sources.

**Figure 2.12.** Change in illustrative retail business gas prices (2016, 2020, 2030)



**Source:** CCC analysis.

**Notes:** We have included EU ETS allowances as a cost in the marginal consumption of energy.

**Table 2.10.** Gas price % change from 2016 (and proportion of change in price due to low-carbon policies) (2020, 2030)

	2020	2030
<b>Small commercial</b>	15% (55%)	69% (41%)
<b>Medium commercial</b>	3% (n/a)	57% (30%)
<b>Large manufacturing (ETS)</b>	13% (18%)	121% (47%)
<b>Large (metal/mineral) manufacturing (ETS)</b>	14% (19%)	127% (47%)

**Source:** CCC analysis.

**Notes:** We have included EU ETS allowances as a cost in the marginal consumption of energy.

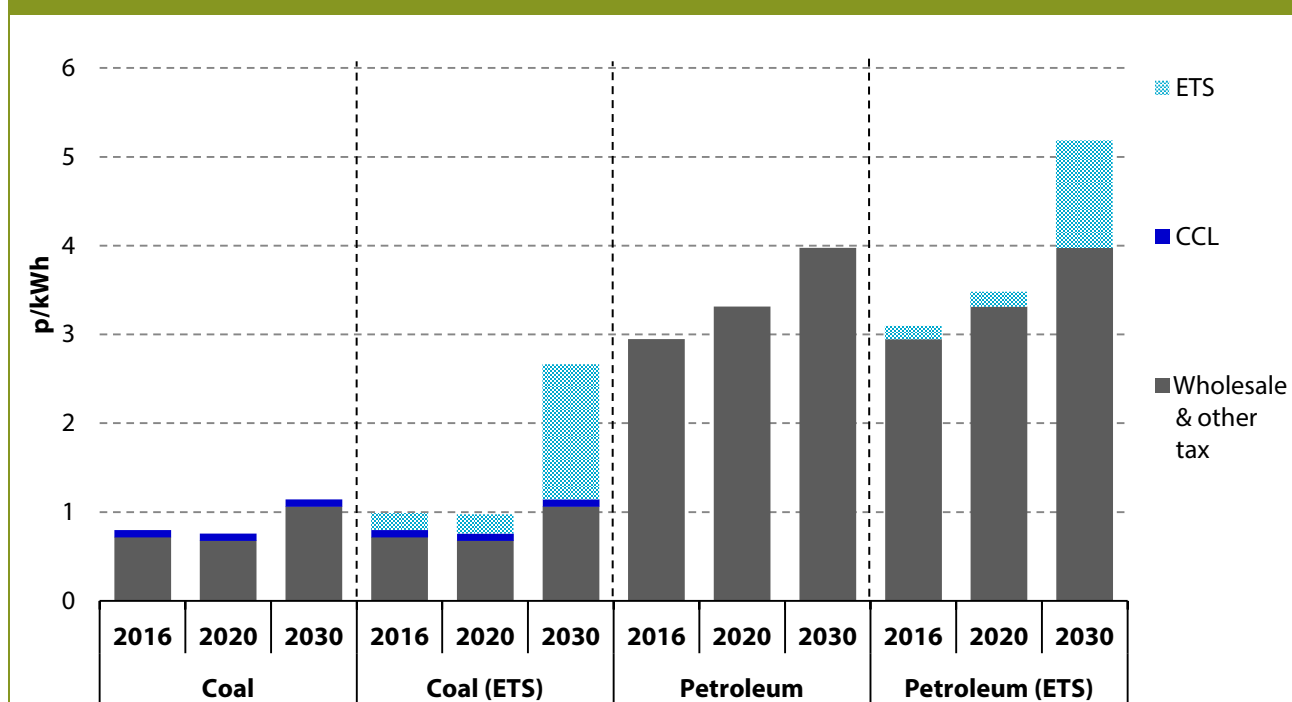
**Table 2.11.** Proportion of gas price due to low-carbon policies (2016, 2020, 2030)

	2016	2020	2030
<b>Small commercial</b>	7%	14%	21%
<b>Medium commercial</b>	19%	15%	23%
<b>Large manufacturing (ETS)</b>	11%	12%	30%
<b>Large (metal/mineral) manufacturing (ETS)</b>	7%	9%	29%

**Source:** CCC analysis.

**Notes:** We have included EU ETS allowances as a cost in the marginal consumption of energy.

**Figure 2.13.** Change in average business petroleum and coal prices (2016, 2020, 2030)



**Source:** CCC analysis.

**Notes:** We have included EU ETS allowances as a cost in the marginal consumption of energy.

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## (d) Outlook for energy efficiency potential

There are significant opportunities to offset the increase in energy prices through uptake of energy efficiency measures.

### *Commercial*

Our scenarios for meeting carbon budgets include opportunities for reducing electricity consumption by around 16% by 2030, although more may be possible.

- A 9% energy saving can be achieved through measures such as energy management and building fabric efficiency measures (e.g. insulation).
- An estimated further 7% saving is possible from replacing appliances and products, due to EU regulations on minimum efficiency standards for electric appliances.
- Examples of best practice in the sector suggest larger reductions are feasible in many instances, irrespective of size of firm.
- As noted in our previous reports (e.g. *The Fifth Carbon Budget*), the evidence base for abatement potential in the non-residential sector needs to be strengthened. Some work on this is underway (e.g. BEES project).<sup>66</sup>

There is therefore potential for many businesses to at least partly offset the average 28% increase in electricity prices to 2030 expected to result from low-carbon policies.

There is also scope to reduce gas consumption in commercial buildings by around 5% by 2030 through energy efficiency measures such as new efficient boilers and insulation, and through better energy management (e.g. heating controls).

### *Manufacturing*

In March 2015 BEIS published a set of 'Industrial Decarbonisation and Energy Efficiency Roadmaps to 2050' for eight heat-intensive sectors, identifying energy efficiency opportunities and abatement options in the manufacturing sector.<sup>67</sup>

Our analysis for the fifth carbon budget estimated that opportunities for energy efficiency in use of electricity and other fuels could reduce combined energy bills by 10%-15% for energy-intensive sectors, based on the opportunities identified in the roadmaps.<sup>68</sup>

The UK Government is working on a set of 'action plans' with industry to specify actions and clear milestones to promote the abatement efforts identified in the roadmaps.

## (e) Outlook for energy bills and consumer prices

### *Commercial*

In 2016 low-carbon policies added 26% on average to commercial sector energy costs. This is due to rise to 30% in 2020 and 34% in 2030 (Table 2.12). Therefore, we estimate the expected impact of low-carbon policies as a share of operating costs will rise from 0.2% in 2016 to 0.3% in

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<sup>66</sup> BEIS (2016) *Building Energy Efficiency Survey*. Available at: [www.gov.uk](http://www.gov.uk).

<sup>67</sup> BEIS (2015) *Industrial Decarbonisation and Energy Efficiency Roadmaps to 2050*. Available at: [www.gov.uk](http://www.gov.uk).

<sup>68</sup> CCC (2015) *The Fifth Carbon Budget: the next step to a low-carbon economy*. Available at: [www.theccc.org.uk](http://www.theccc.org.uk).

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2020 and 0.5% in 2030 (Table 2.13). The Government's forthcoming plan for meeting the fourth and fifth carbon budgets should provide opportunities for energy efficiency improvements, which in our scenarios would cut energy costs by 7% on average.

If all cost increases are passed through to consumer prices, by 2020, costs from low-carbon policies would add 3p to a £10 basket of goods (equivalent to a 0.3% increase in operating costs). By 2030, a total of 5p would be added, though the extent to which increases in energy costs are passed through to consumers depends on market structures and competition (Box 2.3).

### *Manufacturing*

In 2016 low-carbon policies added 21% on average to manufacturing sector energy costs. This could rise to 26% in 2020 and 30% in 2030 (Table 2.12). However, proportionally the low-carbon policy cost impact on the more energy intensive sectors will be slightly lower, due to the compensation and exemptions available for low-carbon policy costs for these firms.

We estimate the expected impact of low-carbon policies as a share of operating costs will rise from 0.4% in 2016 to 0.6% in 2020 and 1.0% in 2030 for manufacturing (Table 2.13). For the more energy-intensive sectors low-carbon policies as a share of operating costs will rise from 0.7% in 2016 to 1.0% in 2020 and 1.6% in 2030. The more electro-intensive manufacturing sectors will see a larger low-carbon policy impact, although under current Government plans for compensation and exemption available to these firms, impacts will be dampened for those deemed "most at risk" of carbon leakage. The Government should ensure businesses can plan on the basis that this will continue to be the case, while keeping the precise coverage, level and conditionality of the compensation and exemptions under review (see Chapter 3).

For more energy-intensive sectors, current low-carbon policy costs are equivalent to around 10% of their gross operating surplus, therefore increases in these costs could potentially have a greater impact on firms if they cannot pass these through to consumers.

By 2020, costs from low-carbon policies would add an additional 6p to a £10 spent on goods and services produced in the manufacturing sector (equivalent to a 0.6% increase in total costs). By 2030, a total of 10p would be added.



**Table 2.11.** Energy cost change from 2016 and proportion of bill that is low-carbon policy cost for commercial, manufacturing and energy-intensive sectors (2016, 2020, 2030)

	Commercial sector (58% of UK GVA)		Manufacturing sector (10% of UK GVA)		Energy-intensive sectors (2% of UK GVA)	
	Energy cost change	% low-carbon	Energy cost change	% low-carbon	Energy cost change	% low-carbon
<b>2016</b>	-	26%	-	21%	-	18%
<b>2020</b>	14%	30%	14%	26%	12%	23%
<b>2030</b>	53%	34%	63%	30%	60%	27%

**Source:** CCC analysis based on BEIS (2016) *Digest of UK Energy Statistics*, BEIS (September 2016) *Quarterly Energy Prices And ONS (2016) Input-Output supply and use tables*. Available at: [www.gov.uk](http://www.gov.uk).

**Notes:** See Table 2.1.

**Table 2.12.** Energy and low-carbon policy costs as a proportion of operating costs (and Gross Value Added) for the commercial, manufacturing and energy-intensive sectors (2016, 2020, 2030)

	Commercial sector (58% of UK GVA)		Manufacturing sector (10% of UK GVA)		Energy-intensive sectors (2% of UK GVA)	
	Energy	Low-carbon policies	Energy	Low-carbon policies	Energy	Low-carbon policies
<b>2016</b>	0.9% (1.1%)	0.2% (0.3%)	2.0% (5.4%)	0.4% (1.1%)	3.8% (14.4%)	0.7% (2.6%)
<b>2020</b>	1.0% (1.2%)	0.3% (0.4%)	2.3% (6.2%)	0.6% (1.6%)	4.2% (16.5%)	1.0% (3.8%)
<b>2030</b>	1.3% (1.7%)	0.5% (0.6%)	3.3% (9.0%)	1.0% (2.7%)	5.9% (25.2%)	1.6% (6.7%)

**Source:** CCC analysis.

**Notes:** See Table 2.1.

#### **Box 2.4.** Do businesses pass through all low-carbon costs to households, through product prices?

In theory, if businesses pass through 100% of the low-carbon policy costs to their product prices, then UK households will pay more for decarbonisation than the immediate impact on their energy bills. Our estimates suggest that low-carbon policies could add around 3p and 6p to a basket of goods across the economy, in 2016 and 2030 respectively. However, actual energy costs that are passed through to consumers may be smaller, due to the energy intensity of the UK commercial sector, the mixture of imported and domestic goods the UK consumers purchase, and competition within sectors.

- Around 30% of UK output (by GDP) is exported and does not affect UK consumer prices at all.
- Similarly, a large fraction of UK manufactured products are imported, therefore domestic consumer good prices are only partially affected by the energy prices paid by UK manufacturers.
- The ability of businesses to pass through particular input price increases are a function of a complex interplay of the economic cycle, degree of within-sector competition, changes to other input prices, potential for international competition, level of taxation and so on. It is not clear that a small increase in overall cost will be directly passed through to consumers, particularly for the vast bulk of UK commercial activity which is not energy intensive. For example, in the financial service industries, retail and light commercial sectors energy bills typically amount to around 1% of total purchases and employment costs (see table 2.13).

**Source:** ICEPT (2012) *Investigating the discourse around policies and consumer bills*. Available at: [www.imperial.ac.uk](http://www.imperial.ac.uk).

### **(f) Uncertainty around projections of future energy and carbon prices**

The estimates presented in this chapter are based on a central projection of fossil fuel prices, carbon prices and low-carbon policy costs. There is however considerable uncertainty around these projections, particularly in the case of gas and carbon prices (Table 2.14).

- If gas prices are lower than in our central projection (e.g. 38p/therm in 2030 instead of 62p/therm), then the percentage impact of low-carbon policies will be high, but energy bills to 2030 will rise less than under central assumptions.
- If gas prices are high (72p/therm), the impact of low-carbon policies on energy bills will be lower, but as low-carbon policies only make up a small proportion of energy prices, overall bills will increase, compared to our central assumption.
- If carbon prices rise more than in our central scenario (e.g. to £127/tCO<sub>2</sub> in 2030, instead of £65/tCO<sub>2</sub>) then energy bills and the impact of low-carbon policies in 2030 would be higher than in the central case. However the value of shifting to low-carbon power generation would be higher.

Investment in low-carbon generation in the power sector reduces volatility in energy prices and energy bills by reducing exposure to uncertain fossil fuel and carbon prices.

**Table 2.13.** Changes in energy bills to 2020 and 2030 (and proportion of increase that is due to low-carbon policy), given a range of gas and carbon prices

	Commercial sector		Manufacturing sector		Energy intensive sector	
	2020	2030	2020	2030	2020	2030
Central gas and carbon prices	14% (59%)	53% (50%)	14% (66%)	69% (40%)	12% (64%)	70% (28%)
Low gas price	8% (104%)	43% (77%)	6% (162%)	52% (66%)	4% (190%)	53% (44%)
High gas price	26% (30%)	57% (42%)	31% (29%)	77% (32%)	29% (26%)	79% (29%)
Low carbon price	16% (42%)	54% (47%)	13% (62%)	68% (40%)	11% (60%)	70% (29%)
High carbon price	26% (63%)	63% (55%)	25% (72%)	83% (44%)	23% (65%)	87% (26%)
Low gas price & high carbon price	12% (103%)	46% (79%)	11% 118%)	61% (62%)	11% 105%)	66% (38%)
High gas price & low carbon price	26% (30%)	57% (42%)	31% (28%)	77% (33%)	29% (26%)	79% (30%)

**Source:** CCC analysis.

# Chapter 3: Maintaining UK competitiveness in a low-carbon economy





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The Climate Change Act requires the assessment of the impact of the carbon budgets on the “economy and the competitiveness of particular sectors of the economy”. In many sectors of the economy, any costs for measures used to achieve carbon budgets are likely to be passed on to consumers. In practice, the UK has reduced emissions by 38% from 1990 to 2015 while the economy grew by nearly 65% and manufacturing economic output has been maintained (Figure 3.1). However, moving towards a low-carbon economy could present competitiveness challenges and will present opportunities to some specific sectors of the UK economy.

Businesses that produce energy and carbon-intensive products that compete in international markets may face competitiveness challenges if they are exposed to significant cost changes not faced by international competitors. If that results in changing the location of production to other countries (“offshoring” or “carbon leakage”) it would be undesirable for the economy and potentially global emissions. In this chapter we consider whether such shifts are likely to have taken place in the past and how they can be avoided in future.

Moving towards a global low-carbon economy will require the development of new materials, products, technologies and services. In these growing markets there will be new domestic and export opportunities for UK business.

### Key messages:

- **Competitiveness.** Low-carbon policies have not had a major impact on the competitiveness of UK manufacturing to date. To ensure that remains the case the Government should ensure compensations and exemptions for firms at risk of carbon leakage are predictable and reliable. There are at least three reasons to think that competitiveness effects of UK carbon budgets have been low:
  - **Output trends.** With the exception of the financial crisis, the UK's manufacturing output has shown fairly steady slow growth since 1990 (Figure 3.1), despite strengthening low-carbon policies since the early 2000s.
  - **Emissions drivers.** Outside the financial crisis, falls in UK industrial emissions largely reflect shifts to lower-carbon fuels, improved energy productivity and structural changes towards less carbon-intensive manufacturing.
  - **Impact of low-carbon policy on prices.** Following some delays in introduction, manufacturing sectors deemed by the Government 'at most risk of carbon leakage' now receive compensations and exemptions from the costs of low-carbon policies. These can reduce low-carbon policy costs on electricity by up to 80%. For these firms low-carbon policy adds less than 10% to the electricity price, which adds less than 2% to operating costs in the case of steel.
- **International comparison.** UK industrial gas prices are low by European standards but electricity prices are high. Differences in low-carbon policies cannot explain the difference in electricity prices, which stem primarily from higher wholesale and network costs. It is not clear why these costs are higher in the UK than in many comparable economies or by how much wholesale energy and network costs differ. This should be considered further in the review of business energy costs announced in the Government's consultation on the industrial strategy.
- **Opportunities and the low-carbon economy.** The UK economy will need to adapt as the UK continues to reduce emissions and as low-carbon products replace high-carbon products internationally. That transition is already underway and presents opportunities for UK

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businesses, including those currently producing high-carbon products. It must be integral to the Government's new industrial strategy.

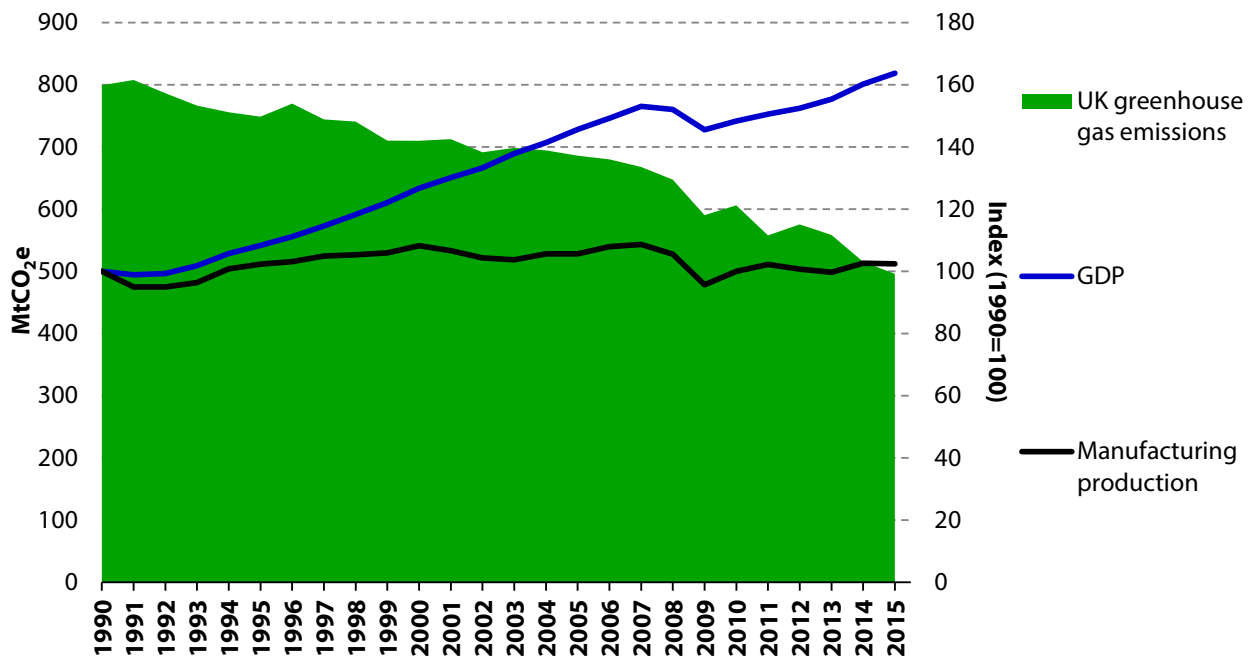
- The UK low-carbon economy is already estimated to employ hundreds of thousands of people and contribute around 2-3% of GDP, which is a comparable size to energy-intensive manufacturing. It has been growing faster than the rest of the economy.
- Following the Paris Agreement, global demand for low-carbon goods and services is set to expand many times over to 2030 and then again to 2050. UK businesses must adapt to meet this need in place of the declining demand for high-carbon goods and services.
- The UK is particularly well-placed to take advantage of growing global markets for low emission vehicles; low-carbon finance, insurance and consulting; low-carbon electricity; smart grids and energy efficient products.
- Reducing emissions also brings important co-benefits, particularly for health, resulting from improved air quality, better housing, reduced noise and more active transport (e.g. walking and cycling).

- **Recommendations:**

- Cost compensation and exemptions should remain so long as there are differences in low-carbon policy costs between the UK and elsewhere. The Government should ensure businesses can plan on the basis that this will be the case, while keeping the precise coverage, level and conditionality of the compensation and exemptions under review.
- Longer term, the Government should consider policies to ensure a level playing field with other countries while encouraging action to reduce emissions. That could be based on more consistent international approaches or border tariff adjustments that put a charge on imports based on their carbon content.



**Figure 3.1.** UK greenhouse-gas emissions, GDP and manufacturing production (1990-2015)



**Source:** BEIS (2016) *Final UK greenhouse gas emissions national statistics: 1990-2015*. Gross Domestic Product and manufacturing index of production from ONS (2016).

**Notes:** The left axis shows UK greenhouse gas emissions, the right axis shows GDP and manufacturing production on an index where 1990=100.

We set out our analysis in three sections:

- Overview of competitiveness and sectors at risk
- Historical competitiveness effects of UK climate policy
- Current UK low-carbon economy and future opportunities

## (a) Overview of competitiveness and sectors at risk

### (i) Competitiveness and carbon budgets

The Climate Change Act requires the Committee to consider the ‘competitiveness of particular sectors of the economy’. We have made a series of assessments of the impacts of carbon budgets on competitiveness dating back to our first report in 2008.<sup>69</sup> In those assessments we have emphasised:

- Shifting to a low-carbon economy will bring both competitiveness challenges and opportunities for new businesses. There is no long-term employment penalty from moving to a low-carbon economy. Moreover, given likely shifts in international regulation and policy this shift is required and underway.

<sup>69</sup> CCC (2008) *Building a low-carbon economy*. Available at: [www.theccc.org.uk](http://www.theccc.org.uk).

- Competitiveness concerns could arise if the UK imposes larger costs on firms than competitors in international markets. However, even with tight carbon targets, competitiveness problems can be avoided with effective policy design.
- The possibility of material competitiveness effects is limited to a small subset of sectors that are both energy-intensive and internationally traded. For these sectors it is important to avoid competitiveness effects: even individual installations are economically important at the local level while shifts in production to other countries could adversely affect global carbon emissions, defeating the purpose of UK policy.

There are three primary effects of carbon leakage that are of concern:

- Installations close, with production moved elsewhere,
- Activity is reduced in existing installations,
- Expanded activity and new investment occurs in foreign markets with less tight greenhouse gas targets and associated costs.

Disentangling the effect of climate policy from other drivers is difficult. We focus on the links to climate policy specifically, but clearly other factors are important:

- **Globalisation and high UK real wages.** Comparative advantage shifts production away from labour intensive industries in competition with lower wage cost economies like China, and to 'high-tech' and service sector based industries.
- **Exchange rates.** Because manufacturing is export led, the sector can be sensitive to changes in the value of the pound. Periods of declines in manufacturing occurred during periods of a strong pound, e.g. in the early 1980s, and early 2000s. However, this is only one factor and it is also worth noting that the fall in the pound post-2008 seems to have done little to boost manufacturing growth.
- **Wider economic trends.** UK manufacturing output fell considerably during the financial crisis of 2008 and to a lesser extent in the recession of the early 1990s.

As well as exploring the effects of climate policy across the economy we include 'deep dives' on three sectors where significant closures occurred: steel, aluminium and cement (section 2(b)).

## (ii) Sectors at risk of competitiveness problems

Sectors are only at risk where their outputs are traded and where climate policies add materially to their costs:

- There are many sectors of the economy where 'competitiveness' effects are not an issue with regards to low-carbon policy, because the activity is inherently untraded. An increase in the operating cost base of UK retailers, for instance, will not induce a shift of shopping activity to other countries.
- There are many sectors which are subject to international competition but where energy costs are so small as a percentage of total production cost that the impact of low-carbon policies is unlikely to be material compared with other drivers of location. Financial services is one such sector.

We focus therefore on manufacturing sectors where energy costs are a greater proportion of operating costs, particularly for energy-intensive sectors.

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UK manufacturing is a significant part of the UK economy and source of emissions.<sup>70</sup>

- The sector is 10% of UK Gross Value Added (GVA)<sup>71</sup> and 8% of UK jobs (2.5 million jobs).
- In 2015, manufacturing directly accounted for 85 MtCO<sub>2</sub> (17%) of UK emissions.

Emissions in manufacturing are concentrated among energy-intensive sectors, defined as those that spend over 10% of their GVA on energy (Figure 3.2).

- The key energy-intensive industries are: paper & paper products, basic metals, non-metallic minerals (i.e. cement, glass, ceramics etc.), refineries, chemicals, rubber and plastics.<sup>72</sup>
- Together these accounted for around 2% of UK GVA, 1.5% of UK jobs (around 485,000 jobs) and 13% of UK CO<sub>2</sub> emissions.<sup>73</sup>

The Government has estimated around 15% of manufacturing electricity consumption will meet the threshold for being exempt from the majority of the costs of supporting low-carbon generation (see Chapter 2). This threshold applies where electricity costs are at least 20% of a firm's Gross Value Added.

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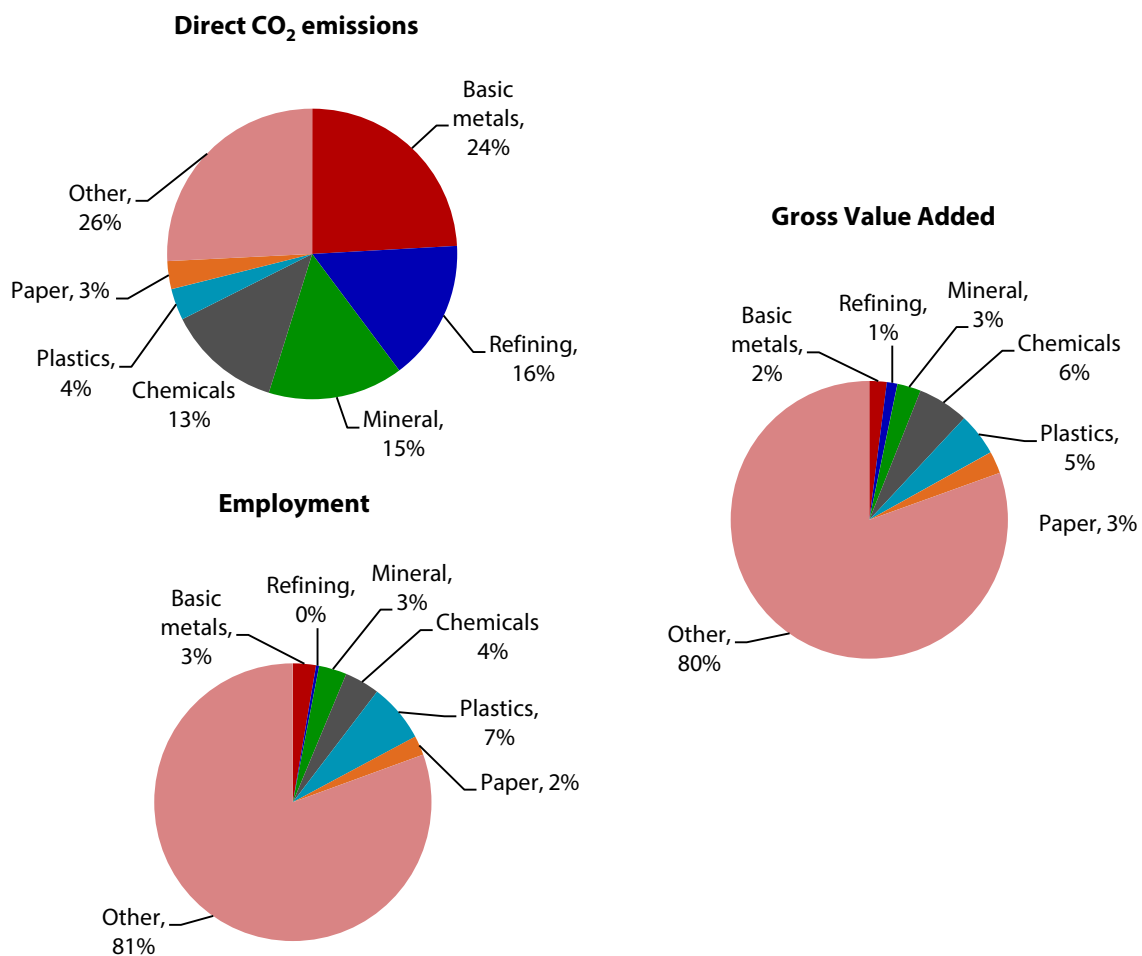
<sup>70</sup> Manufacturing definition used for this analysis includes refining and covers ONS SIC codes 10-33.

<sup>71</sup> This is a 2014 figure. GVA is the measure of the value added to the economy.

<sup>72</sup> There are other sectors production that is also energy-intensive, such as parts textiles and wood manufacture.

<sup>73</sup> GVA data from ONS *Supply Use Tables* (2014), employment from ONS *Labour Market Survey*.

**Figure 3.2.** UK manufacturing emissions, Gross Value Added (GVA) and employment by sector (2014)



**Source:** CCC analysis: direct CO<sub>2</sub> emissions based on ONS (2016) *Environmental Accounts* and BEIS (2016) *Final UK greenhouse gas emissions national statistics: 1990-2015*. Gross value added from ONS (2016) *Supply & Use Tables* and employment (average for year) from ONS (2015) *Annual Business Survey*.

**Notes:** Numbers may not sum due to rounding.

## (b) Historical competitiveness effects of UK climate policy

The four sections that follow cover four approaches for assessing competitiveness effects to date.

- (i) Trends in UK manufacturing output and emissions
- (ii) Deep dives on sectors in decline
- (iii) Decomposition of drivers of emissions reductions
- (iv) Assessment of costs faced by UK industry as a result of climate policies compared to competitors

### (i) Trends in UK manufacturing output and emissions

In 2015 UK manufacturing output was 2% higher than it was in 1990, while direct greenhouse-gas (GHG) emissions have halved (Figure 3.2). That is consistent with the economy-wide UK trends where overall output grew by nearly 65% while emissions fell 38%.

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Output of UK manufacturing reached an all-time high in 2007 before it was hit by the financial crash in 2008. Outside of the recessions of the early 1990s and late 2000s manufacturing production grew by an average of 1% per year<sup>74</sup>. This growth is slower than the 2-3% average growth of the economy as a whole. Despite continued steady growth, UK manufacturing has made up a declining share of GDP since the early 1950s.<sup>75</sup>

- Manufacturing as a share of total economic output has fallen from 30% in 1960 to 10% today.<sup>76</sup>
- Manufacturing as a share of total employment has fallen from nearly 40% in 1964 to 8% today.<sup>77</sup> The number of people employed in manufacturing has dropped steadily as productivity per employee has increased.<sup>78</sup>
- The decline in manufacturing as a share of GDP, is a phenomena experienced in other developed western economies. France and the US have similar manufacturing shares of economic output to the UK and have experienced a similar declining trend over the last couple of decades.<sup>79</sup>

These steady trends are despite increased ambition to reduce greenhouse gas emissions in recent years, suggesting that increased ambition is unlikely to have been a key driver overall.

**Conclusion: The high-level trends in UK manufacturing out and emission since 1990 suggest that UK climate policy has not had a major negative effect on UK manufacturing.**

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<sup>74</sup> ONS IOP data from 1992-2007 and 2009-2015.

<sup>75</sup> ONS (2014), *The Changing Shape of UK Manufacturing*, Available at: [www.ons.gov.uk](http://www.ons.gov.uk).

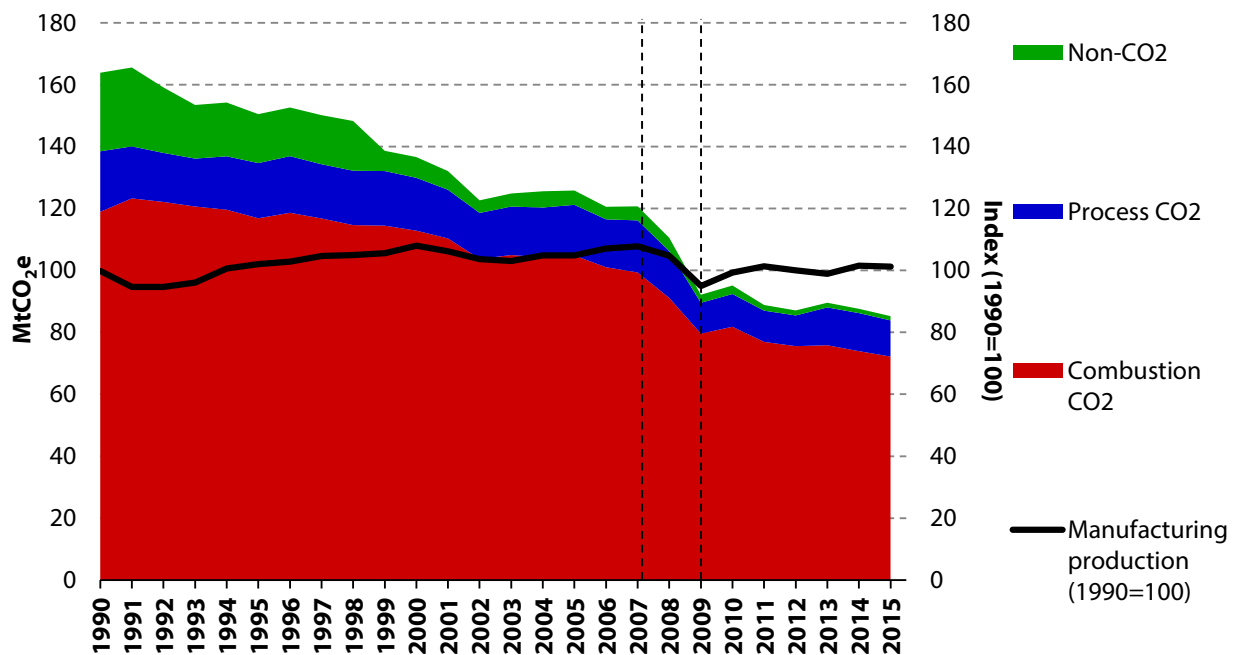
<sup>76</sup> OECD (2016) *OECD in Figures*. Available at: [www.oecd-ilibrary.org](http://www.oecd-ilibrary.org).

<sup>77</sup> ONS, *Labour Market Statistics*, [www.ons.gov.uk](http://www.ons.gov.uk).

<sup>78</sup> ONS (2014), *The Changing Shape of UK Manufacturing*. Available at: [www.ons.gov.uk](http://www.ons.gov.uk).

<sup>79</sup> Over 1997-2014. Available at: [data.worldbank.org](http://data.worldbank.org).

**Figure 3.3.** UK manufacturing and refining emissions and production (1990-2015)



**Source:** BEIS (2016) *Final UK greenhouse gas emissions national statistics: 1990-2015*. ONS (2016) *Index of production*.

**Notes:** Dotted lines indicate period of financial crash. The left axis shows UK greenhouse gas emissions, the right axis shows GDP and manufacturing production on an index where 1990=100.

## (ii) Deep dives on sectors in decline

Whilst the overall trend in industrial activity has been broadly flat, some specific sectors have experienced significant declines. The Committee commissioned Cambridge Econometrics to assess three sectors that have experienced contraction in UK capacity (steel, aluminium and cement).

The main purpose of the case studies was to identify the causes for the decline in each of the sectors. The results of the analysis found some common themes across the sectors:

- **Financial crisis.** All three case studies demonstrate that a large part of the decline occurred during the global economic crisis of 2007-09. Key customer sectors include construction, motor vehicles and other transport equipment (including aerospace, trains) which were impacted by the crash.
- **Exchange rates.** The steel and aluminium case studies cite that the strong value of sterling, prior to the financial crash, raised UK prices on the international market and subsequently impacted on sectors profitability.
- **Increasing global competition.** In the case of steel, overall production capacity had been rising worldwide since 1990. China's economic slowdown since 2013 depressed demand, but was not been met by an equivalent fall in production. China has therefore driven a global glut in the world steel market, pushing down global steel prices. This has increased pressure on steel producers in Europe where local demand has remained low since the financial crisis. The EU aluminium sector has started to face a similar pressure from the Chinese markets.



- **Electricity prices.** Energy costs have risen in recent years, reflecting rising electricity prices, which were typically higher in the UK than in competitor countries. However, the analysis suggests that the majority of this higher electricity cost has been the result of higher UK wholesale/network costs compared to other countries rather than because of climate policies.
- **Low-carbon policy.** Steel and cement were included in the EU ETS from its start and all sectors pay low-carbon policy costs on energy consumed, although these costs have been reduced due to free allocation of allowances and a number of exemptions and compensations.
  - The EU ETS had a limited direct impact on steel and cement in the first two phases as they were granted protection in the form of free allowances.
  - Each of the sectors has benefitted from a discount on the Climate Change Levy (CCL) due to the introduction of Climate Change Agreements. Also over the last few years these sectors have benefitted from CCL exemptions for mineralogical/meteorology processes.
  - While electricity prices from carbon pricing and supporting low-carbon generation have been increasing, the Government's Energy Intensive Industries (EII) package seeks to reduce this cost through offering compensation to electro-intensive sectors.
  - However, the case studies recognise that a large part of the compensation package did not fully come into effect until 2016. Other EU countries introduced their packages far earlier which had the effect of increasing the relative costs on UK sectors for those years.

Overall, while these sectors have experienced declines in production over the last few years, and have been impacted by UK low-carbon policy, the case studies do not suggest that UK low-carbon policy was a primary cause of that decline. Higher wholesale energy prices and developments in domestic and international markets have played a bigger role.

***Conclusion: Whilst it is difficult to separate the effects of different factors, our deep dives suggest climate policy was not the main driver of declines in steel, aluminium and cement.***

### **(iii) Decomposition of drivers of emissions reductions**

Falling emissions from the UK manufacturing and refining sectors can be attributed to four factors:

- **Output effects** (i.e. emissions fall as total industrial activity falls).
- **Structural effects** (e.g. total manufacturing output may stay constant, but the relative mix of manufacturing changes resulting in a less carbon-intensive mix of manufacturing output),
- **Switching to fuels with lower direct emissions** (e.g. coal to gas, or fossil fuel to electricity).
- **Energy productivity** (e.g. improvements in energy efficiency, changes in product mix or plant utilisation).

If manufacturing emissions fall due to output effects then this may indicate deteriorating competitiveness with other countries and a cause for concern. Structural effects can indicate that while there is overall output growth, certain sectors' competitiveness may be weakening. Fuel switching and energy productivity are not a concern for competitiveness, and in fact the latter may indicate reducing costs of production.

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Around 90% of the reduction in manufacturing emissions occurred before or as a result of the 2008 financial crisis. It is helpful therefore to split up historical emission changes into three time periods: pre-crisis, financial crisis and post-crisis (Table 3.1).

Analysing the three time periods around the financial crisis shows that emissions initially declined through improvements in energy productivity. Since the financial crisis structural movement towards a less carbon-intensive mix of industrial output played more of a role alongside fuel switching.

- **Pre-crisis (1990-2007).** A growing manufacturing sector meant that the majority of the fall in emissions was due to energy productivity improving at 1.1% per annum, changes in product mix or changes in plant utilisation.
- **Financial crisis (2007-2009).** The majority of the fall in emissions occurred due to a contraction in manufacturing output, which disproportionality impacted on more carbon-intensive firms.
- **Post-crisis (2009-2014).** A growing manufacturing sector reduced emissions through structural change (i.e. faster growth for lower carbon parts of the manufacturing sector) and energy productivity.

Based on the Climate Change Act 2008, our advice on carbon budgets reflects a production-based approach to emissions accounting. This follows the approach adopted around the world, including within the relevant UN frameworks. Meeting global targets requires all countries to decarbonise production. However, monitoring consumption emissions helps to understand the degree to which other economies are decarbonising (Box 3.1).

***Conclusion: Falling UK industrial emissions have reflected improving energy productivity, shifts to lower-carbon fuels and a transition to a less carbon-intensive mix of manufacturing output. Falling output during the financial crisis reduced emissions from UK manufacturing production and imports of manufactured goods to a similar degree.***

**Table 3.1.** Manufacturing sector combustion emissions decomposition analysis

		Pre- crisis (1990-2007)	Financial crisis (2007-2009)	Post-crisis (2009-2014)	Total (1990-2014)
Proportion of 1990-2014 emission decline		45%	45%	10%	100%
Factor impact proportion	Total output	-	55%	-	-
	Structural	5%	30%	45%	30%
	Fuel switching	30%	15%	10%	25%
	Energy productivity	65%	-	45%	45%

**Source:** CCC analysis.

**Notes:** Factor proportions show the relative share of emission reduction over that time period that that can be attributed to each factor, e.g. over 1990-2007, 65% of the fall in emissions can be attributed to an improvement in energy productivity. For periods where total output increased we record that it had zero impact on the reductions in emission, this includes the whole period of 1990-2014 as output increased. Numbers are rounded to nearest 5%.

### Box 3.1. UK consumption and its carbon footprint

The 'carbon footprint' refers to emissions that are associated with the consumption spending of UK residents on goods and services, wherever in the world these emissions arise along the supply chain, and those which are directly generated by UK households through private motoring and home heating. These emissions are often referred to as 'consumption emissions' to distinguish them from estimates relating to the emissions produced within a country's territory.

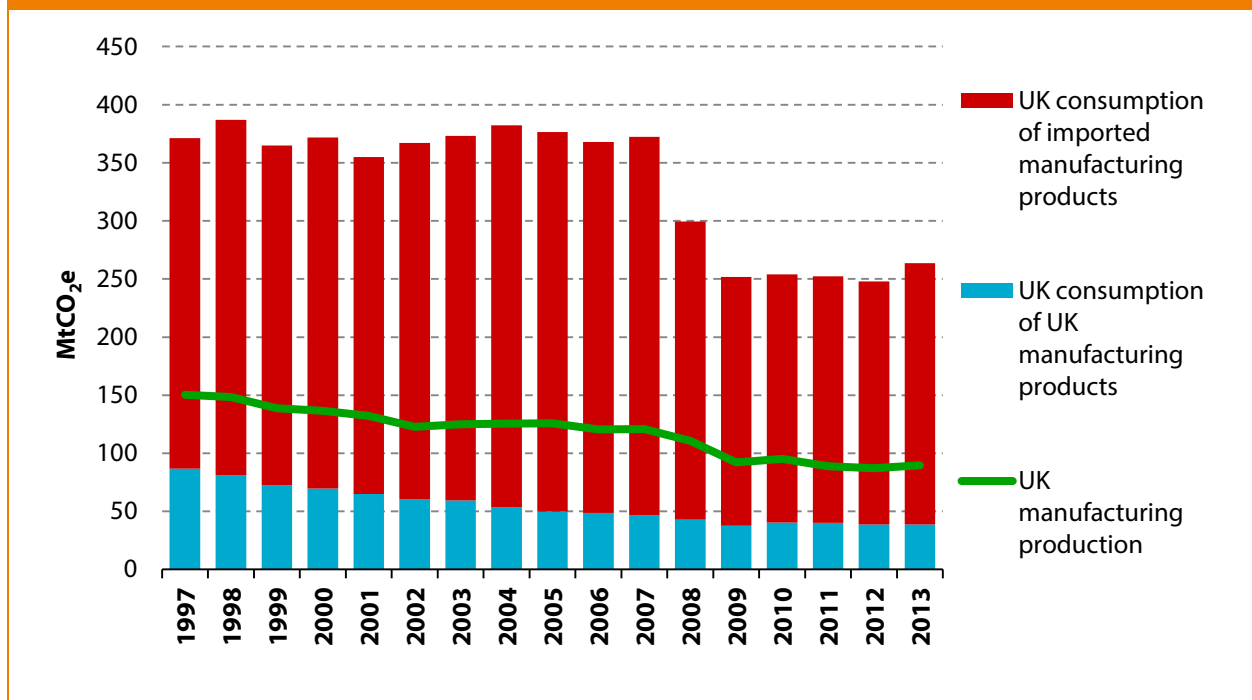
The Government has produced estimates of UK emissions on a consumption basis. These are classified as experimental statistics because of inherent uncertainties in the estimation, which requires consideration of where imported goods are coming from and emissions in their supply chains. The estimates suggest (Figure B3.2):

- There is uncertainty in estimates, but the UK has a carbon footprint substantially larger than its production emissions, reflecting the relatively small share of manufacturing in UK GDP,
- Whilst industrial emissions on a production basis fell by around 20% between 1997 and 2007, emissions from consumption of manufactured goods were broadly flat,
- Consumption emissions have fallen from 2007-2013 more sharply than production emissions, largely due to the recession. Emissions attached to imports fell 31%.

There is a need for international action to cut global emissions, as a consequence of which the UK's carbon footprint would fall. Consumption emissions should continue to be monitored to check whether these are falling in line with required global action, or whether further action is required.

### Box 3.1. UK consumption and its carbon footprint

Figure B3.1. UK manufacturing production and consumption carbon footprint (1997-2013)



Source: CCC analysis based on: the manufacturing subset of Defra (2016) *UK's Carbon Footprint 1997 – 2012*, and BEIS (2016) *Final UK greenhouse gas emissions national statistics: 1990-2015*. Available at [www.gov.uk](http://www.gov.uk).

#### (iv) Assessment of costs faced by UK industry as a result of climate policies compared to competitors

The Committee's scenarios for meeting the carbon budgets involve a 24% reduction in industrial emissions from 2015 to 2030. That central scenario is based on BEIS projections that allow for a 21% increase in UK manufacturing output in the same period and can be achieved largely through measures that are low-cost or cost-saving, so are unlikely to have negative competitiveness impacts. Where measures are required that are higher cost (such as application of carbon capture and storage), these should be delivered through policies that do not negatively affect industry competitiveness (see section 3(c)).

In this section we consider the competitiveness implications of policies that are already planned and in place, specifically the price impacts of UK climate policies on energy costs (as set out in Chapter 2) in the context of international energy prices and the direct costs of the EU Emissions Trading System.

We report that analysis in two sub-sections:

- (i) UK energy prices in an international context
- (ii) EU Emission Trading System

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### *i) UK energy prices in an international context*

Energy-intensive industries with high exposure to international competition are potentially sensitive to changes in energy costs relative to other countries. This section assesses energy prices faced by sectors in the UK as against prices in other countries.

Comparing UK industrial gas prices in 2015 against other countries shows that the UK had one of the lowest gas prices, although data suggests that North American sectors benefit from the lowest gas prices (Figure 3.4). This partly reflects a relatively low level of tax on gas in the UK, with discounts and exemptions to the Climate Change Levy.

Comparing UK industrial electricity prices against other countries is more difficult due to issues around the robustness of data and greater complexity in the policy framework, with policy costs differing by individual firm.

Inclusive of taxes and levies, average industrial electricity prices in the UK are relatively high (Figure 3.5). Germany ranks next highest to the UK. However, the same dataset shows that without taxes and levies prices in Germany are nearly halved. Taxes and levies, which may include the impact of low-carbon measures, can therefore be very significant. These can vary by industry or sector, and averages may not be a good indicator of this impact.

The Committee commissioned Cambridge Econometrics (CE)<sup>80</sup> to estimate electricity prices for electro-intensive firms in the UK and key international competitors in 2016 and 2030. CE focused on key competitor countries where we have the most imports/exports: Germany, China, USA, France, Netherlands, Belgium and Ireland. Key findings are that:

- UK electricity prices for industrial sectors based on Eurostat data are relatively high compared to other countries.
- The majority of this higher cost appears to be due to higher wholesale and network costs.
- An electricity price gap between the UK and other countries is likely to persist until 2030, due to increases in wholesale gas prices and support for low-carbon generation.
- There is also a price differential between EU countries and the US, which will persist, partially due to an expected increase in the EU ETS price.<sup>81</sup>

The analysis used EU published and Eurostat data on wholesale and network costs to ensure consistency in comparison between EU countries. However, this data appears to differ quite substantially from electricity price estimates published by BEIS, even though the Eurostat data is based on estimates submitted by Member States.

The focus of the rest of our analysis is on the relative costs from low-carbon policies for UK sectors compared to other countries. In Chapter 2 we presented potential costs from low-carbon measures on electricity. The cost paid varies significantly depending on the sector and whether they receive compensation for low-carbon policy costs.

There are significant differences in 2016 between countries in the impact on electricity costs of low-carbon policies, including taxation to incentivise energy efficiency, support for low-carbon

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<sup>80</sup> Cambridge Econometrics (2017), *Competitiveness impacts of carbon policies on UK energy-intensive industrial sectors to 2030*, [www.theccc.org.uk](http://www.theccc.org.uk).

<sup>81</sup> As forecast by BEIS.

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generation, carbon prices and the impacts of additional renewable energy in the energy mix.<sup>82</sup> For ease of comparison we show an upper and lower bound for low-carbon costs in other countries, for each sector (assuming the same electricity consumption and electro-intensity as in the UK):

- **Lower bound.** The US has the lowest direct low-carbon policy costs due to a modest energy efficiency charge on electricity. However, Ireland has a relatively large quantity of renewable electricity within its energy mix and sectors benefit from a lower wholesale cost as a result. This could reduce the cost of low-carbon policy for sectors in Ireland close to zero.
- **Upper bound.** Manufacturing sectors in Germany potentially have the highest costs due to low-carbon policy. However, application of this cost is variable depending on pension contributions and the policy cost as a proportion of gross value added, and so can be much lower. It is difficult to allow for this criteria, so the assessment should be seen as an upper bound of German costs from low-carbon policy for these sectors.

For 2016 we have looked at how the cost of low-carbon measures for specific UK sectors compares with the range (Figure 3.6):

- **Fabricated metal sector.** Production is not as electro-intensive as other sectors. We have therefore assumed that this sector pays the full policy cost without discounts or compensation in the UK or other countries. Our analysis shows that although the costs paid are much higher than other UK sectors, this is far lower than the full cost for supporting low-carbon generation in Germany.
- **Cement, glass, ceramics and industrial gas sectors.** Costs from low-carbon policy in the UK are close to the highest costs faced internationally though they are still around 15% of electricity costs.
- **Metals, paper, plastics and fertilizers.** Costs from low-carbon policy are towards the lower bound of this range and are around 10% of electricity costs. However, the most electro-intensive firms in Germany may also be pay much less than the higher bound estimate.

To 2030 we have estimated that if the low-carbon exemption policy is maintained then UK sectors will continue to be within the range of international comparators, and towards the upper bound of that range in some sectors (Figure 3.7).

The main factor explaining differences between electricity prices faced by UK sectors is not the costs of low-carbon policies, but rather the higher UK electricity wholesale and network costs, where the difference can be several pence/kWh. UK electricity prices for manufacturing would remain above most of our competitors even if low-carbon policy costs were zero. In addition, larger firms in some of the key competing countries benefit from sizeable discounts or exemptions from network and transmission costs.<sup>83</sup>

Understanding of these differences should be improved in the review of business energy costs announced in the Government's green paper on the Industrial Strategy.

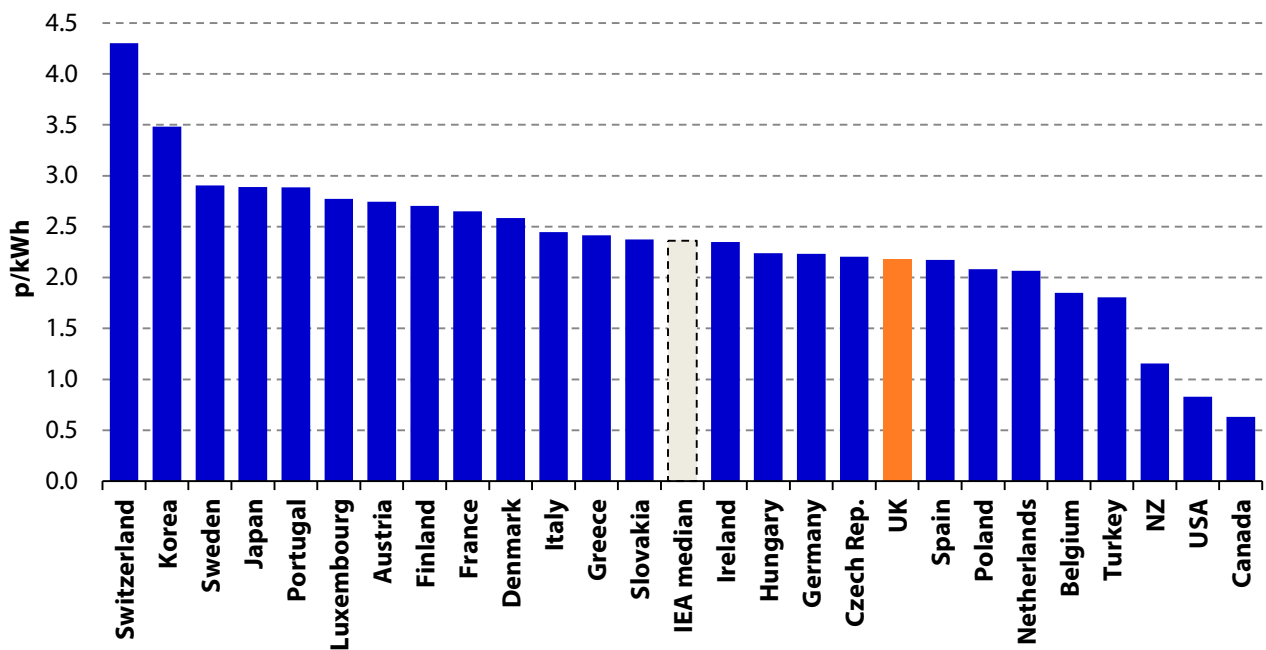
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<sup>82</sup> This includes additional network costs from intermittent renewables and reduced wholesale costs because of the merit order effect.

<sup>83</sup> German, France and the Netherlands exempt some industrial users for up to 90% of the transmission and distribution costs.

**Conclusion: Low-carbon policy costs are currently a small contributor to UK energy costs for electro-intensive industries with high exposure to international competition. UK firm's may face higher costs from low-carbon measures even with exemptions and compensation, but the main cause of higher electricity prices are wholesale and network costs.**

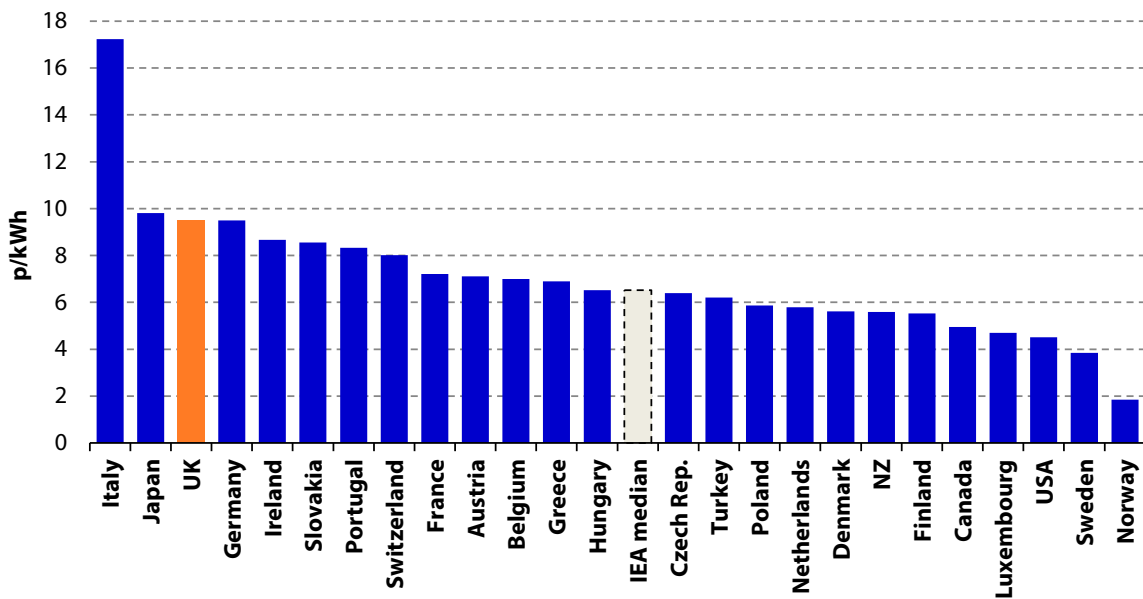
**Figure 3.4.** Average industrial gas prices (with taxes and levies) (2015)



**Source:** BEIS (2017) *Industrial gas prices in the IEA*. Available at: [www.gov.uk](http://www.gov.uk).

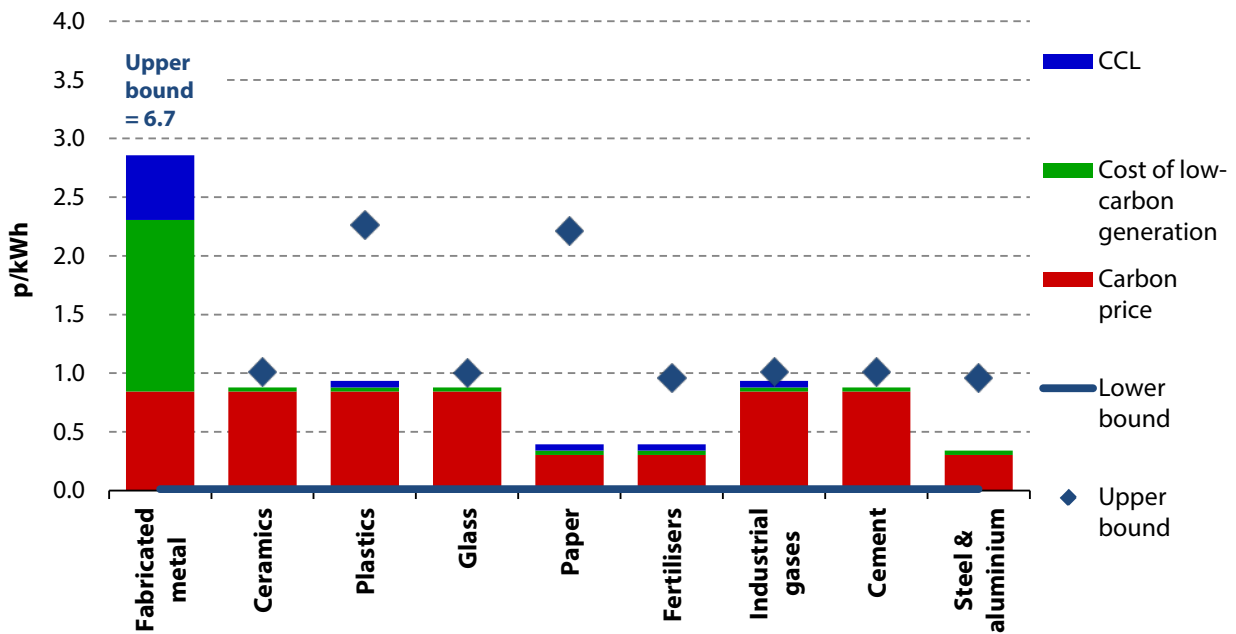


**Figure 3.5** Average industrial electricity prices (with taxes and levies) (2015)



**Source:** BEIS (2017) *Industrial electricity prices in the IEA*: Available at: [www.gov.uk](http://www.gov.uk).

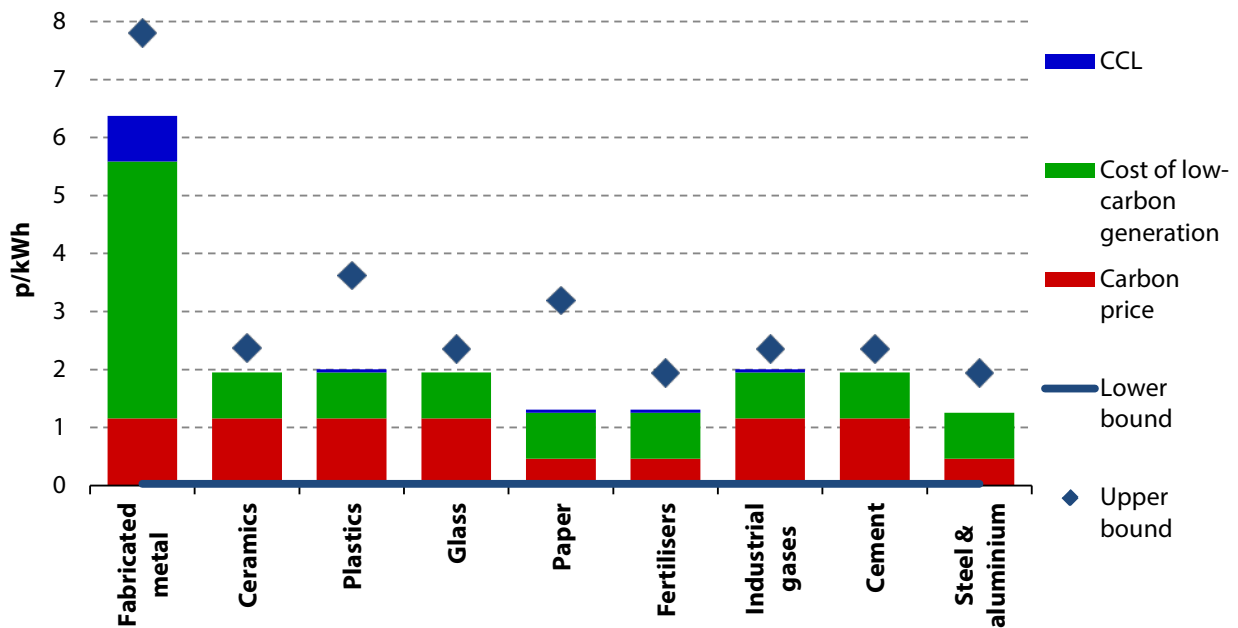
**Figure 3.6.** Low-carbon policy cost relative to range of key competitors, by sector (2016)



**Source:** CCC analysis based on Cambridge Econometrics (2017)

**Notes:** All sectors are electro-intensive enough to receive compensation or exemption from 85% of the costs to support of low-carbon generation (apart from fabricated metal sector). Difference between the upper bound for paper/plastics and other sectors reflects the exemption from the German electricity tax (Stromsteuer). Lower bound is zero.

**Figure 3.7.** Low-carbon policy cost relative to range of key competitors, by sector (2030)



**Source:** CCC analysis based on Cambridge Econometrics (2017).

**Notes:** See figure 3.6.

### ii) EU Emission Trading System

UK energy-intensive sectors that are included in the EU Emissions Trading System (ETS) are required, at the level of individual installations, to surrender allowances to cover their emissions. Purchase of allowances would raise the costs of energy-intensive installations relative to competitors outside the EU that do not face these 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 (Box 3.2).

#### Historical allocation of allowances

The Committee commissioned Cambridge Econometrics (CE) to assess the extent of free allocation compared to verified emissions to date for nine UK energy-intensive sectors in the EU ETS.<sup>84</sup> These nine sectors were chosen based on their potential competitiveness risks in the EU ETS and their size in the UK economy.

We have considered free allocation compared to verified emissions in each phase (Figure 3.8).

<sup>84</sup> Cambridge Econometrics (2017) *Competitiveness impacts of carbon policies on UK energy-intensive industrial sectors to 2030*, www.theccc.org.uk. The nine sectors considered are steel, refineries, chemicals, hollow glass, paper & pulp, cement, lime & plaster, bricks and ceramic tiles.

- **Phase I (2005-2007).**<sup>85</sup> Free allocation was in line with verified emissions for the majority of sectors. Any surplus allowances from Phase I could not be carried over into Phase II.
- **Phase II (2008-2012).** Due to the economic slowdown as a result of the 2008 financial crisis, all sectors were over-allocated in Phase II. Steel, chemicals, bricks, cement and lime & plaster were over-allocated allowances by 40% of actual emissions or more. It is also possible that surplus allowances from Phase II have been carried forward to Phase III.
- **Phase III Historic (2013-2015).** In the early years of Phase III, free allocation has not covered all verified emissions for many of the sectors. Refineries, paper & pulp, hollow glass, ceramic tiles and bricks received free allocation of around 20% below actual emissions.

For most of the sectors considered, it is possible that historical over-allocation of free allowances in Phase II could have been used to offset the under-allocation so far seen in Phase III, although this may not have been the case on an individual installation basis.

Up to 2015, firms will at most have had to buy emissions allowances for a small proportion of their emissions, generally in recent years, when the EU ETS price has been very low (e.g. it was under £6 per tonne in 2015, compared to a peak of nearly £20 per tonne in 2008). This is unlikely to have had a large competitiveness effect given that the implied cost penalty is less than 1% of GVA in 2015 for most sectors.<sup>86</sup> These conclusions concur with other studies on the impact of the EU ETS.<sup>87</sup> However, these are broad findings only and may not reflect the impact on individual installations or participants.

### *Future allocation of allowances*

Cambridge Econometrics also assessed how far free allocation would cover projected emissions from these sectors assuming no change in production levels or emission intensity.

For the rest of Phase III (2016-2020) the pattern follows that established in Phase III so far in that for many of the sectors projected emissions are expected to exceed their free allocation.

The process of allocating free allowances has not been agreed within the EU, so Cambridge Econometrics considered a range based on three proposals for Phase IV (Figure 3.9, Box 3.3). Key findings are that:

- The 'binary' proposal has the widest list of sectors that receive free allowances. All sectors would have free allocation below their actual emissions by between around 5%- 35%.
- The 'tiering' proposals are more effective in supporting the sectors that are seen at most at risk of carbon leakage, but provide less support for other sectors.
  - Steel and chemicals would allocation close to their expected emissions,

<sup>85</sup> Phase I was a pilot phase to test the functionality of the scheme rather than a tool to deliver substantial emissions reductions. Phase I covered only CO<sub>2</sub> emissions from power generators and energy-intensive industries and almost all allowances were distributed for free. The EU ETS initially covered 25 EU countries, Romania and Bulgaria joined in 2007.

<sup>86</sup> CCC analysis based on Cambridge Econometrics (2017), suggests that the cost of allowances would have been limited to less than 1% of GVA in 2015, assuming no use of potential surplus allowances. The exception was cement which was a cost of 2.8% of GVA, although this was based on 2012 GVA estimates which are historically low.

<sup>87</sup> Such as Grantham Research Institute who state "the recent empirical literature finds, on average, very little evidence of adverse economic consequences from the EU ETS." Grantham Institute (2016) *Evaluating the EU Emissions Trading System: Take it or leave it?* Available at: [www.imperial.ac.uk](http://www.imperial.ac.uk).

- But this would be made up by other sectors receiving far fewer free allowances, such as bricks, glass, and lime & plaster.

Depending on the proposal chosen, sectors may need to purchase allowance if they cannot find ways to reduce their emissions. There is also a possibility that carbon prices rise significantly from their current low levels. This could present competitiveness challenges with other countries outside of the EU. It will be important to keep these potential competitiveness pressures under review.

**Conclusion: The EU ETS has had limited competitiveness effects to date since most industrial emissions have been covered by free allowances. Industrial emitters now need to buy allowances for some of their emissions, which could result in competitiveness challenges if the carbon price rises and if they are not able to reduce emissions in line with the tightening allocation of free allowances.**

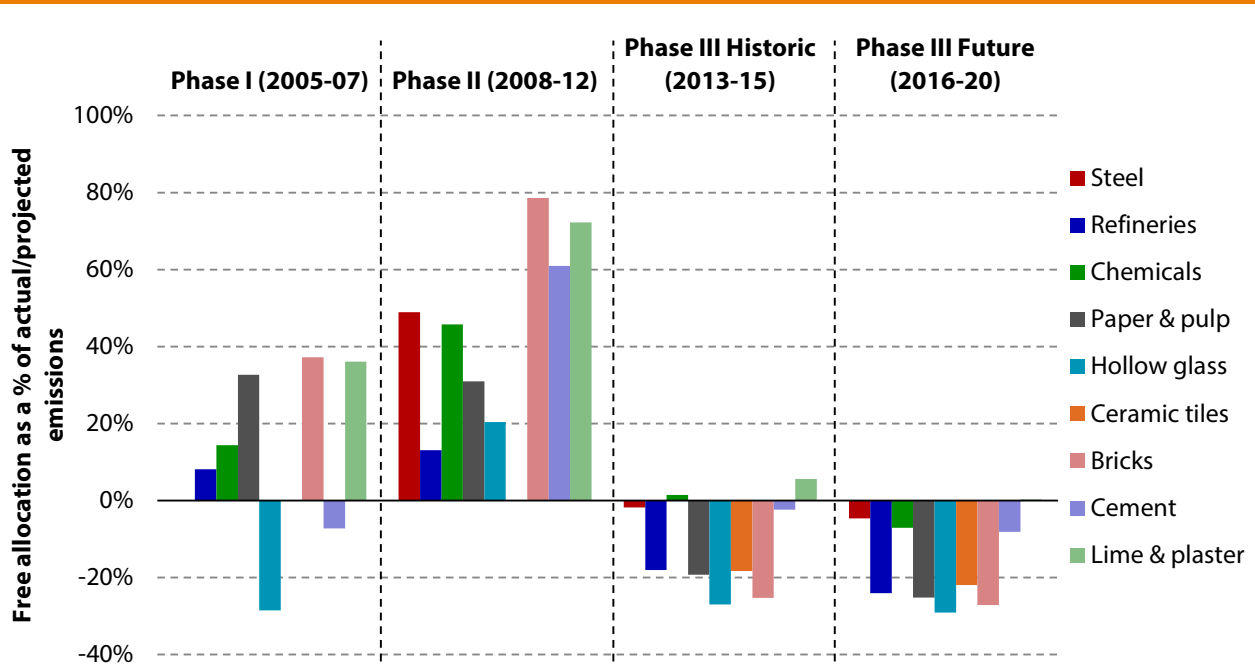
### Box 3.2. Allocation of free allowances in the EU ETS

Sectors covered by the EU ETS, with the exception of most of the EU power sector, are provided with a free allocation of allowances in order to assist with their transition towards a low carbon economy. Industrial sectors at significant risk of competition from countries without similar carbon costs are eligible to receive a higher proportion of allowances for free.

- During Phases I and II, most allowances in all Member States were given out for free based on historical GHG emissions.
- From Phase III a benchmarking approach was introduced for the free allocation of allowances. The total amount of free allocation each installation should receive is determined by product-related GHG emission benchmarks, to the extent feasible. Those benchmarks are set at the average emission level of the 10% most efficient installations within each sector. In this way, installations that are highly efficient should receive all or almost all of the allowances they need to comply with EU ETS obligations. Inefficient installations have to make a greater effort to cover their emissions with allowances, either by reducing emissions or by purchasing more allowances.
- For Phase IV, it has been proposed that the benchmarks will be updated twice, although the framework for the proportion of free allocation that sectors will receive against this benchmark is still to be finalised (see Box 3.4)

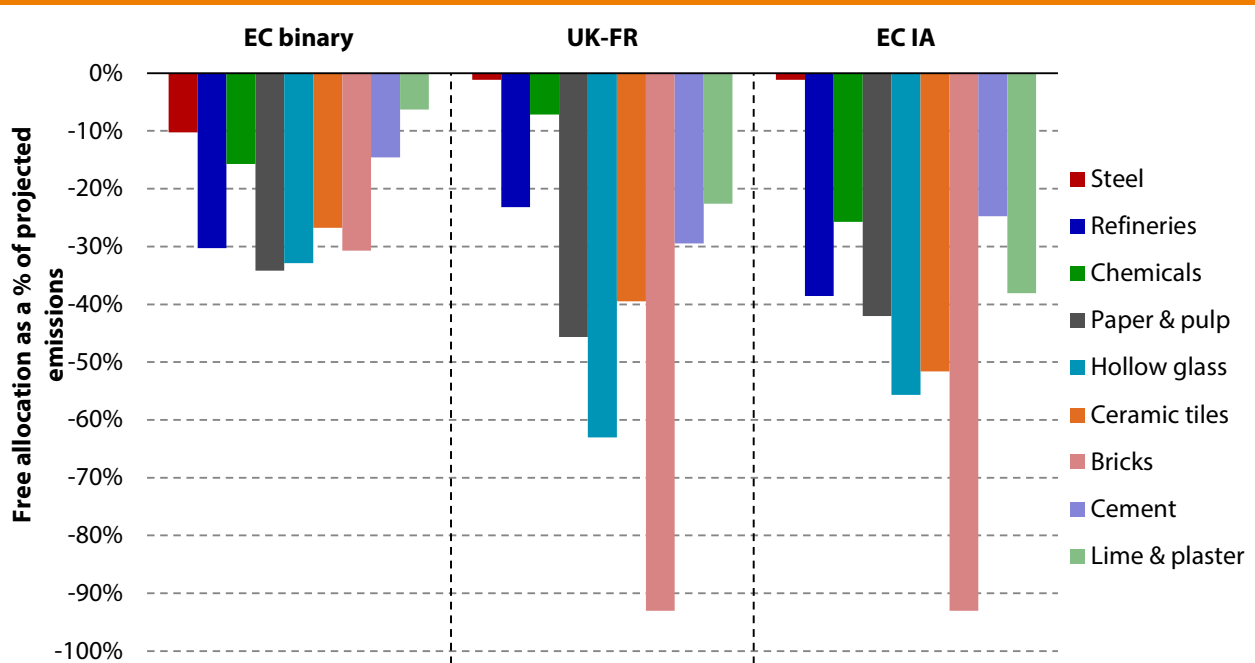
**Source:** Cambridge Econometrics (2017) *Competitiveness impacts of carbon policies on UK energy-intensive industrial sectors to 2030*. Available at: [www.theccc.org.uk](http://www.theccc.org.uk).

**Figure 3.8.** EU ETS free allowances allocation as a proportion of actual or projected emissions, by phase and sector



Source: Cambridge Econometrics (2017) *Competitiveness impacts of carbon policies on UK energy-intensive sectors*.

**Figure 3.9.** EU ETS free allowances allocation as a proportion of projected emissions in Phase IV and sector, depending on allocation method



Source: Cambridge Econometrics (2017) *Competitiveness impacts of carbon policies on UK energy-intensive sectors*. Available at: [www.theccc.org.uk](http://www.theccc.org.uk).

### Box 3.3. Phase IV (2021-2030) free allocation proposals

From 2020, free allocation will be determined by a single carbon leakage indicator by multiplying sectors trade intensity by its emissions intensity (see notes). There are three main proposals that we have considered on how free allowances will be allocated.

- **Binary approach.** In this case if the carbon leakage indicator is above a proposed threshold value of 0.2, the sector is considered to be at risk of carbon leakage and receives 100% free allocation against their benchmark; other sectors receive 30% in 2021 declining to zero in 2027.
- **Tiered approaches.** The EC Impact Assessment (**EC IA**) and the UK-France proposal (**UK-FR**) are 'tiered' approaches where those sectors at greatest risk of carbon leakage receive as great a share of free allocation, whilst providing lower coverage to sectors at relatively lower risk of carbon leakage. Four leakage risk categories are defined (high-, medium-, low-, or no-risk) with corresponding compensation levels, depending on the thresholds set.

On 15 December 2016, both the ITRE and ENVI committees voted for the continuation of the current binary approach, despite earlier drafts proposing a tiered approach. This decision is undergoing the ordinary legislative procedure, whereby both the European Parliament and the Council need to agree on the final legislation. The decision is still uncertain, and our analysis looks at both possibilities.

Table B3.3 below sets out the allocation of free allowances considered for these three proposals.

**Table B3.3.** Binary and tiered (EC IA/UK-FR) proposals for free allocation

Sector	Carbon leakage indicator	% of benchmark free allocation		
		EC binary	EC IA	UK-FR
Steel	>2.5	100%	100%	100%
Chemicals	>2		80%	100%
Refineries	1.98		80%	100%
Cement	1.27		80%	75%
Paper & pulp	1.17		80%	75%
Lime & plaster	0.97		60%	75%
Ceramic tiles	0.93		60%	75%
Hollow glass	0.78		60%	50%
Bricks	0.17		30% in 2021, declining to 0% by 2027	

**Source:** Cambridge Econometrics (2017) *Competitiveness impacts of carbon policies on UK energy-intensive sectors*. Available at: [www.theccc.org.uk](http://www.theccc.org.uk).

**Notes:** The trade intensity indicator is defined as the ratio between the total value of exports to non-EU countries

**Figure 3.9.** EU ETS free allowances allocation as a proportion of projected emissions in Phase IV and sector, depending on allocation method

plus the value of imports from non-EU countries, and the total EU market size. The emissions intensity is defined as a share of the GVA, i.e.  $TC = [(Di \times AF + I) \times P] / GVA$ , whereby the carbon intensity of sector is a function of its direct CO<sub>2</sub> emissions (D), the auctioning factor (AF), the indirect emissions from electricity consumption (I), the carbon price (P) and the sector GVA.

### (c) Current UK low-carbon economy and future opportunities

In this section we consider the implications for the UK of the world moving to a low-carbon economy:

- i) The UK low-carbon economy
- ii) UK opportunities of moving to a global low-carbon economy
- iii) Designing future policy to reduce emissions and grow UK industry

#### a) The UK low-carbon economy

Measuring the size of the UK low-carbon economy is not straightforward. Many companies operating in sectors of the economy, or producing products or services that might be labelled “low-carbon” also operate in non-low-carbon sectors. The traditional Standard Industrial Classification (SIC) codes used to classify industry sectors do not easily map to “low-carbon” activities.

Estimates of the size of the low-carbon economy have been published by the Government (Box 3.4). These suggest, from data covering the first few years of this decade (2010-2013), that the sector has been growing strongly:

- On a relatively narrow “low-carbon” definition, the estimates suggest 11,550 firms operating directly in the sector in 2013. Including supply chain activity employment totalled 460 thousand (1.6% of UK employment), generating almost £45 billion GVA (almost 3% of UK GVA).
- In the 3 years to 2013, employment increased 12% and GVA<sup>88</sup> 28%, compared to increases of 2% and 11% respectively for total UK employment and GVA over the same period.

We commissioned the consultants, Ricardo, to update this assessment. Their estimates suggest a small fall in employment numbers between 2013 and 2015, but the quality of this data is in doubt.<sup>89</sup>

An alternative source for more recent data is available from the ONS “Low carbon and renewable energy economy” survey. The definition of the low-carbon sector within this survey is narrower<sup>90</sup> than the previous BIS survey and available data for 2015 is limited to direct activity only (i.e. excluding the supply chain). From this source, numbers of employees in the sector fell slightly between 2014 and 2015. However, confidence intervals on the ONS data are very wide, and we cannot be confident in the change in estimates between only 2 years.

<sup>88</sup> Cash terms.

<sup>89</sup> Ricardo (2017) *UK business opportunities of moving to a low carbon economy*. Available at: [www.theccc.gov.uk](http://www.theccc.gov.uk).

<sup>90</sup> It excludes financial sector businesses for example.



It will be useful that survey evidence on the size and components of the low-carbon economy continues to be collected. A more reliable picture of the low-carbon economy can only be built up with a longer run of data.

**Box 3.4.** Estimating the size of the low-carbon economy

A methodology for estimating the size of the low-carbon economy in the UK was developed for the 2015 report published by the Government, “The size and performance of the UK low carbon economy”.

This adopts a definition of the “low carbon economy” as the economic activities that deliver goods and services which generate significantly lower emissions of greenhouse gases. This means that the products and technologies included should deliver “a step change in performance” (condensing boilers, for example, are excluded).

The activities of 24 sectors are included, in 6 broad sector groupings (Table B3.5a).

**Table B3.4a.** Low-carbon sectors and groups

Grouping	Sectors
Low-carbon electricity	<ul style="list-style-type: none"> <li>• Onshore wind</li> <li>• Offshore wind</li> <li>• Nuclear energy</li> <li>• Hydroelectric energy</li> <li>• Marine energy</li> <li>• Solar photovoltaic</li> <li>• Carbon capture &amp; storage</li> </ul>
Low-carbon heat	<ul style="list-style-type: none"> <li>• Geothermal heat</li> <li>• Heat pumps</li> <li>• Solar thermal</li> <li>• Heat networks</li> </ul>
Waste processing, energy from waste and biomass	<ul style="list-style-type: none"> <li>• Recycling-recovery &amp; processing of materials from waste</li> <li>• Generation of energy from waste and biomass</li> <li>• Alternatives fuels</li> <li>• Biomass equipment</li> </ul>

### Box 3.4. Estimating the size of the low-carbon economy

Energy efficiency products	<ul style="list-style-type: none"> <li>• Energy efficient lighting</li> <li>• Insulation</li> <li>• Energy efficient windows and doors</li> <li>• Heat recovery and ventilation</li> <li>• Energy controls and control systems</li> <li>• Sustainable architecture and buildings</li> </ul>
Low-carbon services	<ul style="list-style-type: none"> <li>• Low-carbon advisory</li> <li>• Low-carbon finance</li> </ul>
Low emission vehicles	<ul style="list-style-type: none"> <li>• Low emission vehicles</li> </ul>

A database of firms operating in these sectors was developed. A sample of the firms was contacted to gather data on the extent of activity in each sector (the same firm may operate in more than one low-carbon sector), as well as the proportion of activity outside the low-carbon sectors.

To the extent that inclusion of firms in the database was on a self-reported basis (some businesses may not identify themselves in this way) the true level of low-carbon activity may be under-estimated.

The estimates separately identify supply chain activity as well as direct activity in the sector. This supply chain activity is based on multipliers published by ONS.

The survey shows growing contributions to value added and employment (Table B3.5b) in these sectors over the period 2010-2013.

Using this same methodology, updated estimates for 2015 are provided in the Ricardo consultancy report, published with this report. Given uncertainties in the application of the methodology, we do not directly quote these estimates here.

**Table B3.4b.** Employment in the UK low-carbon economy (2010-2013)

Sector grouping	2010	2011	2012	2013
Low-carbon electricity	112,500	127,500	138,000	140,800
Low-carbon heat	29,300	30,100	31,300	32,600
Energy efficiency products	92,100	93,300	93,800	94,200
Low-carbon services	28,100	27,500	28,200	28,000
Waste processing, energy from waste and biomass	133,400	135,800	140,600	146,900

### Box 3.4. Estimating the size of the low-carbon economy

Low-emission vehicles	16,100	19,000	18,200	18,100
Total	411,400	433,100	450,300	460,600

**Source:** BIS (2015) *The size and performance of the UK low carbon economy: Report for 2010 to 2013*. Available at: [www.gov.uk](http://www.gov.uk).

## b) UK opportunities of moving to a global low-carbon economy

At the Paris climate conference (COP21) in December 2015, over 190 countries adopted a universal global climate deal that has since been ratified. The agreement sets out a global ambition to limit global warming to well below 2°C and to pursue efforts to limit it to 1.5°C. To support this, the Paris Agreement sets an aim of net zero global emissions in the second half of the century.

Before and during the Paris conference, countries submitted comprehensive nationally determined contributions (NDCs). Current pledges through the NDCs fall short of a path to meet the stated aims of the Paris Agreement, but the Agreement includes a process for taking stock of progress and increasing action (Box 3.5).

Increasing numbers of businesses and investor groups also recognised the need for action and made their own commitments. The Non-State Actor Zone for Climate Action (NAZCA)<sup>91</sup>, a global platform that brings together commitments by companies, cities, subnational regions and investors, now records 30 separate business-lead initiatives, with more than 3,300 participants. Commitments are of various types, but include adoption of science-based emission reduction targets and procurement of renewable electricity. The number of participants has increased markedly (17%) since the Paris conference.

The UK economy will need to adapt as the UK continues to reduce emissions and as low-carbon products replace high-carbon ones internationally. The transition is already underway. In some areas, like the move to electric vehicles and increased use of solar photovoltaics and wind power, global momentum is already substantial and promises lower cost alternatives to fossil fuels in the future. Overall the transition presents opportunities for UK businesses, including those currently producing high carbon products.

The Committee commissioned Ricardo to assess the potential economic opportunity of a global transition to a low-carbon economy, where the UK is placed in producing the goods and services needed for this new economy and specific areas where the UK may have advantage (Box 3.6).

Ricardo's assessment suggests that global markets for low-carbon goods and services, in a world taking actions to reduce emissions consistent with keeping global temperature rise to 2°C, will expand many times over:

<sup>91</sup> Non-State Actor Zone for Climate Action. Available at: [climateaction.unfccc.int](http://climateaction.unfccc.int); Business Contribution to Global Climate Action, 2016 Status Report, UN Global Compact, November 2016.

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- The global market for products and services related to the production of low-carbon electricity could expand at an annual average rate of 5-7% between 2015 and 2030, and 4-5% from 2030 to 2050.
  - The global market for products and services related to low emission vehicles (including battery electric vehicles, plug-in hybrid electric vehicles and fuel cell electric vehicles) could grow at an average annual rate of 25-30% to 2030, and then around 7% from 2030 to 2050.
  - The global market for low-carbon financial services could grow at annual average rates exceeding 10% to 2030, before settling back to annual growth around 2-3% from 2030 to 2050.

Ricardo identified that the UK is particularly well-placed to take advantage of growing global markets for low emission vehicles, low-carbon finance, insurance and consulting, low-carbon electricity, smart grids and energy efficient products (Table B3.6).

UK businesses will need to adapt to meet growing global demands, and the transition away from high-carbon goods and services. Their success in doing this will depend on factors including the UK's ability to build on areas of comparative advantage, performance in low-carbon innovation, and the policy environment – the transition should, for example, be integral to the Government's new industrial strategy.

The potential benefits should not be measured as the size of the low-carbon economy, whether in terms of jobs or GVA. The economy will need to transition out of some areas and into others. However there are big opportunities from managing that transition smoothly and in line with UK comparative advantage. Even on a simplifying assumption that the UK is no more successful in these growing global markets than maintaining its current market share in related technology areas, Ricardo estimate that, within a growing economy, the share of overall UK output devoted to low-carbon goods and services could grow from around 2-3% now up to 8% by 2030, and rising further to 2050.

### Box 3.5. International developments and the Paris Agreement

The Paris Agreement is the first truly global effort to reduce emissions. Its central aim is to strengthen the global response to the threat of climate change by keeping global temperature rise to well below 2°C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5°C.

There were over 190 parties to the Agreement, including the UK. It entered into force on 4 November 2016, after it had been ratified by at least 55 Parties to the Convention, accounting for at least 55% of total greenhouse gas emissions. Currently, 133 countries have ratified.<sup>92</sup>

In the run-up to the Paris meeting, Parties submitted pledges of action to 2030, known as Intended Nationally Determined Contributions (INDCs). Following the Agreement, these pledges are known as Nationally Determined Contributions (NDCs). Current pledges do not together add up to a pathway that meets the aims of the Agreement: global emissions are projected to grow more slowly than previous projections, but still rise to 56 GtCO<sub>2e</sub> per year in 2030, while parties to the Agreement recognised 40 GtCO<sub>2e</sub> per year in 2030 as the level consistent with staying below 2°C.<sup>93</sup>

In 2018, Parties will take stock of collective efforts in relation to progress toward the goal set in the Agreement and to inform the preparation of further, stronger NDCs. There will also be a global stocktake every 5 years to assess collective progress and to inform further individual actions by Parties.

### Box 3.6. UK business opportunities in the global transition to a low-carbon economy

Ricardo developed a methodology to assess the potential scale of UK business opportunities, going through a number of steps:

- Consideration of timelines for deployment of different technologies, in a world committed to a low-carbon transition. This drew on IEA Energy Technology Perspectives for a global view and the scenarios for the UK developed in the Committee's fifth carbon budget advice;
- Consideration of UK strengths in those markets, narrowing down from a long-list of potential low-carbon goods and services, to a small number of areas for further quantification. This selection was informed by a review of literature, existence of a domestic market within the UK, and availability of data;
- Estimation of the size of future global markets for those selected low-carbon materials, goods and services, assuming a transition to a low-carbon economy consistent with staying below a global temperature increase of 2°C;
- Estimation of potential UK shares of those markets going forward, on an assumption that UK market share is maintained at current levels.

The assessment is necessarily uncertain, but identified a number of areas of potential UK strengths (Table B3.7). Further detail of the methodology and results are available in the full report, published on the Committee's website.

<sup>92</sup> As of 8<sup>th</sup> March, [http://unfccc.int/paris\\_agreement/items/9485.php](http://unfccc.int/paris_agreement/items/9485.php).

<sup>93</sup> UNFCCC (2016), Updated synthesis on the aggregate effect of INDCs. Available at: [www.unfccc.int](http://www.unfccc.int)

### Box 3.6. UK business opportunities in the global transition to a low-carbon economy

**Table B3.6.** Assessment of UK potential to capture market share and examples of current UK strengths

Low-carbon economy (LCE) sector	Potential to capture market share	Examples of current UK strengths
Energy efficient products	Medium	Smart Grids, advanced building design, materials and manufacturing systems
Energy from waste and biomass	Low to Medium	Biofuels, waste recycling techniques
Low-carbon electricity	Medium	Off-shore wind, energy storage, solar PV
Low-carbon services	High	Finance, insurance, consultancy
Low emission vehicles, infrastructure, fuels cells and energy storage	Medium to high	Power systems & transmissions, batteries, logistics, telematics,
Other products and services	Medium to high	Membranes, catalysts, bioprocessing

**Source:** Ricardo (2017) *UK business opportunities of moving to a low carbon economy*. Available at: [www.theccc.gov.uk](http://www.theccc.gov.uk).

### c) Designing future policy to reduce emissions and grow UK industry

In our fifth carbon budget advice, we set out our analysis on the potential reductions in energy and emissions that are possible in the UK manufacturing sector, 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 (CCS) have high up-front costs but are cost-effective against projected carbon values.

Where these measures do involve a cost (e.g. CCS) policy will need to be carefully designed to avoid creating competitiveness problems. That should be a consideration as the Government

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develops its new approach to CCS, in light of the Oxburgh report and advice from the Committee in 2016.<sup>94</sup>

Our scenarios are based on BEIS's projection for a 21% increase in UK manufacturing economic output from 2015 to 2030 (i.e. they allow for significantly more growth in UK industry than the 2% increase from 1990 to 2015). Opportunities to improve efficiency imply that this increase can be accommodated while energy use falls by 12% and emissions by 23%.

The Government has launched a consultation on its industrial strategy. The consultation identifies a role for Government across 10 'pillars'.<sup>95</sup> As the strategy is further developed these should be applied to the areas of potential UK advantage identified above. The Government has already identified an important role for the industrial strategy in the areas of smart power, offshore wind and CCS.

Ideally competitiveness risks would be avoided by having consistent carbon pricing and policy internationally for at-risk sectors. Despite the progress of the Paris Agreement, that remains unlikely for most sectors for the foreseeable future – even if all countries adopted similarly stringent emissions goals they are likely to choose different approaches to implement them.

UK policy will therefore need to continue developing to ensure that competitiveness risks remain limited in future.

- **UK compensations and exemptions.** Our assessment above suggests that, in combination with continued higher generation and distribution costs, low-carbon policy costs could push UK electricity prices above some competitors to 2030. Compensations and exemptions for electro-intensive industries facing competitiveness risks should therefore continue until then. The Government should signal this intention and continue to review the set of industries requiring exemption/compensation.
- **The EU ETS rules for Phase IV (2021-2030) are still being finalised.** As set out above, current plans for allocating free allowances appear unlikely to cover all emissions from at-risk industries. Should that remain the case, other approaches may be needed to avoid competitiveness effects. One option would be border tariff adjustments (BTAs), which impose an equivalent tax on imported products. This would equalise the burden on domestic-produced and imported goods and ensure that final consumers face the carbon price signal in their choices. However, there are various practical complexities to implement them (e.g. the risk of retaliatory tariffs, the difficulty in establishing the carbon emissions in imported goods) and the EU have recently rejected a proposal to include BTAs for the cement sector.
- **Longer-term options for UK policy.**
  - **Brexit.** After leaving the EU, the UK might not remain a member of the EU ETS (e.g. no other countries outside the single market are currently in the EU ETS). Should the UK leave the EU ETS then it would need to develop its own policy to drive emissions reduction from industry without creating competitiveness risks (i.e. a replacement for the EU approach of free allowances).

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<sup>94</sup> Oxburgh (2016) *Lowest cost decarbonisation for the UK: The critical role of CCS. Report to the Secretary of State for Business, Energy and Industrial Strategy from the Parliamentary Advisory Group on Carbon Capture and Storage (CCS)*. Available at: [www.ccsassociation.org](http://www.ccsassociation.org). CCC (2016) *Letter to Rt Hon Amber Rudd: A strategic approach to Carbon Capture and Storage*. Available at: [www.theccc.org.uk](http://www.theccc.org.uk).

<sup>95</sup> BEIS (2017) *Building our Industrial Strategy*. Available at: [www.gov.uk](http://www.gov.uk).



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- **Border tariff adjustments.** As the UK negotiates new trade deals outside the EU, the possibility of using border tariff adjustments should be considered.
  - **Policies to drive CCS and other reductions in industrial emissions.** Beyond energy efficiency improvements, if industry were required to bear the full costs of measures such as applying CCS it is unlikely that any progress would be made. Policy instead should either aim to create a market for low-carbon products (e.g. through public procurements or regulations on the use of materials) or provide support to installations that covers the costs of measures to reduce emissions (e.g. long-term contracts that pay industry to capture and store CO<sub>2</sub>).

The Committee will continue to keep these issues under review



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