Energy prices and bills – impacts of meeting carbon budgets

Committee on Climate Change | December 2012

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Preface

The Committee on Climate Change (the Committee) is an independent statutory body which was established under the Climate Change Act (2008) to advise UK and devolved administration governments on setting and meeting carbon budgets, and preparing for climate change. Amongst other issues, the Climate Change Act requires the Committee to consider the impact of carbon budgets on energy supplies and fuel poverty.

Setting carbon budgets

In December 2008 we published our first report, 'Building a low-carbon economy – the UK's contribution to tackling climate change', containing our advice on the level of the first three carbon budgets and the 2050 target; this advice was accepted by the Government and legislated by Parliament. In December 2010, we set out our advice on the fourth carbon budget, covering the period 2023-27, as required under Section 4 of the Climate Change Act; the fourth carbon budget was legislated in June 2011 at the level that we recommended.

Progress in meeting carbon budgets

The Climate Change Act requires that we report annually to Parliament on progress in meeting carbon budgets; we have published four progress reports in October 2009, June 2010, June 2011 and June 2012.

Advice requested by Government

We provide ad-hoc advice in response to requests by the UK Government and the devolved administrations. Under a process set out in the Climate Change Act, we have advised on reducing UK aviation emissions, Scottish emissions reduction targets, UK support for low-carbon technology innovation, design of the Carbon Reduction Commitment and renewable energy ambition. In September 2010, July 2011 and July 2012, we published advice on adaptation, assessing how well prepared the UK is to deal with the impacts of climate change.

The Committee

The members of the Committee are the Rt. Hon John Gummer, Lord Deben (Chairman), David Kennedy (Chief Executive), Professor Samuel Fankhauser, Sir Brian Hoskins, Paul Johnson, Professor Dame Julia King, Lord Krebs, Lord May and Professor Jim Skea.

The Committee would like to thank the core team that prepared the analysis for this report: Alice Barrs, Jenny Hill, Alex Kazaglis, Laura McNaught, Clare Pinder, Meera Sharma and Mike Thompson. The Committee would also like to thank other members of the team who provided additional support: Ute Collier, Adrian Gault, Ewa Kmietowicz and Indra Thillainathan.

Contents

Executive summary and key messages

In our December 2011 report on household energy bills we assessed trends and key drivers of energy costs over the period 2004-2010 and we projected the impact of low-carbon policies on bills in 2020. We separately identified support for low-carbon technology which will increase bills, and opportunities to offset this through energy efficiency improvement.

In this report we update the analysis on household energy bills using new data on prices and consumption in 2011, and new information on future costs following agreement on support to be provided through the Renewables Obligation. We then extend the analysis to cover the commercial and industrial sectors.

We also provide a high-level assessment of bill impacts beyond 2020 associated with achieving a largely decarbonised power sector by 2030, as compared to a system largely based on unabated gas-fired generation. This complements analysis in our June 2012 progress report, which showed that it is economically sensible to invest in a portfolio of low-carbon technologies over the next two decades. Our new analysis illustrates the benefits from such a strategy as insurance against the risk of high prices associated with unabated gas-fired generation, reducing the impact on household bills in the long term and enhancing competitiveness of UK industry (i.e. by reducing exposure to rising carbon prices and potentially high gas prices).

Our key messages are (see Box 1 for a more detailed summary):

- **Historic increases in energy bills:** Although energy bills have increased significantly for residential, commercial and industrial consumers in recent years, this is mainly due to increases in the international price of gas and investment in electricity/gas networks (e.g. contributing 62% and 16% respectively of the increase in household energy bills since 2004). Impacts have been smaller from support for low-carbon technologies and support for energy efficiency improvement (e.g. less than 10% each of the increase in household bills since 2004).
- **Projected increases in energy bills.**
  - Our analysis suggests that support for low-carbon technologies will increase annual energy bills by around £100 by 2020 (a 10% increase on the 2011 bill) for an average 'dual-fuel' household (i.e. for the 86% of households that use gas for heating and electricity for lights and appliances).

- Energy costs will also rise significantly for commercial and industrial users due to low-carbon policies (e.g. we project increases of around 20-25% from 2011 to 2020). However, average energy costs are only a small component of total costs for these sectors (i.e. less than 0.5% of costs in the commercial sector and around 3% of costs in the industrial sector). Therefore the impact of the increase in energy costs on total costs and final prices of goods and services will be very small (e.g. increased energy costs as a result of low-carbon policies to 2020 will add around one penny to every £10 spent on goods and services produced by the commercial sector, and six pence to every £10 spent on manufactured goods).
- Projected bill increases to 2020 are consistent with our previous estimates of the costs of meeting carbon budgets (i.e. less than 1% of GDP in 2020).
- Beyond 2020, we project limited bill increases across residential, commercial and industrial consumers to support low-carbon investment.
- In an alternative scenario with investment focused on unabated gas-fired generation, there is a risk of much higher cost increases in the long term (e.g. the average annual household bill in a gas-based system could be as much as £600 higher in 2050 than in a low-carbon system if gas and carbon prices turn out to be high).

- **Energy efficiency opportunities.** There is scope to offset the bill increases resulting from low-carbon policies through improvements in energy efficiency. However, incentives under current policies are insufficiently strong and new policies will be required if this potential is to be realised.
- **Fuel poverty and competitiveness risks.** The impacts of low-carbon policies will be largest for households with high electricity use (e.g. those with electric heating) and for a small number of energy-intensive industries. It will be important therefore to ensure that support for low-carbon technologies does not result in increased levels of fuel poverty, through targeting support for energy efficiency at vulnerable households, with a particular focus on those households using electric heating. It will also be important to ensure that potential competitiveness impacts for energy-intensive industries are addressed; we will provide a detailed analysis of competitiveness risks and potential mitigating measures in our competitiveness report in spring 2013.

We set out the analysis that underpins these messages in five sections:

1. The economic rationale for power sector decarbonisation
2. Residential energy bills
3. Commercial and public sector energy bills
4. Industrial energy bills
5. Projected bill impacts in the long term under low-carbon and gas-based systems

Box 1: Summary findings by sector

Residential energy bills

We focus on the energy bill for an average 'dual-fuel' household (i.e. for the 86% of households that use gas for heating and some cooking, and electricity for lights and appliances), and consider implications for non-typical households at a high level.

- **Current energy bills.** The average annual dual-fuel energy bill in the residential sector fell by £85 between 2010 and 2011, from £1,055 to £970 (i.e. by 8% in nominal terms, by 12% in real terms, allowing for general price inflation). Residential electricity and gas prices increased in 2011, mainly due to changes in the wholesale gas price, as in previous years. This was more than offset by falling energy consumption due to milder weather in 2011. The cost of low-carbon policies was broadly unchanged in 2011 – the cost of supporting investments in low-carbon generation (including renewables) remained at around £35 per household per year while the cost of funding energy efficiency improvements in homes, which has fuel poverty and affordability benefits, remained at around £50.
- **Projected energy bill impacts to 2020.** We project that the annual bill for an average dual-fuel household will be around £40 higher in 2015 than 2011 and around £100 higher in 2020 (in real terms, i.e. before general price inflation) due to support for investment in low-carbon generation technologies (i.e. renewables, nuclear and CCS, including costs of required investments in the electricity grid to support low-carbon technologies). The £100 impact in 2020 comprises £75 of direct support and £25 of support via increases in the carbon price, which will also raise revenue for the Exchequer.
- **Opportunities for energy efficiency improvement.** There are opportunities to more than offset the increase in bills due to low-carbon policies through better insulation, purchase and use of more efficient appliances, and behavioural measures. We expect that bills will be reduced by around £35 on average in the period to 2020 due to the replacement of old inefficient boilers. Further savings of £85 are available from more efficient lights and appliances and £25 from improved efficiency in heating systems, mainly through insulation measures (this figure is an average across all households, with much higher savings at the level of individual households that improve insulation). Whether all of these are realised will depend on the policy framework and the extent to which incentives for uptake of measures are strengthened, particularly as regards more efficient appliances.
- **Non-typical households.** Households with electric heating (less than 10% of all households) will be particularly exposed to the increasing costs of supporting low-carbon investment since these affect the electricity price, but not the gas price. It will be important therefore to bring forward measures to mitigate bill impacts for these households. One opportunity is through the Energy Company Obligation (e.g. a share of the spending under ECO is expected to benefit households with electric heating), and the Government should continue to develop policies to protect vulnerable households in electrically-heated homes and more generally.
- **Energy bill impacts beyond 2020.** Achieving a largely decarbonised power sector by 2030 will require further increases in the average annual bill of around £25 per household through the 2020s, with probable reductions thereafter. Bill increases in the 2020s would be higher in a scenario with extensive investment in unabated gas-fired generation, with significant further increases beyond 2030 and a risk of much higher bills in the long term (e.g. the average annual bill in a gas-based system could be as much as £600 higher in 2050 than in a low-carbon system). This reflects our expectation that carbon prices will continue to rise in an increasingly carbon-constrained world, and the inherent uncertainty in gas prices, which could also rise.

Commercial energy bills

In the commercial sector our analysis focuses on medium-sized users that pay the Climate Change Levy (CCL – a tax on energy use) and are covered by the CRC Energy Efficiency Scheme (formerly known as the Carbon Reduction Commitment – a scheme aimed at improving the energy efficiency of large non-energy-intensive consumers). We also consider other types of firm, such as those outside the CRC, and find that the expected impacts of low-carbon policies are broadly comparable.

Box 1: Summary findings by sector

- Energy bill trends. Energy bills in the commercial sector increased by around 110% from 2004 to 2011 (compared to general price inflation of 22% over the same period), largely due to increases in the wholesale price of gas. Policies that reduce carbon emissions contributed a 33% increase in energy bills from 2004 to 2011, of which about half was due to support for low-carbon investments in electricity generation, and half was due to the CRC.
- Projected energy bill impacts to 2020. We project that average bills in the commercial sector will increase in real terms by around 25% to 2020 due to low-carbon policies (i.e. slightly less than they have risen since 2004 due to low-carbon policies). Given that energy costs make up only 0.4% of total costs for the commercial sector, the impact of projected energy bill increases on the total costs and final prices of goods and services produced by the sector is very small (e.g. increased energy costs as a result of low-carbon policies to 2020 will add around one penny to every £10 spent on goods and services produced by the commercial sector).
- Energy efficiency opportunities. There is an opportunity to offset at least some of the increase in bills through implementing energy efficiency measures, but the size of the potential and the costs involved are highly uncertain. For example, whilst we identify potential to reduce energy consumption by at least 10% (i.e. enough to offset just under half of the energy bill impact), we also note that some businesses have achieved significantly greater reductions. In order to unlock this potential it will be important to strengthen policies, including through setting ambitious minimum standards for the private rented sector under the Green Deal legislation.

Industrial energy bills

We analyse energy bills for industrial users (i.e. manufacturers) on average and also consider the impact on energy-intensive users specifically (i.e. those for which energy costs are at least 10% of gross value added). Our analysis covers the impacts of the Climate Change Levy (CCL), discounts on the CCL available under Climate Change Agreements (CCAs) and increased costs of electricity as a result of support for investment in low-carbon generation. We do not include costs of EU Emissions Trading Scheme allowances bought directly by industry, since enough allowances will be allocated for free to industrial firms to cover emissions up to 2020.

- Current energy bills and trends. Average energy costs increased by around 140% in total since 2004 (compared to general price inflation of 22% over the same period), largely due to changes in wholesale fuel prices. Energy costs increased by around 15% due to support for low-carbon generation and increases in the CCL.
- Projected energy bill impacts to 2020. We project that industrial energy bills on average will increase by 19-23% in real terms to 2020 as a result of low-carbon policies. Given that energy costs make up around 3% of total costs for the industrial sector, the impact of projected energy bill increases on the total costs and final prices of goods and services provided by the sector is small (e.g. increased energy costs as a result of low-carbon policies to 2020 will add around 6 pence on average to every £10 spent on goods and services produced by the industrial sector).
- Energy efficiency opportunities. Opportunities exist to reduce energy consumption and therefore costs by at least 8% overall, potentially offsetting a third of the increase due to low-carbon policies. However, DECC's recent energy efficiency strategy estimates that less than a fifth of the energy efficiency potential will be realised under current policies, implying the need for additional incentives.
- Projected bill impacts for energy-intensive industries: Increases in energy prices will have a larger impact on costs of energy-intensive industries (i.e. given the higher share of energy costs in total costs for these industries). There is therefore a potential concern about competitiveness impacts of low-carbon policies for a small number of energy-intensive industries, which may be addressed through a combination of energy efficiency and direct measures to offset low-carbon costs (e.g. the Government has made compensation available for energy-intensive industries to 2014). We will provide a detailed analysis of competitiveness risks and potential mitigating measures in our competitiveness report in spring 2013.

1. The economic rationale for power sector decarbonisation

At the global level, analysis by the International Energy Agency (IEA) shows the need for power sector decarbonisation if the world is to avoid very dangerous climate change.[1]

For the UK, previous analysis by the Committee and by others shows the clear need to decarbonise the power sector in order to meet the UK's 2050 emissions target (i.e. to reduce emissions in 2050 by 80% on 1990 levels), with significant progress desirable by 2030[2].

The implication of this analysis is that unabated gas-fired power generation (i.e. without Carbon Capture and Storage technology – CCS) will become increasingly expensive in a carbon-constrained world. Alternatively, if carbon were not to be constrained, there would be upward pressure on fuel prices in a resource-constrained world. Relying on unabated gas generation at the UK level would therefore exacerbate medium-term affordability and competitiveness concerns. At the global level this would increase risks of dangerous climate change.

In order to avoid these costs and risks, and given long lead-times for development of less mature technologies and turnover of the capital stock, it is necessary to start to invest in power sector decarbonisation now. Early decarbonisation will not only break the link between electricity prices and gas/carbon prices, but will also in due course allow decarbonisation of other sectors through electrification of surface transport and heat.

Given uncertainties and challenges associated with individual technologies, the Committee has recommended that the appropriate strategy is to develop a portfolio of low-carbon technology options including nuclear, renewables and CCS; legislated carbon budgets have been designed to reflect investment in and development of such a portfolio.

In this report we first assess the impacts on energy bills associated with the development of this technology portfolio. This can be seen as an insurance premium against potentially high costs of gas-fired generation. We conclude the report with a high-level assessment of bill impacts in a world where we fail to decarbonise the power sector, and therefore where we remain exposed to increasing carbon costs and the risk of high gas prices associated with unabated gas-fired generation.

1 For example, scenarios set out by the IEA consistent with limiting warming to 2°C (i.e. the climate objective agreed by the United Nation Framework on Climate Change) involve no more than around 10% of global electricity supply from unabated fossil-fired plants in 2050. IEA (2012), *Energy Technology Perspectives 2012 – Pathways to a Clean Energy System.*

2 For example, this conclusion is supported by reports from DECC (their *2050 Pathways* report), the UK Energy Research Centre *(Energy 2050)*, Confederation of British Industry *(Decision Time)*, the Energy and Climate Change select committee (*e.g. Fourth Report – Electricity Market Reform*) and the Scottish Government *(A Low Carbon Economic Strategy for Scotland)*, as well as in the Committee's previous analysis (e.g. see our reports *Building a low-carbon economy* and *The Fourth Carbon Budget*).

2. Residential energy bills

This section updates our December 2011 report on household energy bills. As in that report, we focus primarily on the 86% of households with dual-fuel energy bills (i.e. households that use gas for heating), but we also consider impacts for different household types (e.g. those who use electricity for heating, see section (iii) below).

The average dual-fuel household energy bill is comprised of 45% electricity costs for lights and appliances, and 55% for gas use (mainly for heating, with a small proportion for cooking). In 2011, the residential sector consumed around one third of total UK electricity use (i.e. 112 TWh) and over a half of gas used outside the power generation sector (i.e. 293 TWh).

We now assess the impact of support for low-carbon investments and energy efficiency on electricity, gas and the combined energy bill. We assess both current bills and those projected to 2020; we discuss impacts beyond 2020 in section 5.

(i) Historic increases in household energy bills

(a) Increases in electricity prices and bills from 2004 to 2011

In our December 2011 report we showed that the annual average electricity bill for a dual-fuel household increased by £160 between 2004 and 2010, from £270 to £430 (i.e. by 60%, compared to general price inflation of 17% over the same period)[3]. This was mainly due to increases in the wholesale price of gas. We identified that £30 of the £160 increase was due to policies to support investment in low-carbon generation, and £20 was due to funding for energy efficiency improvements in homes, which also have benefits for affordability and fuel poverty. See Box 2.1 for descriptions of policies affecting household energy bills.

Data for 2011 show that the average retail electricity price faced by UK households rose by around 1.2 p/kWh (9% nominal, and 4% in real terms[4]) over the previous year, from 12.6 p/kWh to 13.7 p/kWh[5]. This was driven primarily by increases in the wholesale cost of electricity and costs associated with the network, with negligible impacts due to investment in low-carbon technologies:

3 Based on Consumer Price Index (CPI) – All Items Index.
4 Adjusting for general consumer price inflation of 4.5%.
5 DECC (2012) *Quarterly Energy Prices* Table 2.2.1. Note that throughout this report figures are rounded and therefore may not sum precisely.

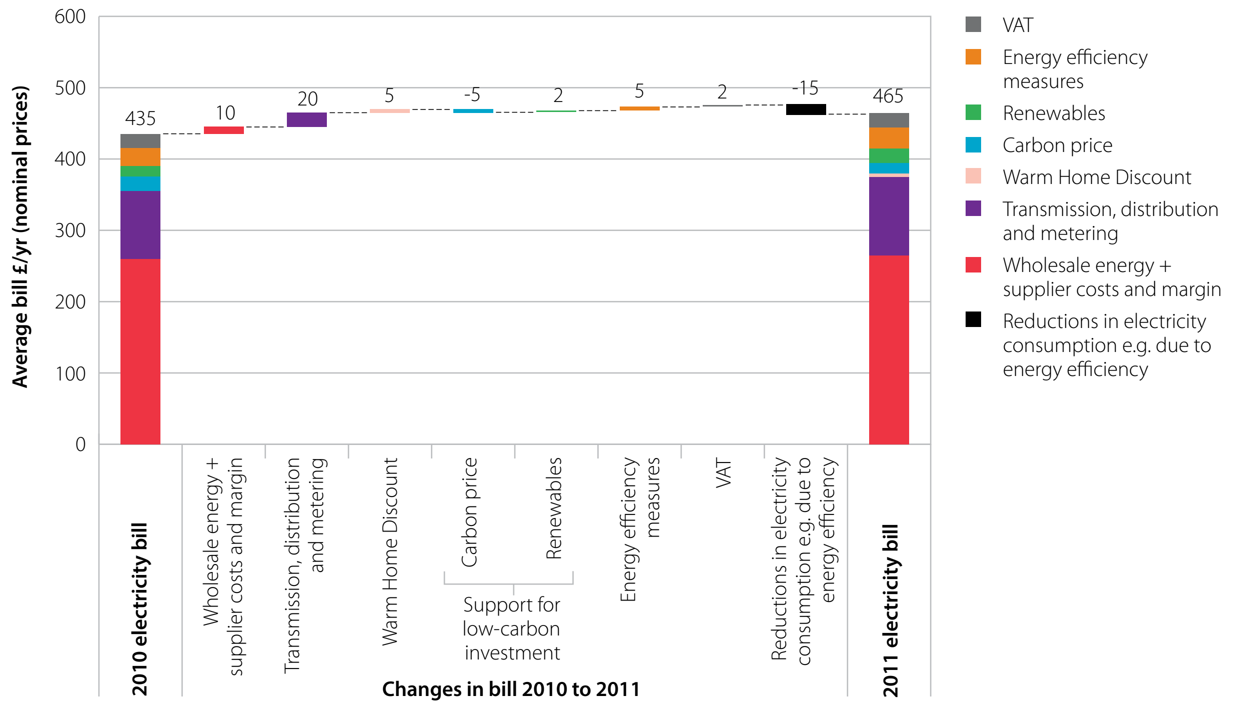
- **Wholesale costs.** Changes in wholesale energy costs (covering both wholesale electricity prices, supplier costs and margins) added around 0.3 p/kWh, driven by increases in the wholesale costs of gas and coal inputs (which rose by 31% and 29% respectively).[6] Recent announcements suggest further price rises during 2012.[7]
- **Transmission and distribution costs.** There was a large increase of around 0.6 p/kWh in the cost of the electricity network, in particular for electricity distribution. This reflects refurbishment and upgrading required as a number of key network components become obsolete (e.g. following the major investment programme during the 1960s and early 1970s).
- **Support for low-carbon investment.** The increasing cost of support under the Renewables Obligation (+0.1 p/kWh) was offset by a lower carbon price (-0.1 p/kWh) in the European Union Emissions Trading Scheme (EU ETS).[8]
- **Energy efficiency funding.** Funding for energy efficiency measures increased slightly (by 0.1 p/kWh).
- **Other policies.** The Warm Home Discount was introduced in April 2011 to offer financial support to low-income and vulnerable households (see Box 2.1 for a full definition). This added 0.1 p/kWh to the domestic electricity price.

The average electricity consumption for dual-fuel households fell slightly (by 2%) in 2011.

As a result, the average electricity bill for dual-fuel households rose from £435 in 2010[9] to £465 in 2011 (Figure 2.1), an increase of £30 (6% nominal, and 2% in real terms). The 2011 bill comprised 57% wholesale energy costs, 24% network costs, 7% low-carbon policy costs (3% due to the EU ETS carbon price, 4% due to support for renewable generation), 6% energy efficiency funding and 6% due to other factors (Warm Home Discount and VAT, charged at the reduced rate of 5%).

6 DECC (2012) *Quarterly Energy Prices* Table 3.2.1, Average prices of fuels purchased by the major UK power producers.
7 Npower, British Gas, Scottish Power, SSE and EDF announced price increases for both gas and electricity tariffs of 6-11% in 2012, effective from November and December.
8 The carbon price during 2011 averaged €12/t, (equivalent to around £10/t) compared with €14/t in 2010.
9 £435 is an updated estimate for 2010, based on revised consumption data (this compares with £430 in our December 2011 report).

Figure 2.1: UK residential electricity bill for average dual-fuel household (2010 and 2011)



Source: CCC calculations.
Notes: Numbers may not sum due to rounding.

Box 2.1: Key policy instruments affecting energy bills in the residential sector

Current policies to encourage residential energy efficiency include:

- **Carbon Emissions Reduction Target (CERT)** is an obligation on energy suppliers to reduce the CO_2 emissions of households. Suppliers primarily meet their obligations by encouraging the uptake of energy efficiency measures. The obligation was introduced in April 2008 and will cease in December 2012 when it will be replaced by the Energy Company Obligation (ECO).
- **Community Energy Saving Programme (CESP)** is an obligation on energy suppliers and electricity generators through community-based partnerships to improve energy efficiency and reduce fuel bills in areas of low income in Great Britain. The obligation was introduced in October 2009 and will cease in December 2012.
- **Warmfront** is an Exchequer-funded fuel poverty programme to deliver energy efficiency and heating measures in England. Funding will expire at the end of financial year 2012-13.

From 2013, these policies will be superseded by new mechanisms:

- **Energy Company Obligation (ECO)** is an obligation on energy suppliers, replacing CERT, CESP and Warmfront and will operate from January 2013. It will complement the financing mechanism of the Green Deal by targeting consumers on low incomes and in "hard to treat" housing, through the **Affordable Warmth**[10] component of the obligation.
- **Green Deal** is a financing mechanism which enables accredited providers to offer residential and non-residential consumers energy efficiency improvements at no upfront cost and to receive payments through a charge on that consumer's electricity bill. The charge is linked to the property and can be passed on to subsequent owners.

10 Under the ECO suppliers will be required to meet three separate targets including (1) carbon emissions reductions in hard to treat homes, (2) heating cost reductions in low-income and vulnerable households (the "Affordable Warmth group"), and (3) carbon savings in communities (15% of this has to be achieved in Affordable Warmth households in rural areas). In this report we refer to (2) and (3) as the "Affordable Warmth" component of the ECO.

Box 2.1: Key policy instruments affecting energy bills in the residential sector

In addition, the EU Ecodesign Directive sets legally-binding EU standards to phase out the least energy-efficient products (i.e. lighting and appliances) and the EU Energy Labelling Directive aims to improve consumer awareness.

To directly address fuel poverty, the **Warm Home Discount Scheme** was launched in April 2011. It is an obligation on energy suppliers to provide financial support to vulnerable customers and customers on low incomes. Those eligible received a discount of £120 on their fuel bill in winter 2011/12.

Policies to support low-carbon generation include:

- **Renewables Obligation (RO)** is a requirement on electricity suppliers to source electricity from renewable sources by purchasing Renewables Obligation Certificates (ROCs) which are issued to generators of renewable electricity by Ofgem.
- **EU Emissions Trading Scheme (EU ETS) and Carbon Price Floor (CPF).** The EU ETS is a carbon trading system which covers large industrial users of energy and power generators in the EU. It covers around 40% of all emissions in the EU, has policy certainty until 2020 and is the largest emissions trading system in the world. The CPF is a UK policy covering electricity generation (i.e. industry covered by the EU ETS is excluded) and designed to guarantee a minimum level for the carbon price by topping it up to a pre-determined target level, beginning at £16/tCO_2 in 2013/14 and rising to £32/tCO_2 in 2020/21.
- **Electricity Market Reform (EMR)** is a package of measures being introduced as part of the 2012-13 Energy Bill to reform the electricity market to deliver low-carbon investment in electricity generation. Low-carbon generation will be offered price certainty through long-term Contracts for Difference (CfDs) around agreed strike prices. EMR also introduces a capacity market to ensure security of supply remains at acceptable levels.

We include all existing and proposed policies in our analysis in this report.

(b) Increases in gas prices and bills from 2004 to 2011

In last year's report we showed that the average annual gas bill for dual-fuel households increased by £295 between 2004 and 2010, from £335 to £630 (i.e. by 90%, compared to general price inflation of 17% over the same period). This was driven by a doubling of retail gas prices over the same period (from 1.8 p/kWh to 3.7 p/kWh), partially offset by a reduction in the average consumption.

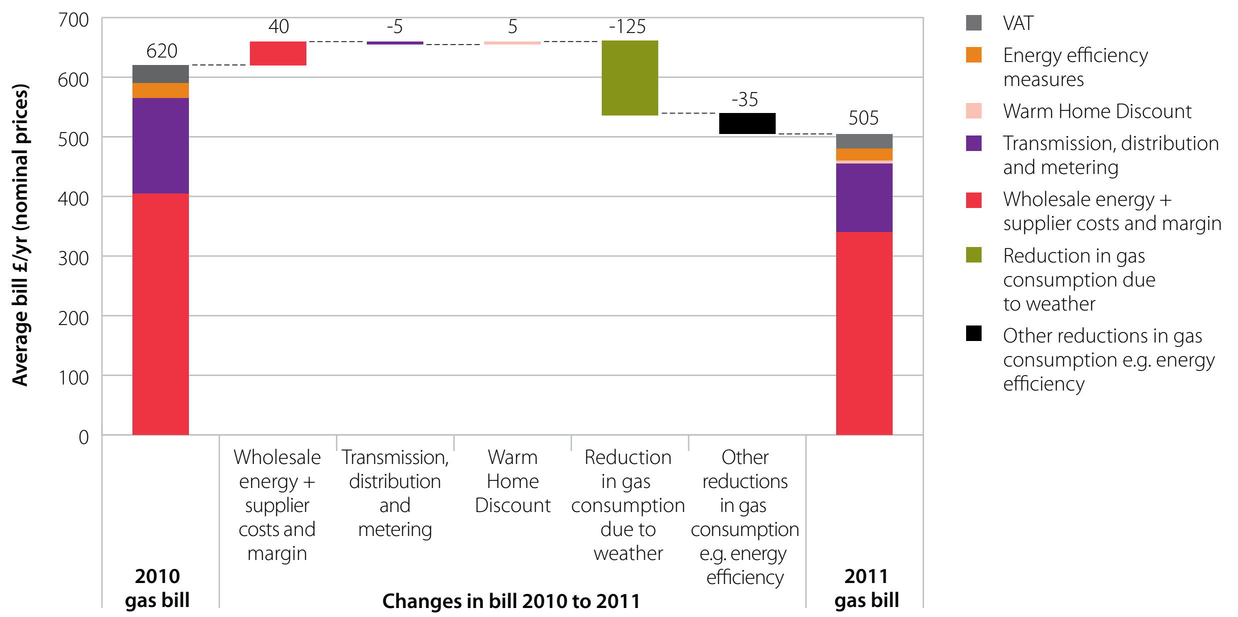
Data for 2011 show that the average retail gas price faced by UK households rose by 0.3 p/kWh (9% nominal, 4.5% in real terms) over the previous year, from 3.7 p/kWh to 4.0 p/kWh[11]. This was driven by an increase in the wholesale cost of gas, with less than 0.1 p/kWh due to new funding for the Warm Home Discount. The only low-carbon policies affecting gas prices are for funding energy efficiency improvement in homes, for which costs remained at around 0.15 p/kWh in 2011. Further increases in residential gas prices have been announced during 2012.[12]

Last year we noted that gas consumption in 2010 was high due to uncharacteristically cold weather. Conversely, winter temperatures in 2011 were milder than average, resulting in a 26% fall in average consumption compared to 2010.

11 DECC (2012) *Quarterly Energy Prices* Table 2.3.1.

12 At the time of writing, npower, British Gas, Scottish Power, SSE and EDF had announced price increases for both gas and electricity tariffs of 6-11% in 2012, effective from November and December 2012.

Figure 2.2: UK residential gas bill for average dual-fuel household (2010 and 2011)



Source: CCC calculations.
Notes: Numbers may not sum due to rounding.

As a result, the average household gas bill fell by £115 (19%) from £620 in 2010[13] to £505 in 2011 (Figure 2.2), with £20 (4%) of the 2011 bill due to funding for energy efficiency measures. Without the weather-driven changes in consumption in 2010 and 2011, bills would have been broadly unchanged.[14]

(c) Combined dual-fuel energy bills in the residential sector

We now consider the combined effect of changes to gas and electricity bills on the total dual-fuel bill.

Last year our analysis indicated that total energy bills for dual-fuel households had increased by £455 on average between 2004 and 2010 (i.e. from £605 to £1,060), largely as a result of wholesale gas costs. Of this increase, £75 was due to policies that reduce carbon emissions – this included a £30 increase in support for investments in low-carbon generation (i.e. from £5 in 2004 to £35 in 2010) and £45 due to increased funding for energy efficiency improvements (i.e. from £5 in 2004 to £50 in 2010).

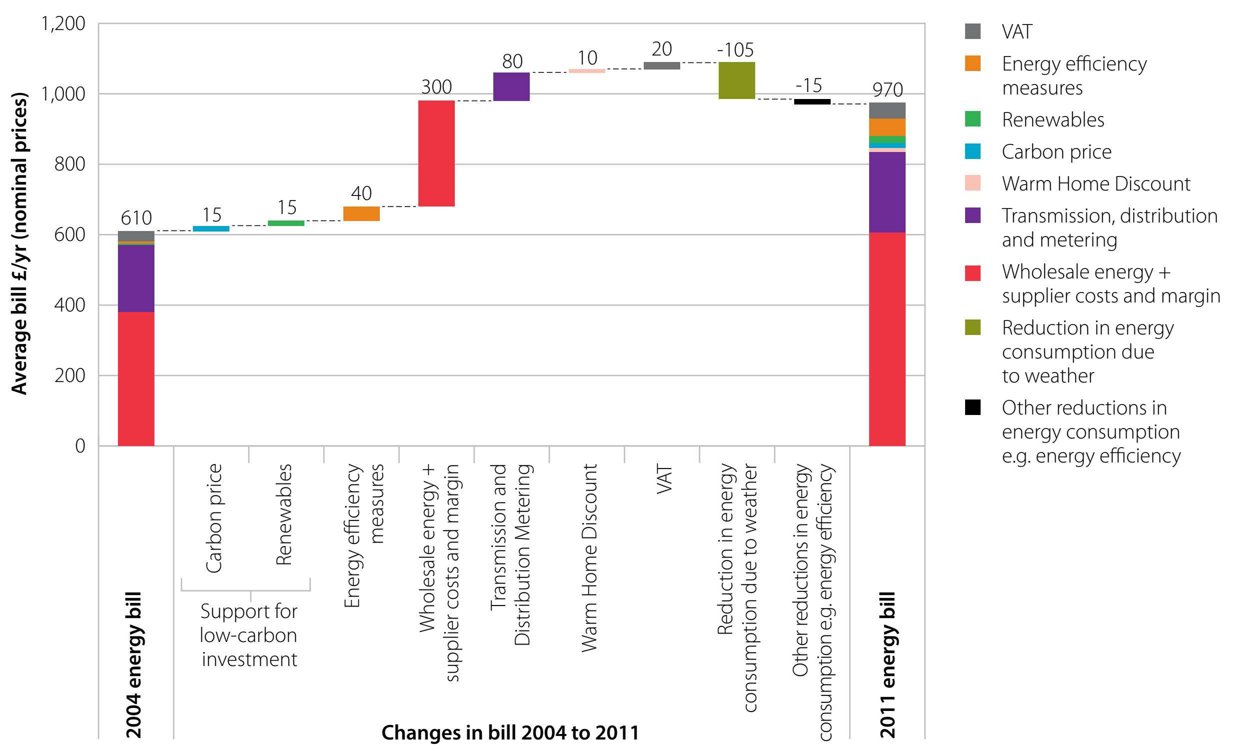
13 Based on the latest consumption data, we have revised downwards our estimate of the gas bill in 2010 to £620 (compared with £630 in our 2011 Report).
14 Adjusting for weather in both 2010 and 2011. Given the variability of weather, our forward projections of bills out to 2020 adjust for temperature, which affects gas consumption for heating. Electricity for the dual-fuel household is unaffected.

In 2011, the total bill fell by £85 (i.e. from £1,055 to £970) as reduced fuel consumption due to milder winter temperatures more than offset increases in fuel costs resulting from higher wholesale and distribution costs. The costs of low-carbon policies remained broadly unchanged.

The overall picture is therefore similar to last year (Figure 2.3). Annual energy bills increased from £610 per household[15] in 2004 to £970 in 2011. Of this £360 increase (60%, compared to general inflation of 22% over the same period), the majority is unrelated to low-carbon policy:

- Around £290 was due to a combination of wholesale and supplier costs (£300), increasing transmission and distribution costs (£80), the Warm Home Discount (£10) and VAT (£20), offset by reduced energy consumption (-£120).
- Around £70 was due to low-carbon policy costs. Within this it is important to distinguish between the £30 cost increase towards decarbonising the energy mix through support for investments in low-carbon power generation including renewables, and the £40 cost increase for funding of energy efficiency measures, without which bills could have increased further over this period.

Figure 2.3: Change in average residential energy (combined gas and electricity) bill (2004 to 2011)



Source: CCC calculations.
Notes: Numbers may not sum due to rounding.

15 Revised estimate for 2004, reflecting updated (slightly higher) estimate of energy consumption. This compares with £605 in our 2011 report.

Our analysis therefore confirms our previous conclusion that large increases in energy bills since 2004 are primarily due to the wholesale price of gas and other factors unrelated to low-carbon policy. For the average dual-fuel household, measures to support low-carbon investments and energy efficiency funding contributed £35 and £50 respectively of the £970 total energy bill in 2011.[16]

Given these bill increases, the average share of household disposable income[17] (i.e. income after tax) spent on energy bills has increased from 2.0% in 2004 to 2.7% in 2011.

(ii) Projected household energy bills

(a) Outlook for electricity prices and bills

Projected electricity prices

Going forward, the key drivers of the electricity price will be policies to support low-carbon investments and energy efficiency, network costs and wholesale energy costs, including wholesale gas prices:

- **Support for low-carbon generation.** This will increase the electricity price due to projected increases in the carbon price, support for renewable generation through the Renewables Obligation (RO), and support for all low-carbon technologies through the Electricity Market Reform (EMR).
  - **Carbon price.** We assume a carbon price rising from £10/tCO_2 in 2011 to £32/tCO_2 in 2020 (in real, 2011, prices), in line with the Government's carbon price floor. This will contribute just over 1 p/kWh to the electricity price in 2020 (i.e. the impact of the carbon price will increase by 0.7 p/kWh, from 0.4 p/kWh in 2011 to 1.1 p/kWh in 2020). We note that a carbon price of £32/tCO_2 would raise around £3 billion revenue for the Exchequer in 2020, creating an opportunity for offsetting tax reductions elsewhere or public spending to mitigate energy bill impacts.
  - **Renewable generation, CCS demonstration and new nuclear.** We estimate the direct costs of support for all low-carbon generation (i.e. renewables, nuclear and plants fitted with carbon capture and storage – CCS) will increase by around 2.2 p/kWh, from around 0.55 p/kWh in 2011 to 2.75 p/kWh in 2020. This includes support for constructing and running new low-carbon capacity under the RO and EMR, costs of connecting to and reinforcing the electricity network, and the costs of back-up capacity to manage increased intermittency (Box 2.2).

16 I.e. the contribution from support for low-carbon investments increased by £30 from £5 to £35, and the contribution from energy efficiency funding increased by around £40 from just over £5 to just under £50.
17 ONS, *Quarterly National Accounts Statistical Bulletin (National Statistics)* Real Household Disposable Income.

- **Energy efficiency funding and smart meters.**
  - We assume that the level of funding raised for energy efficiency measures remains broadly flat in real terms (i.e. around £1.3 billion per year), with no increase in the cost per household (£30)[18].
  - Smart meters have installation costs, but confer cost savings in operation[19]. We assume a net impact of 0.1 p/kWh in 2020, based on the latest Government Impact Assessment[20]. We do not adjust for uncertain potential benefits from smart meters in helping households to manage their energy demand (see below for a discussion of how we capture potential energy savings from behavioural changes that could be incentivised by smart meters).
- **Cost of building and maintaining the network (grid).** We estimate that network costs will increase from 3.3 p/kWh in 2011 to 3.6 p/kWh in 2020, primarily to fund replacement and upgrading of existing assets. Our estimate is based on revenues agreed (or proposed) by network owners and Ofgem as part of the price control reviews, less costs related to low-carbon investments (which we include in the costs of supporting low-carbon generation – see Box 2.2).
- **Wholesale and supplier costs.** There is considerable uncertainty over future gas prices. We focus on the DECC central scenario in which gas prices increase from 60 p/therm in 2011 to 70 p/therm in 2020 (Figure 2.4). In this central case, we project that the rising price of gas will add 1.8 p/kWh to the wholesale electricity price[21]. We assume supplier costs and margins remain constant in real terms at their 2011 level (i.e. 2.4 p/kWh).
- **Warm Home Discount.** We assume funding for this policy rises in line with projections for the Spending Review out to 2014/15 (from £250 million in 2011/12 to £280 million in real, 2011 prices)[22]. The impact on the electricity price will therefore rise by 0.03 p/kWh, from 0.11 p/kWh to 0.14 p/kWh in 2014/15. Thereafter, we assume the impact remains constant (p/kWh) in real terms to 2020.

These assumptions are similar to those in our December 2011 report, with updates to reflect the final support levels under the Renewable Obligation (published in July 2012) and DECC's latest scenarios for future gas prices (published in October 2012).

18 Electricity only; funding for energy efficiency is also raised on gas consumption (around £20).

19 For example, savings to suppliers include reduced costs of metering (e.g. reduced site visits through remote reading and safety checks), reduced costs associated with pre-payment meters (e.g. switching from pre-payment to credit, better debt management). For a full explanation of benefits, see DECC (2012) *Smart meter roll-out for the domestic sector (GB) – Impact Assessment.*

20 DECC (2012) *Smart meter roll-out for the domestic sector (GB) – Impact Assessment.*

21 The 1.8 p/kWh projected increase reflects both a response to the projected increase in gas prices from 60 p/therm to 70 p/therm and a lagged response to recent gas price increases (e.g. gas prices increased from 44 p/therm in 2010, but the wholesale electricity cost only increased 0.3 p/kWh).

22 DECC (2011) *Control Framework for DECC levy-funded spending* http://www.decc.gov.uk/assets/decc/11/funding-support/fuel-poverty/3290-control-fwork-decc-levyfunded-spending.pdf

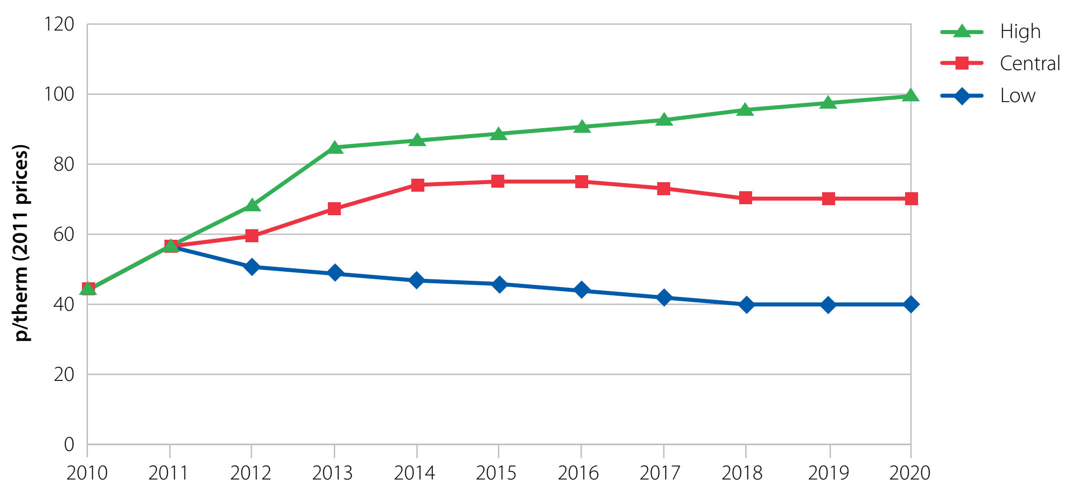
Based on this latest information, we project that the residential electricity price will increase from 13.7 p/kWh in 2011 to 16.7 p/kWh in 2020 due to investment in low-carbon technologies. Of this 3 p/kWh increase, 2.2 p/kWh is due to increased funding for renewables, CCS and nuclear, 0.7 p/kWh is due to the increasing carbon price, and 0.1 p/kWh is due to smart meters.

In addition, there is a further projected increase by 2020 of 0.3 p/kWh to fund network replacements and upgrades unrelated to low-carbon technologies, and a possible increase of 1.8 p/kWh if wholesale gas prices increase as projected in DECC's central case. Together with the impact of Warm Homes and VAT charged at the reduced rate of 5% on these additional elements, this would result in a residential electricity price of 19.0 p/kWh in 2020.

The timing of this increase in the electricity price will reflect the schedule for low-carbon and other investments, and projected changes in the gas price. The increase in low-carbon costs is likely to be fairly steady over the decade, whilst gas prices are likely to be more volatile (e.g. the DECC projection assumes rising then falling gas prices, see Figure 2.4). We project that the combined impact of policies to support low-carbon technologies in 2015 will be around a 1.1 p/kWh increase on 2011 levels (i.e. just over a third of the increase projected to 2020).

We discuss prospects for prices beyond 2020 in section 5, where we identify limited further impacts of low-carbon policies to 2030 and prospects of falling electricity prices thereafter.

Figure 2.4: Projected wholesale gas price (2011 projected out to 2020)



Source: DECC (October 2012) Fossil Fuel Price Projections.

Box 2.2: Estimating the cost of supporting low-carbon generation

In addition to a carbon price, direct support for low-carbon generation will be provided through the Renewables Obligation (RO) up to 2016/17 and Contracts for Differences (CfDs) thereafter, as currently being introduced through the Electricity Market Reform (EMR) as part of the 2012-13 Energy Bill.

From 2015/16 onwards[23], we assume new projects are supported via CfDs, with the cost determined by the difference between the agreed 'strike price' and the 'price index'. Strike prices are assumed to match the levelised cost of generation as estimated in modelling we commissioned from Mott MacDonald for our 2011 Renewable Energy Review. We assume a price index equal to the cost of gas generation facing a carbon price (e.g. we assume a price index of £77/MWh in 2020).

Renewable generation

- We assume support for large-scale renewables installed by 2014/15 under the RO in line with the latest Government Impact Assessment.[24]
- From 2015/16 onwards, we assume further onshore and offshore wind are added at a cost of £88/MWh and £140/MWh, generating 38 TWh and 41 TWh respectively in 2020. We assume other renewables are also brought forward (e.g. biomass, marine) such that total renewable generation is 110-120 TWh in 2020 (i.e. just over 30% of generation). Given these assumptions, we estimate the combined RO/CfD support costs for renewables to be around £6.3 billion in 2020, adding around 2.0 p/kWh to the electricity price.
- We assume support for small-scale generation (via Feed-in Tariffs) is in line with the latest Government Impact Assessment[25] to 2014/15. This equates to around £0.73 billion in 2020, adding 0.2 p/kWh to the electricity price.
- We also include additional costs to the network associated with connecting renewables. This includes investment in transmission infrastructure (i.e. the £8.8 billion of transmission investment identified by the Electricity Network Strategy Group as required to support renewable investment)[26], and options to help manage intermittency (e.g. back-up capacity, demand-side response, and interconnection). Based on detailed modelling for the Renewable Energy Review[27], we estimate that the costs associated with intermittency add around 1 p/kWh for each additional unit of intermittent renewable generation. In 2020, the share of intermittent generation is 24%, implying an additional 0.24 p/kWh on the electricity price.

CCS demonstration

In line with recommendations in our June 2012 progress report we assume four demonstration plants (of an average 390 MW) are added by 2020, with an average of £250 million up-front capital funding (i.e. totalling £1 billion as previously committed by Government). We assume each plant runs for the majority of the year at baseload (i.e. about 3 TWh each per year) at a generation cost of £170-180/MWh. As a result, further support required through CfDs adds around 0.3 p/kWh to the electricity price in 2020.

New nuclear

We assume one new nuclear reactor of 1.6 GW is added by 2020 and runs for the majority of the year at baseload (i.e. generating 12.6 TWh per year), at a cost of £89/MWh (i.e. based on the 2011 Mott MacDonald analysis, not a prediction of the outcome of any individual negotiation). Given these assumptions, total CfD payments to nuclear add less than 0.05 p/kWh to the electricity price in 2020.

We estimated in our 2012 Annual Progress Report, that these investments would require support of around £8 billion in 2020 (real terms, 2011 prices) under the Levy Control Framework (LCF, which sets a cap on spending through certain low-carbon policies). This is broadly consistent with the Government's recent agreement of support through the LCF of 7.6 billion in 2020.

23 In 2014/15 and 2016/17, there will be a period of overlap, when new projects will be able to choose between accreditation under the RO (which will be available until the end of 2016/17) and signing a CfD. We assume that any new generation added from 2015/16 onwards opts for support under the CfD.

24 DECC Impact Assessment (2012) *Government response to the consultation on proposals for the levels of banded support under the Renewables Obligation for the period 2013-17.* Table 18, Option 3. Total cost of renewables support up to 2014/15 £3.267 billion (in real terms, 2011/12 prices).

25 DECC Impact Assessment (2012) *Government Response to Consultation on Feed-in Tariffs Comprehensive Review Phase 2A: Solar PV Tariffs and Cost Control.*

26 ENSG (2012) *Our Electricity Transmission Network: A Vision for 2020.*

27 See Pöyry (2011) Analysing Technical Constraints on Renewable Generation to 2050, and CCC (2011) *Costs of low-carbon generation technologies, 2011 Renewable Energy Review Technical Appendix*, section 5.

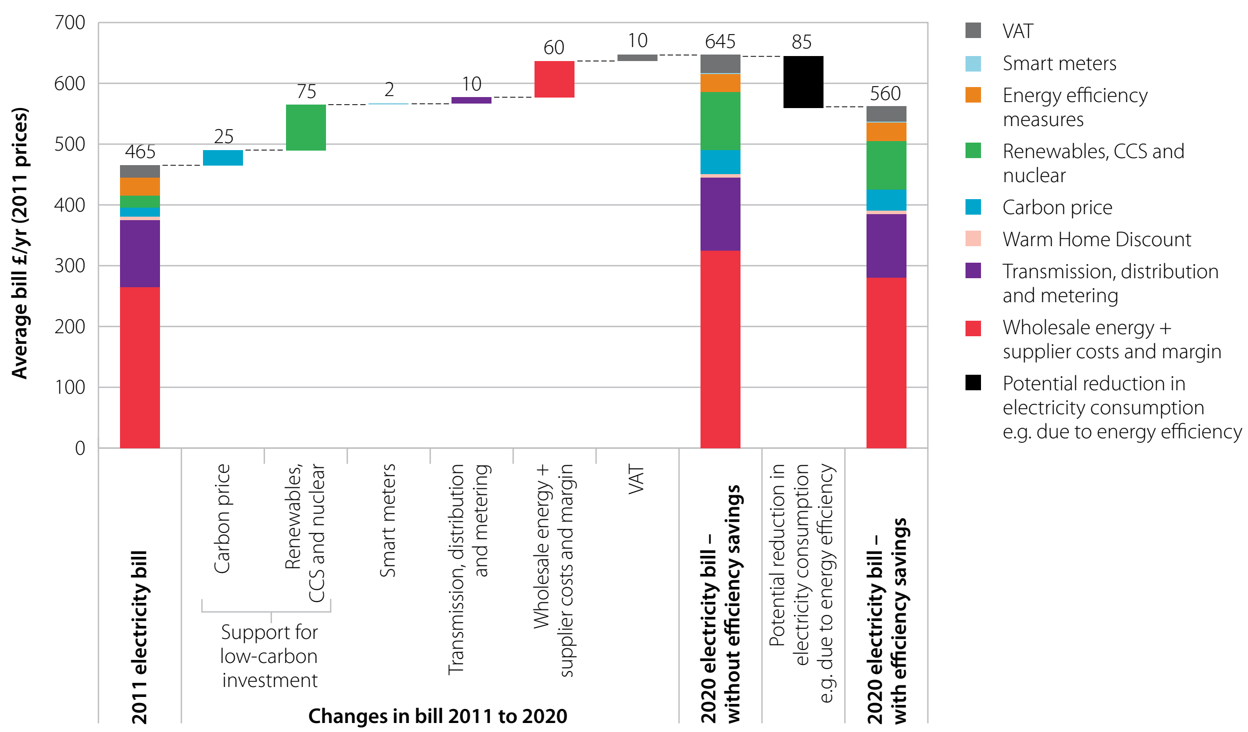
Outlook for electricity consumption and bills

If electricity consumption were to remain constant, then support for low-carbon generation and smart meters would result in a bill increase of around £100 from £465 in 2011 to around £565 in 2020. The projected increase in network costs would add a further £10 and there would be a further increase of £60 if wholesale gas prices rise as in DECC's central scenario, with a £10 increase in VAT bringing the total bill to around £645 (Figure 2.5).

We focus on this scenario of constant consumption to allow us to assess changes in affordability based on *current energy needs*. We do not attempt to predict potential increases in energy bills as households buy more lights/appliances as their incomes rise.

However, there is an opportunity to reduce energy consumption whilst maintaining the same level of energy *services*, through replacing lights and appliances at the end of their expected lives (e.g. 15 years for a refrigerator) with newer more efficient products, and through small changes in how consumers use these products.

Figure 2.5: Change in average residential electricity bill (2011 and projected in 2020)



Source: CCC calculations.
Notes: Numbers may not sum due to rounding.

These measures could reduce electricity demand by around 20%, and possibly more:

- **Efficient lighting and appliances.** There is potential for an average energy saving of around 20% through improved efficiency of new appliances and more efficient lighting:
  - **Appliances.** New appliances at minimum legal standards are significantly more efficient than the current stock average (including reduced energy use in standby modes). Furthermore, there is scope to go well beyond the minimum (e.g. the 'best in class' A+++ fridge-freezers currently available use only one-third of the electricity of the average fridge-freezer found in households, which alone could reduce electricity demand by almost 10% per year in an average household)[28].
  - **Lighting.** The EU phase-out of incandescent light bulbs is delivering savings in electricity consumption for lighting of up to 80% per bulb where consumers switch to compact fluorescent light bulbs. Savings of up to 90% per light fitting can be achieved by switching from halogen spotlights to LEDs.
  - Achievable energy savings for individual houses are higher (e.g. over 40% for efficient lights and appliances, compared with around 20% when spread across the residential sector, and assuming not all households achieve full take-up).
- **Behavioural measures.** Small additional savings can be achieved if households turn off lights in empty rooms and use appliances more efficiently (e.g. washing only full loads and at low temperatures). The roll-out of smart meters may help to facilitate these savings (e.g. while we have previously estimated the potential saving from behavioural measures at 1%, the Government's impact assessment suggests smart meters could unlock savings of around 3%).[29]

If the full 20% potential for energy efficiency can be delivered, this would reduce the 2020 electricity bill by around £85 in 2020. This would offset much of the increase in bills from investments in a diverse low-carbon mix. Delivering these savings will require some investment by households (i.e. the most efficient appliances can have a higher upfront cost), with a cost of around £10 per household per year on average.

Whether this potential is addressed will depend on the successful implementation of policies. New minimum energy efficiency standards have been introduced for a range of appliances under the EU Ecodesign for Energy Related Products Directive and will be tightened over the period to 2020. These standards have been set at levels considerably below the 'best in class' benchmark, but the Government expects energy labelling to encourage manufacturers to produce products that exceed the minimum standards. In our June 2012 progress report we noted that take-up of the most efficient appliances remains very low and highlighted a lack of monitoring in this area.

28 In a recent study sampling 251 households (Household Electricity Survey 2012 for Defra, DECC and the Energy Saving Trust), the average electricity use of fridge freezers was 427 kWh, while the best A+++ medium-sized fridge freezers currently on the market use less than 150 kWh per year.

29 DECC (2012) *Smart meter roll-out for the domestic sector (GB) – Impact Assessment.*

The Government is considering options for encouraging greater appliance efficiency, including a potential role within EMR.

(b) Outlook for gas prices and bills

Projected gas prices

The wholesale price of gas will remain the key driver of changes in retail gas prices over the next decade, along with costs of upgrading and maintaining the network.

- **Wholesale costs.** If gas prices rise as in DECC's central case, we estimate that wholesale energy costs for gas would increase by 0.5 p/kWh from 2.7 p/kWh in 2011 to 3.2 p/kWh in 2020.
- **Transmission and distribution costs.** We estimate that costs associated with the gas network will increase from 0.9 p/kWh in 2011 to 1.2 p/kWh in 2020, primarily to fund replacement and upgrading of existing assets (i.e. gas pipes). Our estimate is based on revenues agreed (or proposed) by network owners and Ofgem as part of the price control reviews.[30]
- **Energy efficiency.** We assume that the small component of the current gas price (around 4%) towards funding energy efficiency does not change on a per household basis, with the level of funding required in 2020 broadly the same as it is today (i.e. around £1.3 billion per year). In the period to 2020, this level of funding would be sufficient to support an extensive insulation programme, including lofts, cavity walls and solid walls. We assume a very small increase (0.02 p/kWh) due to the net impact of smart meters, in line with the latest Government Impact Assessment.[31]

Assuming funding for the Warm Home Discount stays broadly constant, we estimate that the retail price of gas would rise from 4.0 p/kWh to 4.8 p/kWh in 2020 in real terms, an increase of 0.8 p/kWh (20%) from 2011.

Policy to support renewable heat roll-out (i.e. the Renewable Heat Incentive) is to be funded from the Exchequer, and therefore should not add to household bills. We estimate that the required funding for renewable heat will rise to 2020 (e.g. to reach £2 billion in 2020), but will be less than the expected revenue from the EU ETS and carbon price underpin (around £3 billion in 2020).

Under DECC's central projection, gas prices are at their highest in 2015, which could lead to a peak in retail gas prices at 4.9 p/kWh in that year.

30 Allowed revenue for gas transmission and distribution is expected to increase in real terms by 104% and 131% respectively in the period to 2020. Meanwhile, demand for gas is expected to decline by around 15%, implying an increase of around 30% in the total cost per unit of demand.

31 DECC (2012) *Smart meter roll-out for the domestic sector (GB) – Impact Assessment.*

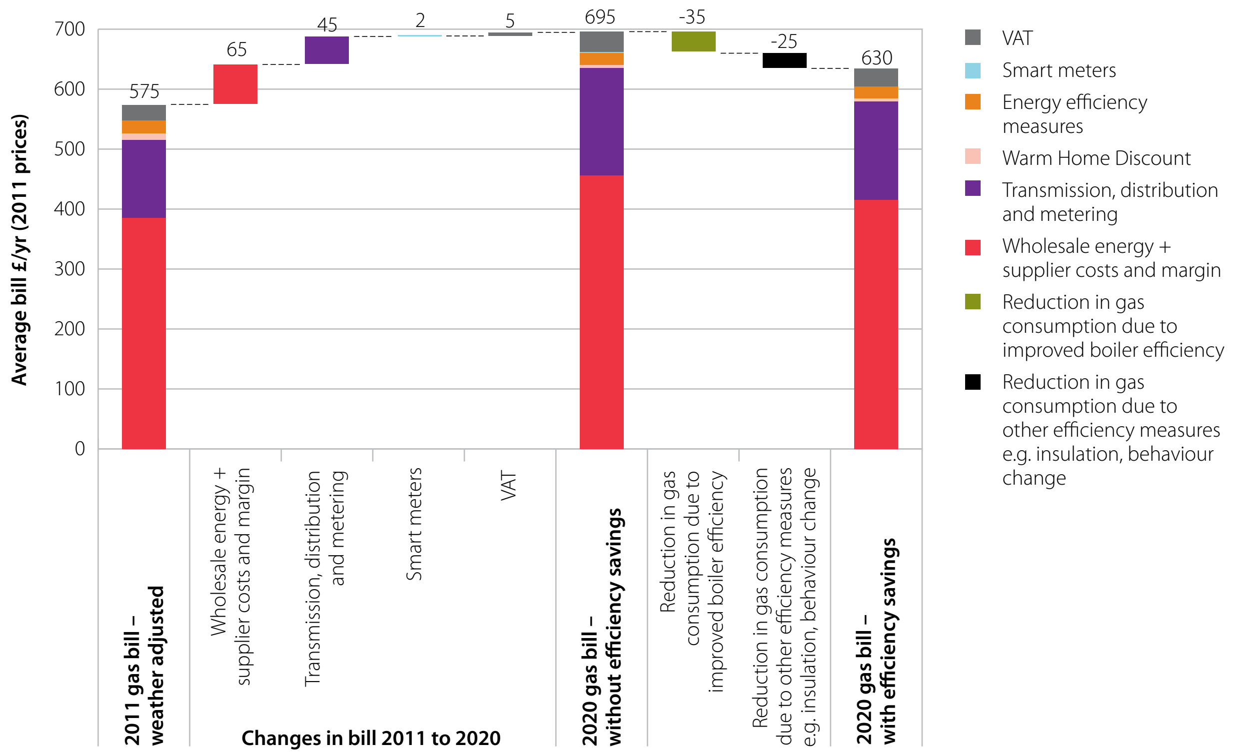
Outlook for gas consumption and bills

Gas consumption in 2011 was unusually low due to the mild winter temperatures. If temperatures had been the same as in an average year[32], then the average dual-fuel gas bill would have been £70 higher at £575 per household.

If household gas consumption were to remain constant at this weather-adjusted level, then our projected increase in prices would result in a bill increase of £120 (20%), to £695 in 2020 (Figure 2.6). This increase is almost entirely unrelated to low-carbon policy, with just £2 due to smart meters.

We expect that households will replace old inefficient boilers as these reach the end of their lives with newer, more efficient, models. This will reduce gas consumption by around 17% for households replacing their boilers, and reduce the average gas bill in 2020 by around £35 (i.e. by 5%, recognising that not all households will replace their boilers between now and 2020).

Figure 2.6: Change in average residential gas bill (2011 and projected in 2020)



Source: CCC calculations.
Notes: Numbers may not sum due to rounding.

32 In an average year, temperatures in the winter months average 4.7°C, whereas in 2011 they were 5.4°C.

Consumption could be further reduced through additional efficiency measures. Improving insulation and making small behavioural changes could significantly reduce gas consumption at the level of the individual household, typically with relatively small upfront costs and short payback periods:

- Installing cavity insulation into uninsulated walls typically reduces gas consumption by 19%, with some households achieving savings of over 25%.[33] This implies an annual saving of £150 for the individual household, with an estimated upfront cost of between £500 and £1875.
- Savings from topping up loft insulation can be significant, depending on existing insulation levels. For example, increasing insulation thickness from 100 mm to 270 mm in an average house would give a £25 annual saving on gas bills for an upfront cost of £100-350.[34]
- Simple measures such as draught-proofing and insulating hot water pipes could save over £50 annually, and at very low upfront cost.[35]
- Turning down the thermostat by 1°C would reduce gas consumption by 10% in an average home, giving an annual saving of over £50 with no upfront cost (and noting that average internal temperatures in the UK have increased by 6°C over the last three decades).

The average reduction in energy consumption will be lower, given that energy efficiency opportunities will not be available and taken up by all households. We assume potential for a 6% reduction on average in household gas consumption, given a level of energy efficiency uptake consistent with meeting carbon budgets (e.g. we assume 3.6 million lofts and 2.5 million cavities are insulated between 2011 and 2020 in response to new policies).[36] This estimate also allows for a 2% increase to replace waste heat as inefficient electric appliances are upgraded.

On average this implies a saving of at least £25 per household could be achieved in 2020. Some of these measures have low or no costs (e.g. the behavioural measures, draught-proofing and insulation of pipework), whilst loft and cavity wall insulation involve a more significant cost. In many cases this will either be paid upfront by householders or funded through the ECO (e.g. for fuel poor households), but if financed through the Government's Green Deal will involve an increase in the energy bill. For example, if 50% of lofts and cavities were to be financed through the Green Deal, then average costs per household per year would be around £5-10 to fund these measures.

Although there has been good progress to date on loft and cavity wall insulation, whether the full potential for these measures is delivered to 2020 will depend on the new market-based Green Deal and the ECO, for which there are risks around projected uptake. As we noted in our 2012 progress report, incentives for easy-to-treat cavity wall and loft insulation remain weak and the Government's estimated installation numbers are substantially lower than the available potential.

33 DECC (2012) *NEED report: summary of analysis using the National Energy Efficiency Data Framework*.
34 Energy Saving Trust estimates (http://www.energysavingtrust.org.uk/Insulation).
35 The Energy Saving Trust estimates £55 for draught-proofing and £15 for pipe insulation (http://www.energysavingtrust.org.uk/Insulation).
36 Achievable levels of insulation uptake are uncertain. In our 2009 progress report we set out a higher level of ambition (up to 10.5 million lofts and 8.1 million cavities from 2008 to 2020). For this report we assume more cautious uptake, and only include measures that would be delivered through new policy (i.e. additional installations may occur without policy intervention). We will update our insulation trajectories in our future work.

(c) Projected dual-fuel energy bills in the residential sector

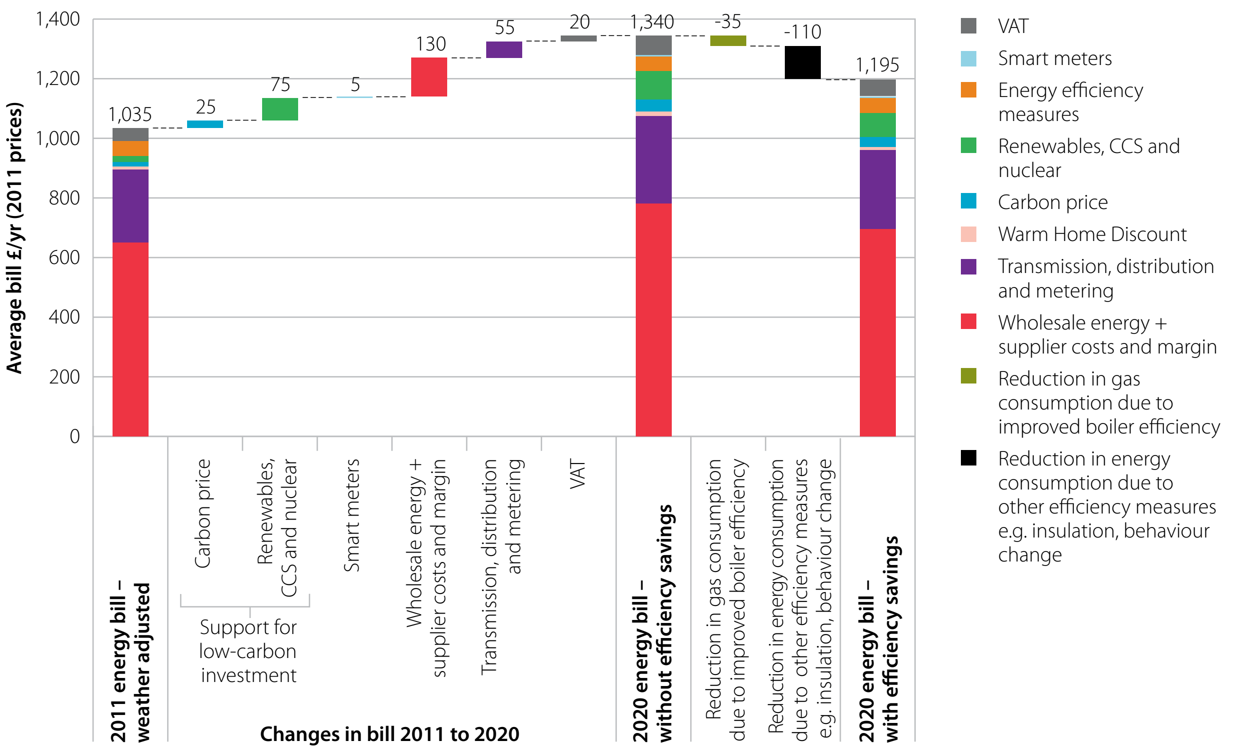
We now combine our analysis of typical electricity and gas bills for the 86% of households with gas heating to set out the prospects for total dual-fuel energy bills. All our projections are in real terms (i.e. they are comparable to costs in 2011 and not scaled up to account for general price inflation in the economy).

The total energy bill was £970 per household in 2011, and would have been £1,035 if temperatures had not been unusually mild.

Looking ahead to 2020, our analysis suggests that, under central assumptions (see below for the implications of alternative assumptions), support for low-carbon power generation will increase energy bills by around £100 (including costs associated with upgrading the electricity grid and providing back-up generation to support more intermittent generation) – see Figure 2.7. This increase will be fairly steady through the rest of the decade (i.e. at around £11 per year), with an increase of around £40 by 2015.

In addition, increasing network costs (i.e. costs of upgrading and refurbishing the electricity grid and gas pipes) are expected to add £55 and increasing wholesale gas prices would add £130 under DECC's central scenario. Including the net cost of smart meters (under £5) and VAT charged at 5% on these additional components gives a total bill of £1,340 in 2020.

Figure 2.7: Change in average residential energy bill – gas and electricity (2011 and projected in 2020)



Source: CCC calculations.
Notes: Numbers may not sum due to rounding.

Although gas prices are uncertain, the estimated impact of low-carbon policies is more robust

The range of DECC scenarios imply a range of possible impacts from wholesale gas prices on energy bills to 2020 from a £90 decline (under the Low scenario) to a £340 increase (under the High scenario).

This uncertainty does not affect the level of support under the Renewables Obligation or the level of the UK carbon price floor, although it will affect the implied support for contracts signed under the Electricity Market Reform (EMR).[37] Therefore, the uncertainty in gas prices causes only limited uncertainty for low-carbon support in 2020 – with the projected increase on 2011 ranging from £90 under the High gas price scenario to £115 in the Low gas price scenario. Since the cost of low-carbon support is highest when gas prices are low, and lowest when gas prices are high, the overall uncertainty in the bill is reduced.

There is also uncertainty over low-carbon technology costs and therefore over the support that will be required to bring forward low-carbon generation investments under EMR. We estimate that this implies a further uncertainty in the impact of support for low-carbon investments of +/– £10 per household in 2020.[38]

A third important uncertainty is over how costs of supporting low-carbon generation will be shared between sectors. While we assume that these have an equal per kWh impact on all sectors, we note that the Government is considering mechanisms to reduce the impact on industry, given competitiveness concerns. Current proposals to exempt some parts of industry from costs associated with EMR (see section 4) could mean that household bills will rise by up to a further £10 to 2020.

Looking beyond 2020, when there is also uncertainty around the rising carbon price and costs of low-carbon generation are expected to fall with learning during deployment, investment in a low-carbon portfolio can reduce exposure to very high electricity prices that could occur under a system dominated by unabated gas-fired generation (see section 5 below).

Opportunities in energy efficiency can offset price rises from low-carbon policies

Offsetting these increases, end-of-life boiler replacement is likely to lead to an improvement in the energy efficiency of gas use, giving savings of around £35 averaged across all households (although savings in individual households are much higher, with boiler replacement typically saving 17% of the gas bill, i.e. around £100, and potentially more if older boilers are being replaced, i.e. up to £300)[39], and a combined bill of £1,305.

Further opportunities for energy efficiency improvement could reduce bills by £110 to £1,195 in 2020, through both physical improvements in lights, appliances and insulation, and behavioural

37 In principle it could feed back to support offered under the RO, but this is unlikely given that the relevant projects will already be at an advanced stage of development (we assume projects commissioning from 2015/16 are supported under EMR) and uncertainty will not be instantaneously resolved.
38 Based on the full range of potential costs identified by Mott MacDonald in analysis for our 2011 Renewable Energy Review.
39 Energy Saving Trust (2012) Replacing your boiler, http://www.energysavingtrust.org.uk/Heating-and-hot-water/Replacing-your-boiler

changes that could be encouraged by smart meters. These reductions are important for both reducing energy bills (e.g. they could more than offset the increase in bills due to low-carbon policies) and reducing carbon emissions (e.g. lofts and cavities together could deliver 4 $MtCO_2$ of abatement). They will need stronger policies, however, if they are to be delivered (see above).

Affordability of energy bills

Without further energy efficiency improvement, the energy bill as a share of average household disposable income would increase from 2.9% in 2011 (adjusted for the unusually mild weather in 2011) to 3.1% in 2020 as a result of low-carbon policies under an assumption of constant income, and remain at 2.9% under projected rises in household income.[40] It would reach 3.7% (or 3.4% if incomes rise) if prices also increase as projected due to network costs and wholesale gas prices.

If improved energy efficiency can be delivered, then the net effect of this and increased low-carbon costs would be to reduce expenditure in 2020 to 2.9% under constant incomes and 2.6% if incomes rise. Including increased gas and network costs, energy bills would be 3.3% of 2020 disposable income (or 3.0% against rising incomes).

(iii) Energy bills for non-typical households

We now consider the 14% of households that do not use gas as their primary heating source, and other households with higher than average energy bills.

Around 7% of homes have oil, LPG or solid fuel heating. Within a higher overall bill they are likely to face a slightly lower cost of low-carbon policies than households with gas heating and have a greater opportunity to benefit from energy efficiency and renewable heat measures:

- The average total energy bill for households with oil, LPG or solid fuel heating was higher than for households with gas heating (at around £2000, rather than £970) in 2011. This reflects the higher fuel costs and/or lower efficiency for heating systems using these alternative fuels.
- Costs of funding energy efficiency measures are recouped by suppliers from gas and electricity bills (i.e. not from other fuels). Therefore, households that meet their heating needs from other fuels currently pay £50 less as a result of low-carbon policies on average than households with gas heating.
- Given that future increases in costs due to low-carbon policies will affect electricity bills, and electricity use for lights and appliances in non-gas homes is likely to be similar to that for gas-heated homes, they face the same expected increase due to low-carbon policy (i.e. a £100 increase to 2020).

40 Office of Budget Responsibility (OBR) projections to 2016 (March 2012), *Economic and Fiscal Outlook*, growth in line with real GDP growth thereafter. Real incomes per household are expected to grow by 10% over the period 2011-2020.

- Higher current costs imply a greater opportunity to benefit from energy efficiency measures affecting heat demand (e.g. loft and cavity wall insulation). Furthermore, these households are particularly well placed to benefit from the Renewable Heat Incentive (RHI), especially in rural locations off the gas grid (e.g. DECC have proposed to target off-grid households in the RHI by setting tariffs that reflect the costs of off-grid installations).

There is uncertainty over the electricity consumption of the 7% of households with electricity as their primary heating source, given limitations to available data. Based on an assessment of data from both DECC and Ofgem we assume that the average electrically-heated home consumes three to four times as much electricity as the average dual-fuel home.[41]

There is also uncertainty over their costs given that around 80% of electrically-heated households are on tariffs that have lower charges for off-peak consumption (e.g. 'Economy 7'). Depending on tariff arrangements total household energy bills currently could be similar to dual-fuel bills or around 50% higher for otherwise similar properties. However, the impacts of low-carbon policies are likely to be similar regardless of the type of tariff (i.e. since many of the costs of low-carbon policies, such as the RO, are charged per unit supplied regardless of time of day).

The largest costs of carbon budgets fall on the electricity price through support for low-carbon generation. Bills for electrically-heated households are therefore likely to increase by more than the bill for dual-fuel households, with energy efficiency only partially able to offset these impacts:

- Given electricity demand that is three to four times higher than that of dual-fuel households, bills for electrically-heated households could increase by £300-400 as a result of support for low-carbon generation (i.e. by three to four times the increase for dual-fuel households).
- We estimate that there is an opportunity to partially offset any increases due to low-carbon policies through energy efficiency, saving around 6% of electricity demand for heating and 20% of electricity demand for lights and appliances on average (i.e. similar opportunities to those in dual-fuel households). If realised, these savings would reduce the average household energy bill by up to £225 in 2020 for electrically-heated households depending on the price paid for electricity used for heating (e.g. for households on Economy 7 tariffs this saving would only be £170).
- In many cases, savings will also be achievable through switching to heat pumps, which provide a more efficient means of electric heating and will be subsidised by the Exchequer when the Renewable Heat Incentive becomes available to the residential sector in 2013.

It will therefore be particularly important that vulnerable households with electric heating are protected through targeted measures, as discussed in section 2(iv) below in the context of fuel poverty.

41 We assume 11,800 kWh (compared to 3,400 kWh in a dual-fuel house). This is the High estimate of average consumption for customers on non-standard tariffs reported by Ofgem. We use the High estimate given that this data will include some households that do not have electric heating, and therefore tend to underestimate demand. Data published by DECC on energy consumption by purpose suggests an average consumption of around 14,000 kWh for electric heating, but will tend to over-estimate demand as it also includes secondary electric heating (e.g. fan or bar heaters that are occasionally used by some dual-fuel households).

Even for those without electric heating, the amount of energy consumed will differ between households, reflecting different characteristics (e.g. occupancy rates, type and age of house, lighting systems, and appliance efficiency – see Box 2.3):

- Relatively high users of electricity will face relatively high impacts from low-carbon policies, since these fall primarily on electricity use.
- In some (but not all) cases households with higher electricity consumption may also have more opportunities than average to reduce consumption through installing more efficient lights and appliances or reducing energy waste.

In general, there is a particular concern about high electricity consumption – related to electric heating or otherwise – which may lead to fuel poverty. There is scope to partially address this through energy efficiency, with further measures possibly required to address fuel poverty concerns.

Box 2.3: How energy consumption can differ across households

Household types: There has been a trend towards smaller households which use more energy per occupant. For example, average energy use in a 3 bedroom property is around 18,000 kWh (i.e. 6,000 kWh per person if occupied by 3 people), versus around 9,000 kWh in a one bedroom flat. Under-occupancy can also increase energy use per occupant, and is especially common amongst older householders. Older householders also tend to spend more time in their homes during the day, therefore requiring more heating than an average household.

House type: Over recent decades, the proportion of flats and detached homes in the housing stock has risen to 19% and 17% respectively. While flats have lower heating requirements, detached homes (with a larger external wall area and therefore greater heat loss) have higher requirements. For example, an average detached house uses 30% more gas than a semi-detached house.

Age of home: Even when older homes have had insulation fitted, they generally cannot match energy efficiency standards in new-built properties (e.g. because of narrower cavities). In some parts of the housing stock (e.g. listed buildings) energy efficiency is often particularly poor, as there are limits to the measures than can be taken.

Ownership: The private rented sector has some of the most energy inefficient homes in the country. In England, nearly 17 % of properties are in Energy Performance Certificate (EPC) bands F and G, compared with 13% in the stock overall and less than 1% in the social housing sector. Improving F and G rated properties to an E rating (e.g. through installing new, efficient boilers) can save around £500 a year in the upgraded property.

Lighting and appliance efficiency: Households with old, inefficient lighting and appliances can have much higher bills than the average. For example, a household with a 15-year-old fridge-freezer, dishwasher and washing machine pays an extra £60 annually compared to households that have new, more efficient appliances. Inefficient lighting can add a further £50 to the annual bill.[42]

Secondary electric heating: Around 1 million households in the UK do not have central heating systems and use secondary systems with a different pattern of consumption (i.e. electric fan or bar heaters that focus heat in occupied rooms). Secondary electric heating may also be used in some households where there is a need to supplement the central heating system (e.g. if the boiler is broken) in which case it is likely that they will be heating their home inefficiently. Support under the ECO aims to shift these households to more efficient heating systems, or to replace broken boilers.

42 According to 'Powering the Nation' (EST, 2012), the average household uses 537 kWh on lighting a year, 70% of which is met by inefficient incandescent and halogen lights.

(iv) Fuel poverty impacts

What is fuel poverty?

Households are currently defined as being in fuel poverty if they need to spend more than 10% of their income on energy in order to maintain an adequate level of warmth. The impact of energy prices on fuel poverty is an important policy consideration and something which the Committee has a duty to consider in relation to carbon budgets under Section 10 of the Climate Change Act (2008).

In March 2012 the final report of the Hills Fuel Poverty Review was published.[43] It questioned the current definition of fuel poverty as failing to capture the depth of fuel poverty, proposing a replacement 'Low Income High Costs' definition and a new measure called the 'fuel poverty gap', on which the Government is now consulting.[44]

- Under the proposed definition a household would be fuel poor if its required spending on fuel to maintain adequate comfort levels is above the median level, and if after spending that amount their remaining income would be below the official poverty line (i.e. if the household is in poverty *because of* relatively high spending on fuel).
- The fuel poverty gap was proposed as a new measure to capture the depth of fuel poverty. It measures the total amount by which the required energy costs of all fuel poor households exceed that for the median household.

Rising electricity and gas prices since 2004 have contributed to an increase in the number of fuel poor households, and an increase in the depth of fuel poverty:

- A fifth of UK households (4.75 million) were in fuel poverty in 2010 according to the current definition[45], compared to 2 million households in 2004 (8%).
- The Hills Review (which only covered England) estimated a smaller increase in the number of fuel poor households under the proposed new definition, from 2.6 million in 2004 to 2.7 million in 2009 for England only (this compares to an estimate of 4 million fuel poor households in England under the current definition).
- The Hills Review estimated a large increase in the depth of fuel poverty, however. The aggregate fuel poverty gap (i.e. covering all fuel poor households) increased from £0.7 billion to £1.2 billion over the same period. The average fuel poverty gap (i.e. the mean gap for individual households) increased from £268 to £437 (all in 2011 prices).

Fuel poverty today is therefore extensive (in terms of the number of households affected) and deep (in terms of the impact on those affected).

43 'Getting the measure of fuel poverty – final report of the Fuel Poverty Review': http://www.decc.gov.uk/en/content/cms/funding/Fuel_poverty/Hills_Review/Hills_Review.aspx
44 DECC (2012) 'Fuel poverty: Changing the framework for measurement'. http://www.decc.gov.uk/en/content/cms/consultations/fuel_poverty/fuel_poverty.aspx
45 DECC (2012) 'Annual report on fuel poverty statistics 2012', http://www.decc.gov.uk/assets/decc/11/stats/fuel-poverty/5270-annual-report-fuel-poverty-stats-2012.pdf

Outlook for fuel poverty and impact of low-carbon policies

The Hills Review projected that (under the new proposed definition) fuel poverty would increase to 2016 (the date by which the UK Government's fuel poverty strategy aims to eliminate fuel poverty) due to energy bill increases unrelated to low-carbon policies. However, a combination of planned measures to support low-carbon investment, energy efficiency and fuel poverty relief would partially offset these increases:

- In the absence of climate change and energy policies, price rises of 1.4 p/kWh for electricity and 0.5 p/kWh for gas (2011 prices) over the next decade would, under the proposed definition, result in an increase in the number of households in fuel poverty of 12% (315,000) in England between 2009 and 2016 (assuming constant consumption). The fuel poverty gap in England would increase from £1.2 billion to £2.0 billion over the same period (i.e. by 65% in real terms, 2011 prices).
- Based on the specific combination of policies modelled by the Hills Review, the net effect of climate change and energy policies is a reduction in the number of fuel poor households of 5% (148,000) in England compared to the 'no policy' scenario, and a reduction in the fuel poverty gap of 10% (£200 million). This assumes that electricity prices increase by 4.0 p/kWh as a result of low-carbon policies (i.e. more than the 3.0 p/kWh impact of low-carbon policies we estimate above), as well as energy efficiency improvement in line with Government impact assessments (which themselves are similar to our assumptions above), and targeted support from the Warm Front Scheme, Warm Home Discount and the Affordable Warmth component of the ECO.[46]

The potential for measures that reduce carbon to also reduce fuel poverty concurs with our finding above that energy efficiency opportunities have the potential to more than offset the costs associated with support for low-carbon generation.

Alongside the need to ensure delivery of energy efficiency measures, the Hills Review emphasised the importance of targeting measures at poorer households, for example through the Affordable Warmth component of the ECO.

The Government has since increased Affordable Warmth funding from 25% to over 40% of the ECO and should closely monitor the distributional impacts of the scheme.

Given that our analysis identifies that low-carbon costs will fall primarily on electricity bills rather than gas and other fuels, it will be important that policies to tackle fuel poverty (e.g. the Affordable Warmth component of the ECO) are targeted particularly at electrically-heated homes and those with high electricity demand (e.g. to provide some support for replacing old inefficient appliances or lighting).

Some households also face higher costs as a result of their particular tariff or payment arrangements. For example, households with pre-payment meters on average pay an extra charge of around £90 per household per year across their energy bill (i.e. both electricity

46 Fuel Poverty Review calculations and Government Impact Assessments/consultation documents.

and gas). Rolling out smart meters to these households would avoid this cost, and should be considered for prioritisation within the Government's plans for smart meter roll-out subject to technical constraints.

(v) Devolved administrations and energy bills

The analysis elsewhere in this report is based on UK-wide average fuel prices and consumption. In this section we consider how electricity and gas prices and average consumption differ in the devolved administrations and the implications for current and projected energy bills.

Household energy prices in the devolved administrations

Available data shows that in 2011 electricity prices were higher than the UK average (13.7 p/kWh) in Northern Ireland by 13% (at 15.5 p/kWh) and in Scotland by 3% (at 14.1 p/kWh), whilst prices in Wales and England (which are not reported separately) were 1% lower (at 13.6 p/kWh). This reflects higher costs unrelated to low-carbon policies, whilst costs of funding energy efficiency programmes are lower in Northern Ireland:

- Northern Ireland faces higher energy transport costs (e.g. all gas has to be imported), is a smaller market with less opportunity for economies of scale, and lacks a diverse energy supply (e.g. is reliant on gas for power generation). Energy efficiency policies in Great Britain (GB) related to energy suppliers, such as CESP and the ECO, do not apply in the devolved energy market in Northern Ireland, where a separate energy supplier scheme, the Sustainable Energy Programme (NISEP) operates. The programme is smaller in scale relative to energy efficiency programmes in GB, resulting in an annual cost to fund the scheme of around £9 for each electricity consumer (i.e. less than the £50 paid on average for energy efficiency across the UK).
- In Scotland, the costs of distributing electricity in the North of Scotland region have been estimated to be up to 50% higher than elsewhere in GB due to the cost of maintaining the distribution network over long distances and in areas of low population densities.

Scottish households faced a slightly lower gas price than elsewhere in GB in 2011 (at 3.95 p/kWh, compared to 4.00 p/kWh in GB). Separate gas price data is not currently available for Wales (again combined with England) or Northern Ireland (due to the limited gas network).

Current energy consumption and fuel poverty in the devolved administrations

Electricity consumption for lighting and appliances appears broadly similar in the devolved administrations to the UK average.[47]

47 Based on an adjustment of the devolved data – which is only available for total consumption – to remove estimated consumption for heating. This adjustment is based on UK average electricity use for heating (adjusted to reflect different heating needs), and the number of households with electric heating in each devolved administration.

Available data on gas consumption across all households shows that average consumption in Scotland (15,900 kWh) is the highest in GB, while average consumption in Wales (14,700 kWh) is slightly below the GB average (15,200 kWh). This primarily reflects the difference in average winter temperatures, which are lowest in Scotland. Data is not available on gas consumption for the average household in Northern Ireland.

However, while dual-fuel households are the dominant type across the UK as a whole, in Scotland and Northern Ireland a much higher proportion of homes are heated by electricity or oil:

- In Scotland, 15% of households use electricity as their main form of heating (compared to 9% across the UK), with penetration reaching as high as 28% in the Highlands and Islands, and 82% in high-rise flats. This generally reflects geography (e.g. remote properties with restricted access to other fuels) and construction (e.g. more buildings not suitable for gas for safety reasons, such as high-rise flats). A further 8% of households use oil, LPG and solid fuels, with only 76% using mains gas for heating (compared to 86% for the UK).
- In Northern Ireland only 16% of households have mains gas heating. The main heating fuel is oil (70% of households, compared to 7% across the UK using oil, solid fuel or LPG), but a lower proportion of households (4%) use electricity for heating than the UK average.
- In Wales, 79% of households have mains gas as their heating source. Electricity is the main form of heating for only 5% of households, with more than twice the proportion of households (11%) using heating oil than across the UK.

As a result, and combined with lower average incomes than the UK as a whole, fuel poverty is higher in the devolved administrations than the UK average (Table 2.1).

Table 2.1: Fuel poverty rates across the UK

Country	Proportion of households that are fuel poor (2010)
UK	19%
Scotland	28%
Wales	26%
Northern Ireland (2009)	44%
England	16%

Source: DECC (2012) 'Fuel poverty in the UK' and Welsh Government (2012) 'Fuel poverty evidence plan'.

Projected bill impacts from meeting carbon budgets

Our analysis of current fuel prices and consumption suggests that dual-fuel households in the devolved administrations are likely to face similar bill increases from meeting carbon budgets to the UK as a whole:

- Electricity consumption for lights and appliances is similar to the UK average, so the bill impacts of supporting low-carbon generation (which only affect the electricity price) will be similar to those at the UK level (i.e. bills may be expected to increase by around £100 from 2011 to 2020 as a result of support for low-carbon investments). The bill impact may be smaller in Northern Ireland, where the Government has announced its intention to exempt generators from the carbon price floor (which could limit bill increases to around £80 if the EU ETS carbon price remains low).
- Although electricity prices are currently higher in Northern Ireland and Scotland, this is not related to low-carbon policies.

Opportunities to offset these bill increases through investing in energy efficiency are uncertain, but may be greater in the devolved administrations:

- Although energy efficiency opportunities are not modelled across the devolved administrations to the same level of detail as the UK as a whole, more reliance on expensive fuels (i.e. heating oil and electricity) suggests that there are larger savings to be made from improving energy efficiency.
- However, there may be more hard-to-treat homes, given different construction methods and prevailing weather conditions (e.g. in Scotland a lower proportion of cavity walls are suitable for insulation than the UK as a whole – 60%, compared to 90% across the UK – due to higher use of timber frames and exposure to driving rain).
- To date, Scotland and Wales have received a proportional share of CERT and CESP measures, given their share in the GB housing stock.

Given similar projected bill increases and uncertain energy efficiency opportunities, the overall impact of meeting carbon budgets on average household energy bills is likely to be similar for dual-fuel households in the devolved administrations.

Our findings for electrically-heated households, however, are particularly important for Scotland. The high proportion of electrically-heated households and relatively high heating demand suggest Scottish households will be disproportionately affected by low-carbon policies (since these primarily affect electricity prices). As noted at the UK level, this implies that it will be particularly important to target these households for energy efficiency measures and any measures to support households in meeting energy costs.

Each devolved administration has its own policies to tackle fuel poverty (e.g. 'Nest' in Wales, targeting of fuel poor households under Scotland's national retrofit programme, and the 'Warm Homes' scheme in Northern Ireland). The success of these policies will require that they reflect the specific household characteristics in that administration, and that sufficient funding is available. It will also require that the devolved governments continue to benefit from UK-wide funding as the Green Deal and ECO are rolled out, and ensure this is distributed in a way that benefits fuel poor households.

3. Commercial energy bills

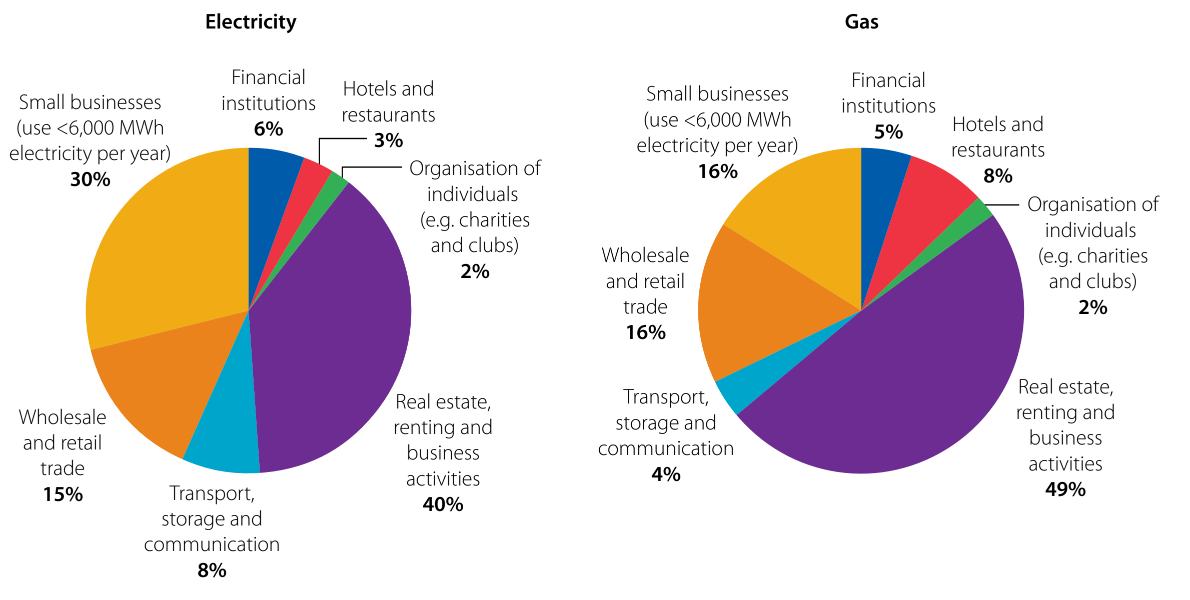
The commercial sector includes retail businesses (e.g. supermarkets), the service sector (e.g. hotels), financial and administrative businesses (Figure 3.1). It excludes businesses that are part of industry (i.e. manufacturing)[48].

Energy spending in the commercial sector currently comprises just over 85% on electricity, 10% on gas, and around 5% on oil. Given the small amount of oil consumed we focus on the combined energy bill of gas and electricity only, as in the residential sector. We estimate that commercial sector spend on gas and electricity accounted for around 0.4% of total sector costs (i.e. energy and other costs, such as personnel and materials).[49]

Our analysis in this chapter is also relevant for public sector organisations (e.g. libraries, government buildings), which face similar energy prices to the commercial sector.

In 2011, the commercial and public sectors consumed around 30% of total UK electricity use (i.e. 96 TWh) and 12% of gas used outside the power generation sector (i.e. 59 TWh).

Figure 3.1: Energy consumption by commercial sector



Source: CCC calculations based on data provided by the Environment Agency.

48 The commercial and industrial sectors are taken as defined in DECC, *Digest of United Kingdom Energy Statistics* Table 1G.

49 Total sector costs from Annual Business Survey (2011), compared to costs for gas and electricity used in commercial buildings for heating, lighting and appliances. Note that the ABS survey reports all energy costs (excluding water costs) as accounting for 1.0% of total costs in 2011, based on a wider definition that includes all fuels used in running the business (e.g. petrol/diesel in commercial vehicles).

(i) Historic increases in energy bills in the commercial sector

(a) Increases in electricity prices and bills from 2004 to 2011

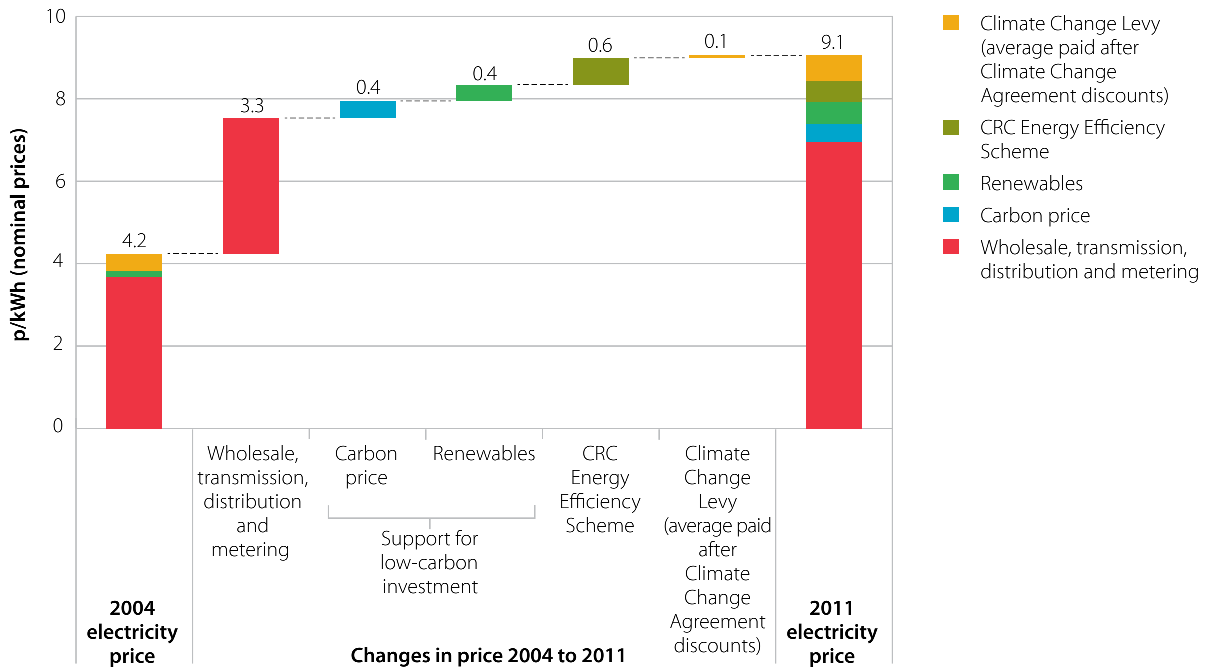
Electricity prices for commercial customers are lower than for households, reflecting economies of scale in supply costs (e.g. we estimate wholesale, network and metering costs were 7.0 p/kWh in 2011, based on the price paid by 'medium sized' non-residential consumers,[50] compared to 11.1 p/kWh for households).

The impact of low-carbon policies is slightly higher in the commercial sector due to a different policy mix:

- Commercial customers do not face costs for funding improvements in residential energy efficiency, for which households paid 0.9 p/kWh in 2011.
- Private and public sector organisations with annual electricity use over 6,000 MWh that are metered on a half-hourly basis are covered by the CRC Energy Efficiency Scheme (CRC, formerly known as the Carbon Reduction Commitment). These organisations are required to purchase carbon allowances to cover emissions associated with energy use for a range of fuels, including electricity and gas. In 2011/12, the CRC was charged at £12/tCO_2, equivalent to 0.65 p/kWh for electricity and 0.22 p/kWh for gas. All revenue from the CRC is paid to the Exchequer, raising approximately £650 million in 2011/12.[51] Although the CRC is not a charge on the energy bill (allowances are purchased separately), for transparency we include the cost as part of the retail prices for electricity and gas.
- All commercial users pay the Climate Change Levy (CCL). The CCL is a tax on the use of energy in industry, commerce and the public sector. From April 2011, the rate of the CCL was 0.51 p/kWh.[52]
- Other costs for supporting low-carbon investment (i.e. renewables support and the carbon price) are likely to be similar to the residential sector (i.e. 1 p/kWh in 2011).[53]

50 DECC, *Quarterly Energy Prices* Table 3.4.1.
51 Environment Agency http://www.environment-agency.gov.uk/static/documents/Business/201112_Compliance_in_the_CRC_Energy_Efficiency_Scheme_and_publication_of_the_2012_Performance_League_Table.pdf
52 Although discounts on the CCL are available for firms that have signed up to Climate Change Agreements (see section 4), these are not common in the commercial sector.
53 This is a necessary approximation in the absence of firm evidence on how costs differ. It may not be exact given differences between commercial and residential consumers in the timing and flexibility of demand, and scope for suppliers to pass through costs differently to different consumers. However, it is likely to be a reasonable approximation as it reflects the nature of the actual costs (e.g. which suppliers face on a per unit basis for the Renewables Obligation and under proposals for EMR).

Figure 3.2: Change in average commercial electricity price (2004 to 2011)



Source: CCC calculations based on DECC *Quarterly Energy Prices* Table 3.4.1. Prices for 'medium' sized consumer (2,000-19,999 MWh p.a.).
Notes: Numbers may not sum due to rounding. CRC only applicable if annual electricity is over 6,000 MWh p.a.

From 2004 to 2011 commercial electricity prices rose by 4.8 p/kWh, from just over 4.2 p/kWh to just below 9.1 p/kWh (i.e. by around 115%, compared with general price inflation of 22% over the same period)[54], see Figure 3.2. As for households this largely reflected increases in wholesale and network costs (i.e. 3.3 p/kWh of the total 4.8 p/kWh increase), with 0.8 p/kWh reflecting increased support for low-carbon generation (i.e. the EU ETS carbon price and the Renewables Obligation), and 0.6 p/kWh due to the CRC. The rate of the CCL paid on electricity increased by 0.1 p/kWh.

Average electricity consumption in the commercial sector has been broadly flat since 2004, whilst total sector costs increased by around 63% (nominal, 30% real).[55]

Given the 115% price increase, electricity costs as a proportion of commercial sector total costs increased from 0.28% in 2004 to 0.38% in 2011, with low-carbon policies accounting for just under half of the increase.

54 Based on Consumer Price Index (CPI) – All Items Index.
55 Annual Business Survey (2004, 2011 provisional figures).

(b) Increases in gas prices and bills from 2004 to 2011

Commercial gas prices are lower than those in the residential sector, again reflecting economies of scale in supply.

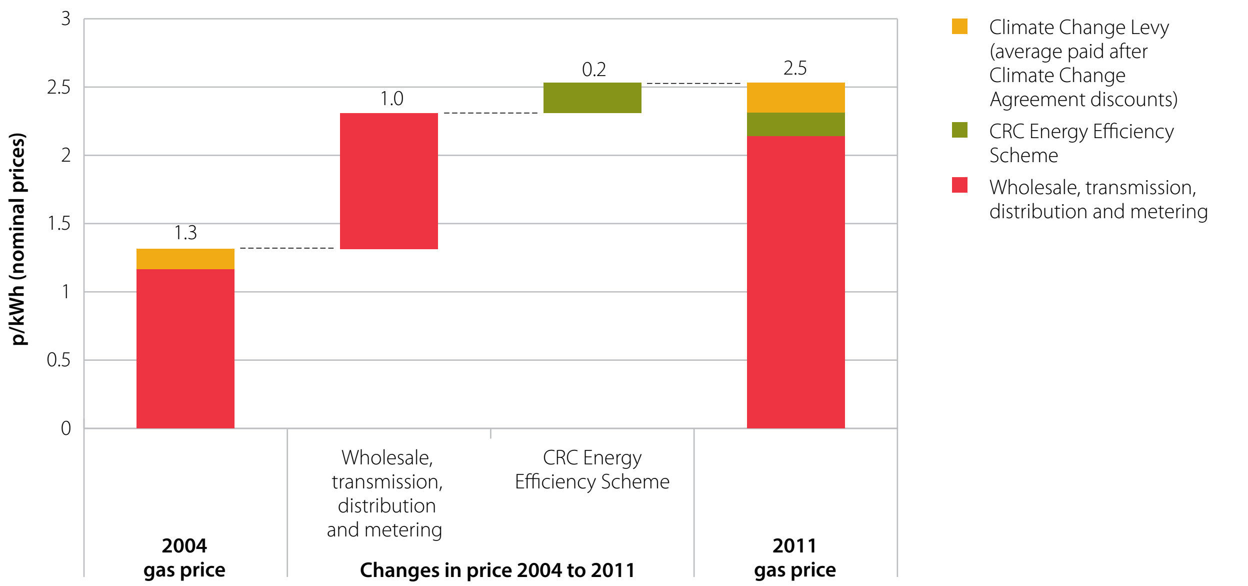
The 2011 gas price for a medium-sized non-residential consumer (i.e. a consumer covered by the CRC) was 2.5 p/kWh[56]. Within this, there were small components relating to low-carbon policies (i.e. 0.17 p/kWh for the CCL and 0.22 p/kWh for the CRC).

From 2004 to 2011, commercial gas prices increased by 1.2 p/kWh from 1.3 p/kWh to 2.5 p/kWh (i.e. by around 95%, compared with general price inflation of 22% over the same period), see Figure 3.3. As for households, this was largely driven by the increased wholesale cost of gas, with costs relating to low-carbon policies (i.e. the CRC, for those covered, and the CCL) adding around 0.2 p/kWh (20%).

Since 2004, consumption of gas has fallen by around a quarter, despite increased sector output (i.e. *energy intensity* fell, implying improved energy efficiency).

Taking prices, consumption and total costs together, gas spend as a proportion of total sector costs increased from 0.04% to 0.05% between 2004 and 2011 (i.e. reductions in energy intensity were almost enough to offset the large increases in the wholesale price of gas).

Figure 3.3: Change in average commercial gas price (2004 to 2011)



Source: CCC calculations based on DECC *Quarterly Energy Prices* Table 3.4.1. Prices for 'medium' sized consumer (2,778-27,777 MWh p.a.)
Notes: Numbers may not sum due to rounding. CRC only applicable if annual electricity is over 6,000 MWh p.a.

56 Including CRC at 0.22 p/kWh.

(c) Combined energy bills in the commercial sector

We now consider the combined effect of changes in electricity and gas prices on total energy bills for the commercial sector. We consider first the impact of price changes alone (i.e. with consumption held constant), and then bring in the effect of reduced energy intensity.

Combined energy bills broadly doubled from 2004 to 2011 as a result of increased energy prices across commercial firms. Holding consumption constant, energy bills increased by around 90-110%, mainly due to wholesale price changes and network costs, with smaller impacts from low-carbon policies, which affected firms covered by the CRC the most (Table 3.1):

- For the average firm covered by the CRC (spending 84% of their energy bill on electricity in 2004) and for a given level of consumption, the combined energy bill increased by around 110% from 2004 to 2011, largely as a result of wholesale and network costs. Energy bills increased by 33% as a result of low-carbon policies, of which half was due to the CRC, and half due to support for low-carbon investments in electricity generation.
- For the average firm outside the CRC (spending 73% of their energy bill on electricity in 2004), combined energy bills rose by 92% (before any changes in consumption). Only 16% of the cost increase from 2004 to 2011 was as a result of low-carbon policies, given that there was no impact due to the CRC and that support for low-carbon generation affected a lower share of their energy bill.

In reality, gas consumption fell and electricity consumption was broadly flat. Since output also rose (i.e. energy intensity fell, probably as a result of improved energy efficiency), energy spend as a share of total sector costs increased by considerably less than implied in Table 3.1. Energy spend rose from 0.3% of total sector costs in 2004 to 0.4% in 2011, with around half of the increase due to energy costs attributed to low-carbon policies.

Table: 3.1: Energy bill impact for different commercial users (2004 to 2011)

		Non-CRC	**Average user (covered by CRC)**	**Electricity only – excluding the CRC**	**Electricity only – including the CRC**
Shares of total energy spend (2004)	Electricity	73%	84%	100%	100%
	Gas	27%	16%	0%	0%
Total increase in energy prices (of which, increase due to low-carbon policy)	Electricity	98% (21%)	113% (36%)	98% (21%)	113% (36%)
	Gas	76% (2%)	93% (19%)	n/a	n/a
Increase in total energy bill from 2004 to 2011 (of which, increase due to low-carbon policy)		**92% (16%)**	**110% (33%)**	**98% (21%)**	**113% (36%)**

Note: For fixed level of consumption. Numbers in brackets show percentage increase in prices / bills on 2004, due to low-carbon policy only.

(ii) Projected increases in energy bills in the commercial sector

(a) Outlook for electricity prices and bills

Drivers of future changes in the commercial retail price are broadly the same as in the residential sector as regards wholesale costs, network costs and support for investments in low-carbon generation. Reduced impacts are expected from the CRC as the carbon intensity of power generation falls.

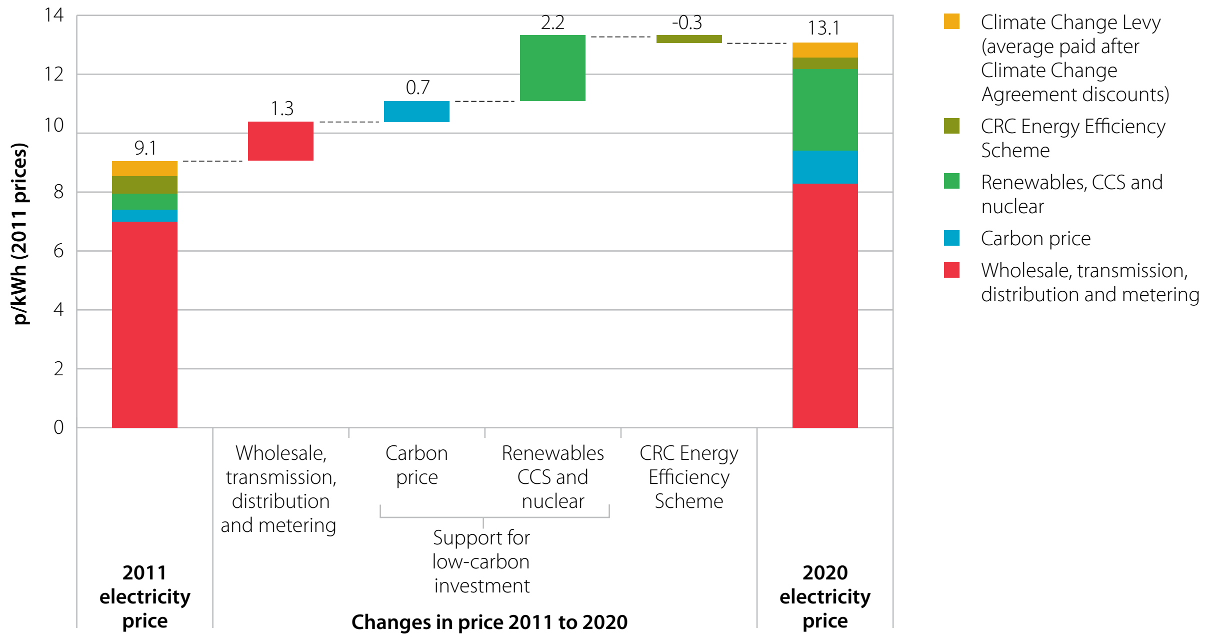
- **Wholesale and network costs.** Consistent with policy design and historical experience, we assume these have the same proportional impact on commercial prices as in the residential sector.
- **Support for low-carbon generation.** We assume that the cost of supporting low-carbon generation (i.e. the EU ETS carbon price, and direct support under the Renewables Obligation and Electricity Market Reform) has the same p/kWh effect on commercial prices as on residential prices.
- **CCL.** The rate of the CCL in 2011 was 0.51 p/kWh. We assume that this remains constant in real terms in the period to 2020, consistent with current policy (i.e. we assume the tax rate increases in line with inflation).
- **CRC.** We assume the CRC carbon price stays flat in real terms at £12/tCO_2, but that the carbon intensity of electricity generation falls in line with the Medium abatement scenario from our Fourth Carbon Budget report (from around 500 gCO_2/kWh currently to around 300 gCO_2/kWh in 2020 on the way to 50 gCO_2/kWh in 2030). The CRC impact on the electricity price therefore falls from 0.65 p/kWh in 2011 to 0.4 p/kWh in 2020, and would be less than 0.1 p/kWh in 2030.

We therefore project that electricity prices for the commercial sector (including the CRC) increase by 4.0 p/kWh (45%) in real terms, from 9.1 p/kWh in 2011 to 13.1 p/kWh in 2020 (Figure 3.4). Around 2.7 p/kWh of this (i.e. a 30% increase on 2011) is due to costs of low-carbon policies, including the CRC. We project a 2.9 p/kWh (35%) increase due to low-carbon policies for firms excluded from the CRC (i.e. a higher impact, since these firms will not benefit from the reduction in the cost of the CRC).

As in the residential sector there is scope to improve efficiency of electricity use, although the size of the opportunity is highly uncertain:

- In our 2008 report *Building a low-carbon economy* we identified potential to reduce business electricity consumption by 9% between 2012 and 2017, but noted that further work was required to form a robust estimate of potential.

Figure 3.4: Outlook for average commercial electricity price (2011 and projected in 2020)



Source: CCC calculations.
Notes: Numbers may not sum due to rounding. CRC only applicable if annual electricity is over 6,000 MWh p.a.

- The DECC 2012 Energy Efficiency Strategy estimates that by 2020 an energy reduction of 16% could be incentivised through current and proposed policies in the commercial and public sector.
- Examples of best practice in the sector suggest much larger reductions are achievable (Box 3.1).

There is therefore potential through improved energy efficiency to at least partly offset the 30% increase in commercial electricity prices expected to result from low-carbon policies.

Box 3.1: Examples of energy efficiency improvements in the commercial sector

Some firms in the commercial sector have already achieved high savings in energy use:

- In 2007 Marks and Spencer (M&S) launched 'Plan A' which aimed to deliver a range of social and environmental commitments by 2012. M&S has exceeded its energy reduction target of 25%, reporting savings of 28% per square foot since 2007. This has been achieved through investment in new technologies in stores and warehouses such as low-energy lighting. The resultant energy reduction saves the organisation £22 million per year. Going forward, M&S expects to meet its target of a 35% reduction between 2007 and 2015.
- Sainsbury's has reduced energy-related carbon emissions by 31% since 2006 in its main supermarkets, exceeding its targeted reduction of 25%. This was achieved through the delivery of energy efficiency and carbon reduction programmes, investment in new technologies and training nearly 200 engineers in green skills. Sainsbury's believes that it is on-track to deliver a 65% reduction in energy-related carbon emissions by 2020 relative to 2005 levels.

DECC is looking to improve the evidence base for commercial sector energy efficiency, with a focus on the food and drink sector for 2013.

(b) Outlook for gas prices and bills

The key driver of future retail gas prices is the wholesale cost of gas. Based on DECC's central projection for wholesale prices and our assumptions on increasing costs associated with the gas supply network, we project gas prices faced by the commercial sector to increase by 0.5 p/kWh (18%) to 3.0 p/kWh in 2020. We assume that other costs (i.e. CCL and CRC) remain constant in real terms, consistent with policy design.

There is scope to reduce bills through improved energy efficiency of gas use. In our 2008 report, the Committee identified an opportunity to reduce commercial sector gas consumption by around 18% through improved heating/cooling systems and better energy management (e.g. optimised heating temperatures and timing). As for electricity, there is considerable uncertainty over the extent of the energy efficiency opportunity.

(c) Outlook for combined energy bills in the commercial sector

The effect of rising energy prices

The overall impact of low-carbon policies for commercial firms will depend on their relative share of electricity spend versus other fuels and whether or not they are covered by the CRC.

If energy consumption were to remain at current levels, then for an average user covered by the CRC (i.e. spending 85% of their energy bill on electricity in 2011) the energy bill would increase by 25% in real terms by 2020 as a result of low-carbon policies (Table 3.2). This 25% increase includes a 7% increase due to the increasing carbon price and a 21% increase due to direct support for low-carbon generation (i.e. renewables, CCS and nuclear), offset by a 2% reduction as the cost of the CRC falls in line with power sector decarbonisation.

The impact on users not covered by the CRC will be similar on average (Table 3.2), reflecting that those firms do not benefit from the falling CRC cost, but are less exposed to increasing electricity costs given the lower share of energy spend on electricity (i.e. 74%, compared to 85% within the CRC).

The largest proportional increase in energy bills as a result of low-carbon policies (35%) will be for firms that meet all their energy needs through electricity, but are not covered by the CRC.

Under DECC's central scenario for fossil fuel prices, bills would further increase by around 15% by 2020 as a result of network costs and rises in the wholesale gas price (i.e. giving a total increase of 40% for an average user covered by the CRC).

Table: 3.2: Projected increases in energy bills for different commercial users (2011 to 2020)

		Average user outside the CRC	Average user covered by CRC	Electricity only – excluding the CRC	Electricity only – including the CRC
Shares of total energy spend (2011)	Electricity	74%	85%	100%	100%
	Gas	26%	15%	0%	0%
Projected increase in energy prices (of which, increase due to low-carbon policy)	Electricity	51% (35%)	44% (30%)	51% (35%)	44% (30%)
	Gas	18% (0%)	18% (0%)	n/a	n/a
Projected increase in total energy bill from 2004 to 2011 (of which, increase due to low-carbon policy)		**42% (26%)**	**40% (25%)**	**51% (35%)**	**44% (30%)**

Note: For fixed level of consumption based on 2011. Numbers in brackets show percentage increase in prices / bills on 2011, due to low-carbon policy only.

Opportunities for energy efficiency

There is significant scope to reduce energy consumption from today's levels. The Committee's relatively conservative scenarios set out above include opportunities to reduce electricity consumption by 9% and gas consumption by 18% through energy efficiency measures. Together these would reduce combined energy bills by around 10%.

The costs associated with delivering these energy efficiency improvements (i.e. the physical costs of installing new insulation, lights, etc) are highly uncertain. Our previous cost estimates imply an annualised cost of around 6% of energy bills, and therefore a net saving on the energy bill of just 4%. Given the uncertainties however, we do not rule out much larger potential savings.

To deliver energy efficiency opportunities, the main policy is currently the CRC. The scheme offers a potentially powerful combination of financial and reputational incentives for energy efficiency improvement.

However, incentives have been weakened by the abolition of the CRC league table in the 2012 Autumn Statement.

It will therefore be particularly important to complement the CRC by setting ambitious minimum standards for the private rented sector (e.g. as provided for in the 2011 Energy Act), through the non-residential Green Deal and by considering the potential role of EMR in incentivising energy efficiency improvement.

Outlook for energy bills as a share of total costs

With no improvement in energy efficiency (i.e. assuming any growth in sector output is matched by growth in energy consumption), our projected energy price increases imply that commercial sector energy spend would increase as a proportion of total sector costs from just over 0.4% in 2011 to 0.6%. Our conservative scenarios for energy efficiency improvement do not significantly change this picture, but as noted above, greater savings may be achievable. The resulting share of energy costs associated with low-carbon policies in commercial sector total costs would be 0.2% in 2020, up from 0.1% in 2011.

Given this small share, the impact on total costs and final prices of goods and services will be very small (e.g. increased energy costs as a result of low-carbon policies to 2020 will add around one penny to every £10 spent on goods and services produced by the commercial sector, over and above the increase of around £2 expected through general price inflation).

The relative impact on households of increases in commercial sector prices as a result of low-carbon policies in the energy sector will therefore be much smaller than the direct costs on energy bills (Box 3.2).

Box 3.2: Impact of low-carbon energy costs on commercial sector product prices

Increasing energy costs in the commercial sector will ultimately be reflected in higher product prices for consumers, such as for supermarket goods. Given that we estimate that increased energy costs due to low-carbon policies to 2020 would make up 0.1% of total commercial sector costs, for a basket of goods costing £10, the total price would increase by around 1 penny in 2020 (i.e. the price would increase by around one pence over the rest of the decade). This is over and above annual price rises of around 20-30 pence each year expected from general inflation.

There could be a further uplift due to increasing energy costs in industry, in turn leading to higher input prices for the commercial sector, to the extent that these are not offset through compensating measures and are passed through the supply chain. Given the need for industry to compete internationally, some of this increase may be absorbed and therefore the pass-through of these costs may be much less than 100%. Furthermore, the impact will be diluted given that the share of energy-intensive products in commercial sector costs will generally be limited (e.g. labour is a much more important input in many cases).

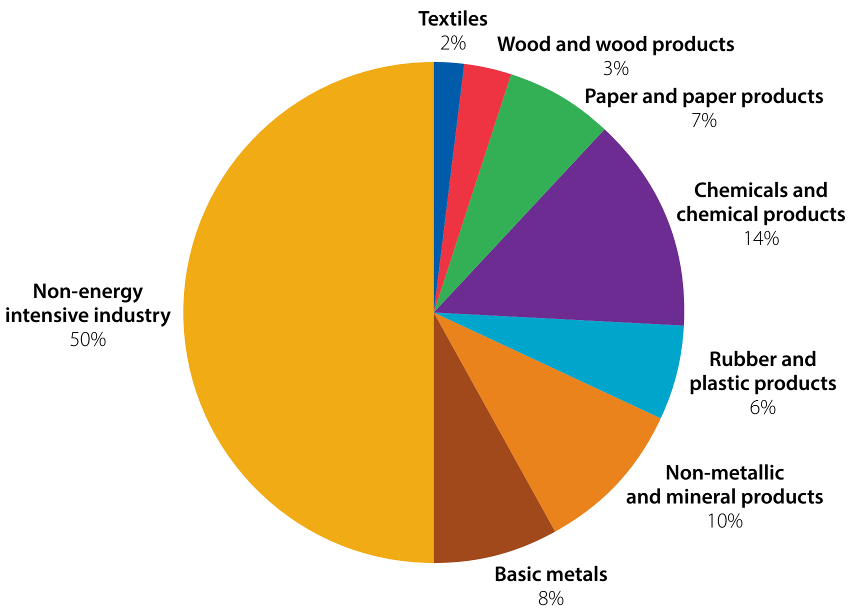
An alternative estimate of the increase in the consumer prices of goods and services can be derived top-down from our estimate of economy-wide resource costs associated with carbon budgets. In our 2008 report *Building a low-carbon economy*
we identified resource costs from decarbonising the power sector to 2020 at 0.2% of GDP. That would imply an average increase in the price of goods and services of around 2 pence for products currently valued at £10. Therefore, our findings in this report are consistent with our previous finding that carbon budgets can be met at a cost of less than 1% of GDP.

4. Industrial energy bills

This section covers energy consumed in industrial applications (i.e. the manufacture of goods such as iron and steel and chemicals) and in industrial buildings (Figure 4.1).

Energy spending (including gas, electricity, oil and solid fuels) in the industrial sector currently makes up 2.9% of total sector costs, comprising 56% electricity, 21% gas, and 23% on other fuels such as coal and oil products. In 2011, the industrial sector consumed around a third of total UK electricity (i.e. 124 TWh) and a quarter of gas used outside the electricity generation sector (i.e. 114 TWh).

Figure 4.1: Industrial energy consumption by sector (2011)



Source: Energy Consumption in the UK (2012).
Notes: Sector disaggregation is shown for energy-intensive industries. Non-energy-intensives industries are reported in aggregate, but include many smaller sectors (e.g. manufacturing of electrical equipment, furniture, etc.).

(i) Historic increases in energy bills

(a) Increases in electricity prices and bills from 2004 to 2011

Electricity prices for industrial customers are generally lower than in the residential and commercial sectors, reflecting direct contracts with suppliers for large electricity consumers, and discounts on the Climate Change Levy (CCL).

- Large consumers of electricity may be able to negotiate lower prices through direct contracts with suppliers, reflecting lower costs of supply (e.g. connecting directly to the transmission network and avoiding distribution costs) and negotiating power as large purchasers and in some cases flexible users.[57]
- Some industrial users will face the full cost of CCL on their electricity use (i.e. 0.5 p/kWh). The majority of industrial electricity consumption (60%), however, is by firms with Climate Change Agreements (CCAs) who receive a 65% discount[58] on the CCL (i.e. they pay 0.2 p/kWh, and on average industry paid 0.3 p/kWh in 2011).

Electricity demand met through autogeneration (i.e. generated on-site, see Box 4.1) is not exposed to many of the costs of electricity bought through a supplier and delivered through the national grid. In particular, autogeneration avoids costs in transmission, distribution, and metering, and costs of supporting low-carbon generation (which are paid via electricity suppliers).

From 2004 to 2011, industrial electricity prices for electricity supplied through the grid rose on average by 3.9 p/kWh to 7.2 p/kWh (i.e. by 116%, compared to general price inflation of 22%), largely due to increases in wholesale and network costs (Figure 4.2).

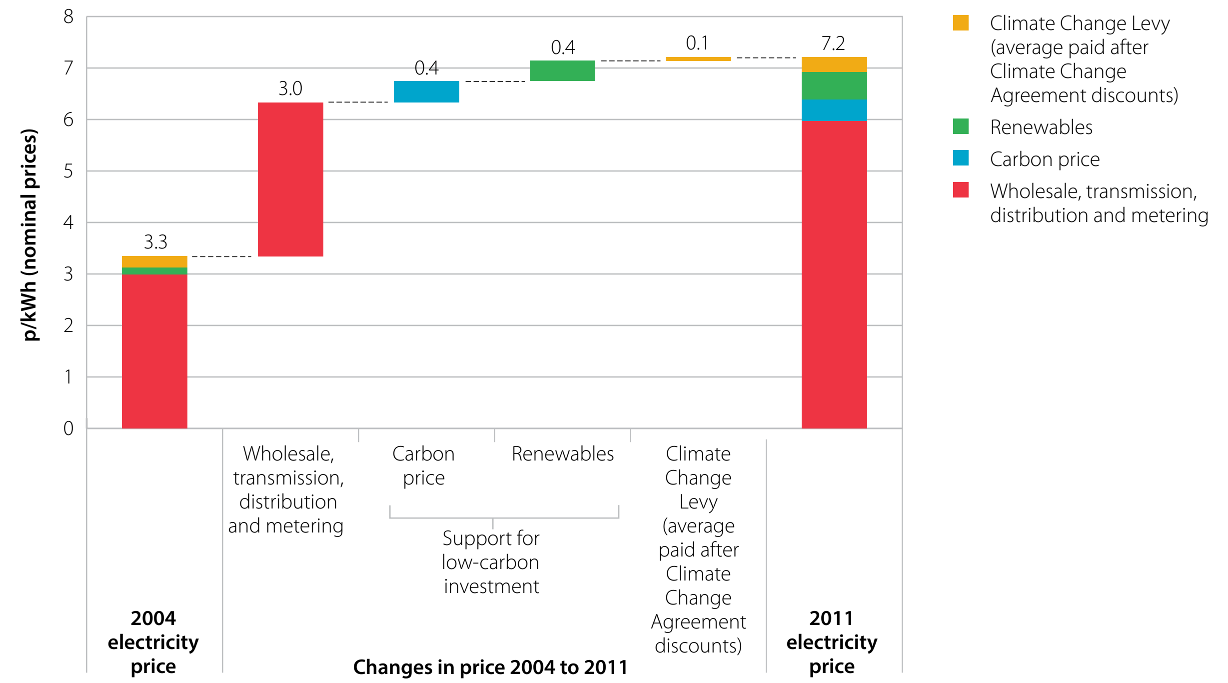
- Wholesale energy and network costs increased by 3.0 p/kWh.
- Costs of supporting low-carbon generation increased by the same amount as in the residential and commercial sectors: the EU ETS increased electricity prices by 0.4 p/kWh, and the Renewables Obligation by 0.4 p/kWh.
- Increases in the CCL added around 0.1 p/kWh to the electricity price for firms paying the full rate and just over 0.05 p/kWh on average (i.e. after discounts for CCAs).

Autogeneration costs increased mainly due to the changes in wholesale energy costs. Based on fuel input data from DUKES[59], we estimate that the cost of autogeneration increased by 63% due to increases in the wholesale cost of fuel input (from 3.3 p/kWh in 2004 to 5.4 p/kWh in 2011). There were minimal impacts from low-carbon policies (the rate of the CCL paid on autogeneration increased from 0.03 p/kWh to 0.04 p/kWh).

Given the higher share of autogeneration in energy-intensive industry[60] (17% of electricity, compared with 11% across industry as a whole), the average electricity price for energy-intensive users rose less than for industry as a whole (by 3.4 p/kWh, compared to 3.7 p/kWh). Energy-intensive industry also paid a smaller component within this price as a result of low-carbon policies (1.0 p/kWh, compared with 1.1 p/kWh across industry).

57 We have not assumed any changes in the relative negotiating power of industry, commercial firms or households in future. 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.
58 Increasing to a 90% discount in April 2013.
59 The Digest of UK Energy Statistics – see Table 7.2.
60 Energy intensives are defined as sectors with higher than 10% energy intensity (energy costs as a proportion of GVA).

Figure 4.2: Change in average retail industrial electricity price (purchased via a supplier, 2004 to 2011)



Source: CCC calculations based on DECC *Quarterly Energy Prices* Table 3.1.3. Average price across all consumer size bands.
Notes: Numbers may not sum due to rounding. Climate Change Levy discounts applicable with Climate Change Agreements (CCAs).

Box 4.1: Autogeneration

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

In industry, 11 TWh was consumed on site (out of a total of 16 TWh generated) and the rest sold back to the grid. Renewables/waste and gas make up the majority of fuels used to run autogeneration (39% and 33% respectively), with the remainder a combination of coal (15%) and other fuels (12% from blast furnace/coke oven gas). The most common technology for autogeneration is Combined Heat and Power (CHP), providing around 85% of total autogeneration.

We include all autogeneration costs in our assessment of electricity prices and bills, but note that heat that can be used in industrial processes is also produced. We do not cover electricity sold back to the grid.

The current stock of CHP units have an average *electrical* efficiency of 24%, and an overall efficiency of 67% (i.e. including the production of heat). The lower electrical efficiencies compared to grid electricity imply a relatively large impact on autogeneration costs from rising gas prices (e.g. rising fuel prices alone added 3.3 p/kWh to autogeneration costs from 2004 to 2011, equivalent to the effect of the combination of gas prices and rising network costs on grid-supplied electricity over the same period).

The main driver of the price of electricity from autogeneration is the wholesale fossil fuel price, with a lower impact from the cost of low-carbon policies than for grid electricity:

- Costs paid via electricity suppliers (i.e. support under the Renewables Obligation and Electricity Market Reform) are not faced by autogeneration.
- The majority of autogeneration (85%) is exempt from the Climate Change Levy (CCL) as CHP schemes which qualify as Good Quality CHP under the UK's CHP Quality Assurance scheme.

Box 4.1: Autogeneration

- Much of the remainder will not face the full CCL cost as they are covered under Climate Change Agreements (CCAs).
- From April 2013, autogeneration will face the Carbon Price Floor (CPF), with discounts for Good Quality CHP to reflect higher efficiency (i.e. they only pay the CPF on the portion of fuels used to generate electricity).
- We assume that firms face the full cost of the carbon price floor (i.e. including both costs of permits in the EU ETS and costs of the UK top-up).

The decision to use autogeneration or grid electricity depends upon the availability of low-cost fuel (e.g. blast furnace gas for iron and steel) and the cost of 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.

Between 2004 and 2011, total industry electricity consumption decreased by 8%, whilst total sector costs fell by around 10% (in nominal terms, 30% in real terms)[61]. Taking prices, consumption and total sector costs together, total electricity costs as a share of total sector costs increased from 0.7% in 2004 to 1.6% in 2011, with costs of low-carbon policies in electricity specifically making up 0.3% of total costs in 2011 on average.

(b) Increase in prices and bills for gas and other fuels from 2004 to 2011

Prices for all direct fuels rose[62] from 2004 to 2011, largely due to factors unrelated to low-carbon policy:

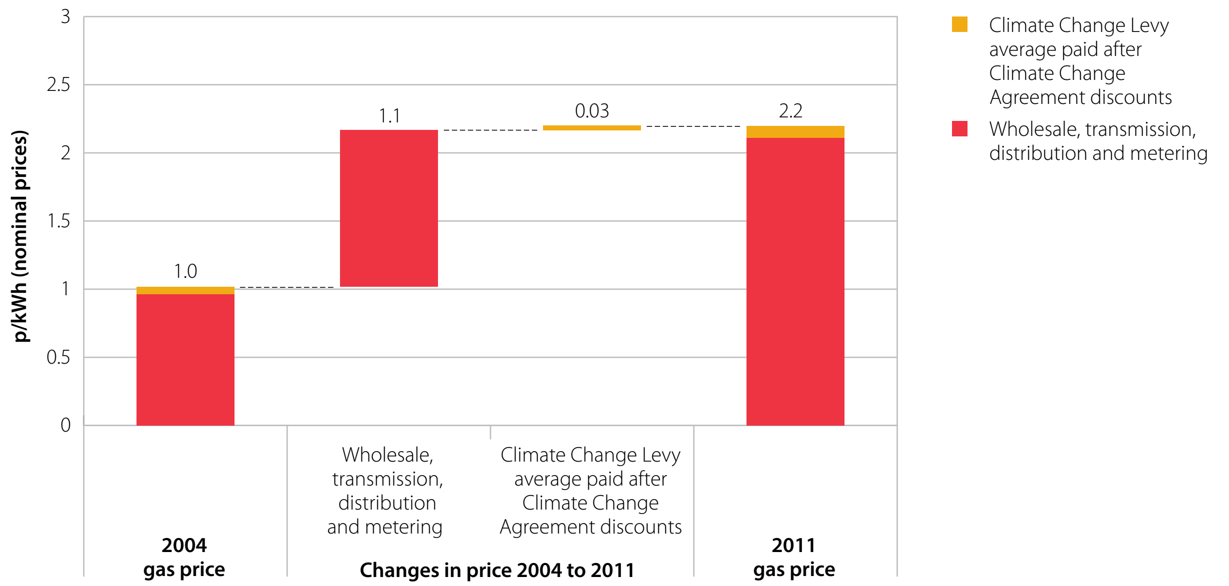
- Industrial gas prices rose by 1.2 p/kWh (116%) from 1.0 p/kWh in 2004 to 2.2 p/kWh in 2011 (Figure 4.3). As for the commercial sector this was mostly due to increases in wholesale and network costs.
- Industrial coal (i.e. solid fuel) prices rose from 0.6 p/kWh to 1.1 p/kWh (i.e. by 90%).
- Prices for heavy oil and gas oil rose by 3.5 p/kWh (270%) and 3.8 p/kWh (190%) respectively.
- The CCL for all fuels was frozen from 2004 to 2006, then rose in line with inflation from 2006 to 2011. It currently adds less than 0.1 p/kWh to the industrial gas price, and less than 0.1 p/kWh to coal prices, allowing for discounts under CCAs.[63]

Although many industrial users are covered by the EU ETS, they currently receive most of their allowances for free (i.e. auctioning for the industrial sector is currently minimal, and will increase from the start of Phase III of the scheme in 2013). The EU ETS therefore does not currently affect their total costs, and we do not include costs from the EU ETS on fuel use.[64]

Between 2004 and 2011, industrial gas consumption fell by 19%, consumption of solid fuels by 20% and consumption of oil by 35%, reflecting falling output during the recession.

61 Annual Business Survey, 2004 and 2011 (provisional figures).
62 Source: DECC *Quarterly Energy Prices,* Table 314. Average across all size bands.
63 The CCL is not charged on oil products.
64 This does not preclude the possibility for the EU ETS to have an impact at the margin (i.e. the opportunity cost of using allowances may encourage firms to take actions to reduce their emissions and may be reflected in final goods prices).

Figure 4.3: Change in average retail industrial gas price (purchased via a supplier, 2004 to 2011)



Source: CCC calculations based on DECC *Quarterly Energy Prices* Table 3.1.3. Average price across all consumer size bands.
Notes: Numbers may not sum due to rounding.

Taking prices, consumption and total sector costs together, between 2004 and 2011 non-electricity costs increased from 0.6% of total costs to 1.3%. The CCL (the only low-carbon measure for non-electricity fuels) accounted for less than 0.05% of total sector costs in 2011.

(c) Current combined energy bills in the industrial sector

We now consider the combined effect of changes in electricity and other fuel prices on total energy bills for the industrial sector. We consider first the impact of prices changes alone, and then the effect of changing energy consumption and sector output.

Combined energy bills for industrial users increased by around 140% on average between 2004 and 2011 as a result of higher energy prices, mainly reflecting increases in the wholesale cost of fossil fuels. Within this increase, the cost of low-carbon policies contributed around a 15% increase from 2004 to 2011 (Table 4.1).

The average combined bill increase was slightly lower for energy-intensive industries given their different fuel mix, while the impacts relating to low-carbon policies were broadly similar across industry groups:

- For energy-intensive industry, energy spend on aggregate increased by around 120%, lower than the industry average given less use of oil-based fuels, for which prices increased the most. Low-carbon costs increased the bill by 15%, broadly the same as the industry average. This reflects a higher than average penetration of autogeneration (which has been unaffected by low-carbon policies) offset by a higher than average share of energy spend on grid electricity (which saw the biggest increase in price due to low-carbon policies).

- For non-energy-intensive industry, energy bills increased by around 150%, higher than average due to a higher share of spend on oil. Energy bills increased by 13% as a result of low-carbon policies (i.e. the remaining 139% of the 152% total increase was unrelated to low-carbon policies).

Table: 4.1: Energy bill impact for different industry groups (2004 to 2011)

<table>
<tr><th colspan="2"></th><th>Non-energy intensive industry</th><th>Sector average</th><th>Energy-intensive industry</th></tr>
<tr><td rowspan="3">Shares of total energy spend (2011)</td><td>Grid electricity</td><td>47%</td><td>51%</td><td>56%</td></tr>
<tr><td>Autogenerated electricity</td><td>2%</td><td>5%</td><td>7%</td></tr>
<tr><td>Other fuels</td><td>51%</td><td>44%</td><td>37%</td></tr>
<tr><td rowspan="3">Total increase in energy prices (of which, increase due to low-carbon policy)</td><td>Grid electricity</td><td colspan="3">116% (26%)</td></tr>
<tr><td>Autogenerated electricity</td><td colspan="3">64% (0%)</td></tr>
<tr><td>Other fuels</td><td>190% (1%)</td><td>170% (2%)</td><td>139% (2%)</td></tr>
<tr><td colspan="2">Increase in total energy bill from 2004 to 2011 (of which, increase due to low-carbon policy)</td><td>152% (13%)</td><td>138% (14%)</td><td>121% (15%)</td></tr>
</table>

Note: For fixed level of consumption based on 2011. Numbers in brackets show percentage increase in prices / bills on 2004, due to low-carbon policy only. Energy-intensive industries are defined as those with energy spend of 10% of their GVA or more. These sectors include textiles, wood, paper, chemicals, rubber and plastic, non-metallic minerals, basic metals. Non-energy intensives industries include many smaller sectors (e.g. manufacturing of electrical equipment, furniture, etc). Change in price of other fuels differs in sectors according to the mix of consumption of oil, gas and solid fuels.

Given the 10% fall in total sector costs (i.e. including non-energy costs) from 2004 to 2011, and reductions in consumption of all fuels, together with increased energy prices, energy costs as a proportion of sector costs increased from 1.3% in 2004 to 2.9% in 2011 on average across industry. Energy costs resulting from low-carbon policies accounted for around 0.3% of total sector costs in 2011. For energy-intensive industry, energy costs were 5% of total costs in 2011, and costs related to low-carbon policies were 0.6%.

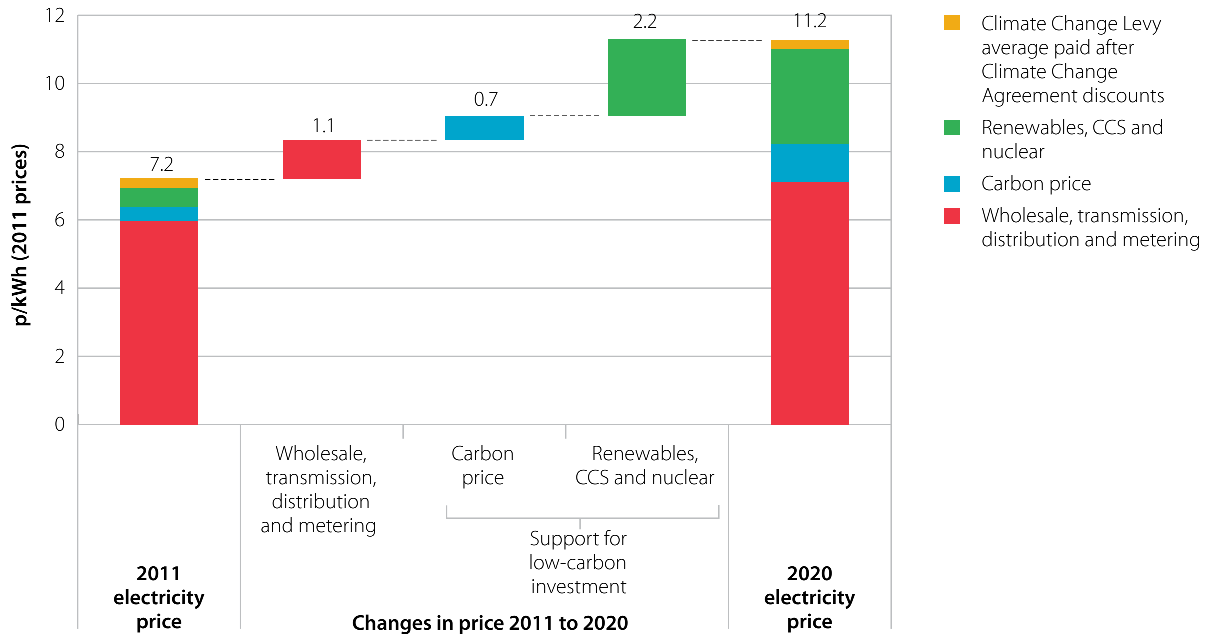
(ii) Projected increases in industrial energy bills

(a) Outlook for electricity prices and bills

Electricity supplied through the grid will face the same upward pressures as the commercial sector, with some differences in other elements of the retail price (Figure 4.4).

- We assume that the increased costs to 2020 of support for low-carbon generation have the same 2.9 p/kWh impact as in the residential and commercial sectors (i.e. increases of 0.7 p/kWh from the carbon price and 2.2 p/kWh from the mechanisms directly supporting low-carbon investment).

Figure 4.4: Outlook for industrial price for electricity supplied from the grid (2011 and projected in 2020)



Source: CCC calculations.
Notes: Numbers may not sum due to rounding.

- We assume that the wholesale and network costs increase at the same rate as in the residential and commercial sectors, giving an increase of 1.1 p/kWh to 2020 under DECC's central scenario for fossil fuel prices.
- We assume that the Climate Change Levy (CCL) stays constant in real terms, and that discounts through Climate Change Agreements (CCAs) increase from 65% to 90%, in line with announced policy. This implies a reduction in the electricity price from 2011 to 2020 of 0.1 p/kWh for firms with a CCA. The average rate paid across the industrial sector (including discounts) falls from around 0.3 p/kWh in 2011 to around 0.2 p/kWh in 2020.

Costs for autogeneration are set to increase as the Carbon Price Floor (CPF) is introduced and wholesale costs increase.

- Autogeneration will be subject to the CPF from April 2013 (see Box 4.1), increasing costs by around 0.9 p/kWh in 2020.
- Under DECC's central scenario for fossil fuel prices, we estimate the cost of autogeneration would rise by a further 0.8 p/kWh by 2020.

We therefore project that industrial electricity prices will increase as a result of low-carbon policies by 2.9 p/kWh (40%) for electricity supplied from the grid and by 0.9 p/kWh (16%) for electricity generated on site.

There is scope to reduce electricity consumption by around 6% through energy efficiency opportunities in industry (e.g. efficient drives and motors), in many cases at low cost.[65] However, further policies are required to overcome barriers to delivery (see section (c), below).

(b) Outlook for other fuels

The only costs related to low-carbon policies for fuels other than electricity are through the EU ETS and the CCL. However, sufficient surplus and free allowances are available in the EU ETS to cover all industrial fuel use to 2020[66], and we assume that the CCL is held constant in real terms. Therefore, we do not project any increase in costs of other fuels related to low-carbon policies.

Under DECC's central scenario, increasing wholesale costs would add 0.5 p/kWh to the industrial gas price by 2020.

There is scope to reduce gas consumption by around 22% through energy efficiency opportunities in industry, often at low cost.[67] As for electricity-related energy efficiency measures, further policies are required to overcome barriers to delivery (see section (c), below).

(c) Outlook for combined energy prices and bills in the industrial sector

The effect of rising energy prices

The implications of projected changes in prices of electricity and other fuels for combined energy bills will differ across industry groups. The specific impact will depend on the fuel mix, and within electricity specifically, the proportion of this that is sourced via the grid rather than generated on site as autogeneration.

In practice, energy-intensive industry, which is a relatively large user of electricity (where the largest impact of low-carbon policies occurs) also tends to rely more on autogeneration (for which costs of low-carbon policies are smaller).

As a result, the share of energy spend on electricity from the grid is broadly comparable across industry (i.e. both energy-intensive industries and other sectors), and therefore the projected increase in energy bills due to low-carbon policies (which primarily affect grid-supplied electricity) is broadly constant across industry (Table 4.2). We project that low-carbon policies will increase average industrial bills by 19-23% from 2011 to 2020.

Under DECC's central scenario for fossil fuel prices, average energy costs would increase by a further 15% by 2020 as a result of network costs and wholesale fuel prices (i.e. bringing the total increase in combined energy bills to 33-39%).

65 CCC (2008) *Building a low-carbon economy – the UK's contribution to tackling climate change.*
66 DECC (2011) *Estimated impacts of energy and climate change policies on energy prices and bills.*
67 CCC (2008) *Building a low-carbon economy – the UK's contribution to tackling climate change.*

Table: 4.2: Projected increases in energy bills for different industry groups (2011 to 2020)

		Non-energy intensive industry	Sector average	Energy-intensive industry
Shares of total energy spend (2011)	Grid electricity	47%	51%	56%
	Autogenerated electricity	2%	5%	7%
	Other fuels	51%	44%	37%
Projected increase in energy prices (of which, increase due to low-carbon policy)	Grid electricity	55% (40%)		
	Autogenerated electricity	31% (16%)		
	Other fuels	11% (0%)	13% (0%)	16% (0%)
Projected increase in energy bill from 2004 to 2011 (of which, increase due to low-carbon policy)		**33% (19%)**	**36% (21%)**	**39% (23%)**

Note: For fixed level of consumption based on 2011. Numbers in brackets show percentage increase in prices / bills on 2004, due to low-carbon policy only. Energy-intensive industries are defined as those with energy spend of 10% of their GVA or more. These sectors include textiles, wood, paper, chemicals, rubber and plastic, non-metallic minerals, basic metals. Non-energy intensives industries include many smaller sectors (e.g. manufacturing of electrical equipment, furniture, etc). Change in price of other fuels differs in sectors according to the mix of consumption of oil, gas and solid fuels.

Opportunities for energy efficiency

The opportunities for energy efficiency in use of electricity and other fuels could reduce combined energy bills by at least 8% on average by 2020 (i.e. given a 6% reduction in electricity consumption and a 22% reduction in gas consumption).[68] Offsetting this, we estimate investment costs associated with these measures equivalent to 3% of the combined energy bill per year.

DECC has identified a larger potential energy saving in their 2012 Energy Efficiency Strategy of around 19% on average (i.e. an average 19% saving across electricity, gas and other fuels). This includes the implementation of both incremental energy efficiency (e.g. more efficient motors) and more substantial refurbishment of existing plant (e.g. relining blast furnaces in the iron and steel sector).

However, the DECC analysis suggests that current policies are likely to unlock only a 3% energy efficiency saving. This reflects significant deployment constraints (e.g. the long lead-times for replacing existing plant such as iron and steel blast furnace) and weakened incentives for energy efficiency through CCAs and the low price of carbon in the EU ETS resulting from the economic recession.

To ensure sufficiently strong incentives are in place, a higher ambition for the CCAs is required that is consistent with meeting carbon budgets. Availability of dedicated finance for energy efficiency opportunities (e.g. through the Green Investment Bank) will also be important in overcoming capital constraints.

68 CCC (2008) Building a low-carbon economy – the UK's contribution to tackling climate change.

Outlook for energy bills as a share of total costs

In the absence of energy efficiency, our projected energy prices imply that energy costs as a proportion of total industrial sector costs would increase from 2.9% in 2011 to 4.0% in 2020. The resulting share of energy costs relating to low-carbon policies would increase from 0.3% in 2011 to 0.9% of total costs in 2020.

Given this small share, the impact on total costs and final prices of manufactured goods will be small (e.g. increased energy costs as a result of low-carbon policies to 2020 will add around six pence on average to every £10 spent on goods and services produced by industry, over and above the increase of around £2 expected through general price inflation).

Given new policies to deliver energy efficiency savings, and based on the Committee's more conservative assessment of potential savings (i.e. 8% rather than the 19% identified in DECC's Energy Efficiency Strategy), the increase in energy costs as a proportion of total industrial sector costs would be 0.3% lower in 2020.

Energy-intensive industries and potential competitiveness impacts

For a small number of energy-intensive industries the impact on total costs resulting from low-carbon policies could be significantly higher. This is particularly the case for industries where energy costs are a higher share of total costs and where electricity supplied via the grid is an important fuel source (e.g. electric-arc steelmaking).

This raises a potential question about competitiveness impacts related to low-carbon policies if these industries cannot pass on the costs to consumers (e.g. because their products are highly traded).

The Government has therefore announced measures to offset these impacts for energy-intensive industries:

- In the 2011 Autumn Statement, the Government announced a package worth £250 million to 2014 to offset the impacts of the carbon price floor and EU ETS on industry via electricity prices (which make up 0.7 p/kWh of the 2.9 p/kWh increase we project in electricity prices as a result of low-carbon policies by 2020). This package is currently at consultation stage, which is due to close in December 2012.
- In November 2012, exemptions were announced to offset the additional costs arising under Electricity Market Reform as part of the 2012-13 Energy Bill (which make up 1.2 p/kWh of the 2.9 p/kWh increase we project by 2020 in electricity prices as a result of low-carbon policies).
- If both these exemptions were provided out to 2020, the increase in electricity prices due to low-carbon policies would be limited to 1.0 p/kWh. As a result the increase in energy costs would be limited to 9% (rather than 23%) and could potentially be offset by the energy efficiency opportunities identified by the Committee and by DECC.

We will return to this question in our spring 2013 report on the competitiveness impacts of carbon budgets, based on a full assessment of costs, opportunities, risks and potential mitigating measures.

5. Projected bill impacts in the long term under low-carbon and gas-based systems

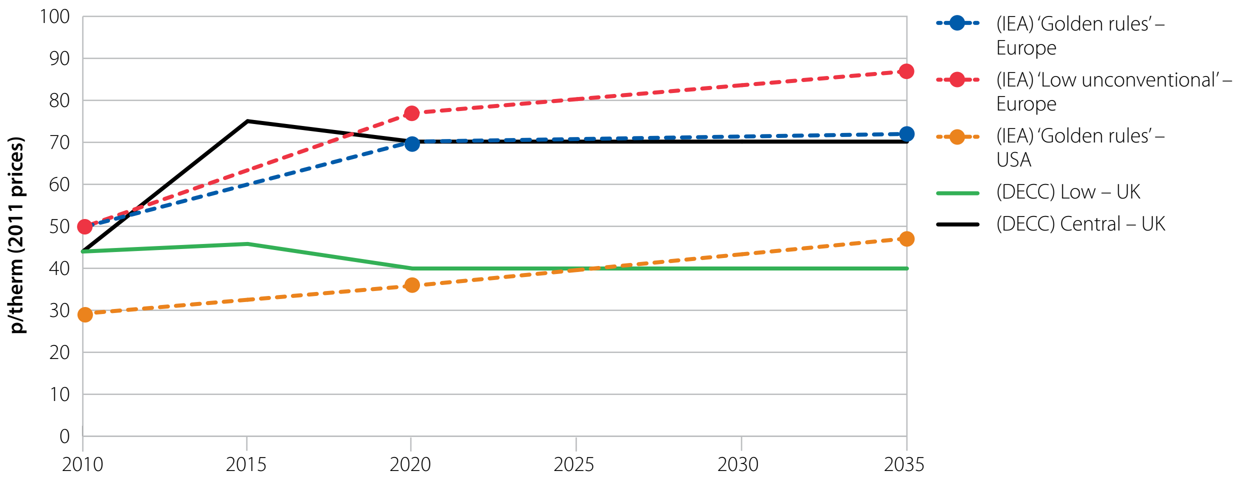
In sections 1 to 4 we have highlighted that support for investments in low-carbon generation from now to 2020 will contribute to increasing energy costs for households and firms.

The benefit of incurring these costs in the short term is that we will develop a portfolio of low-carbon technologies which will be increasingly valuable in a carbon-constrained world.

The value of a low-carbon portfolio will depend on future gas prices, which are not expected to fall in the UK, and carbon prices, which are expected to rise:

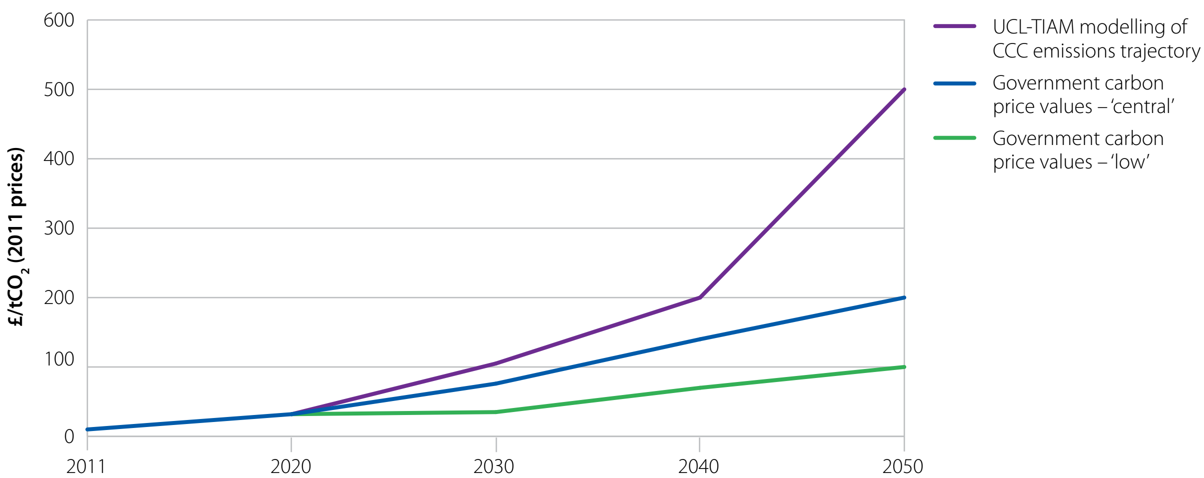
- The International Energy Agency's projections for European gas prices in the 2020s suggest that these would be in line with DECC's central scenario (i.e. slightly higher than currently and broadly flat from 2020, at around 70 p/therm) under a world with significant utilisation of unconventional (e.g. shale) gas resources (Figure 5.1). If the extraction of unconventional gas is more limited, then costs would rise to 2030 (i.e. to reach around 85 p/therm in 2030).
- The Government's carbon price underpin implies an acceleration in carbon prices in the 2020s (i.e. this is set to rise from £32/tCO_2 in 2020 to £76/tCO_2 in 2030. Beyond this, the Government's carbon values assume rising carbon costs to around £200/tCO_2 in 2050, whilst global carbon price modelling suggests significantly higher prices are also possible (e.g. modelling for the Committee by UCL suggests that carbon prices in 2050 could reach around £500/tCO_2 even with an active global carbon market taking advantage of trading opportunities to minimise global abatement costs, see Figure 5.2).

Figure 5.1: Projected gas price (2010 projected out to 2035)



Source: IEA (May 2012) Golden Rules for a Golden Age of Gas. DECC (October 2012) Fossil Fuel Price Projections.
Notes: IEA projections adjusted to £2011. £:$ = 0.65. 'Golden Rules' scenario assumes a 'continued global expansion of gas supply from unconventional (i.e. shale) resources, with far reaching consequences for global energy markets'. The 'Low unconventional' case assumes 'only a small share of the unconventional resource base is accessible for development'. For 2035, DECC projections have been held flat at 2030 levels.

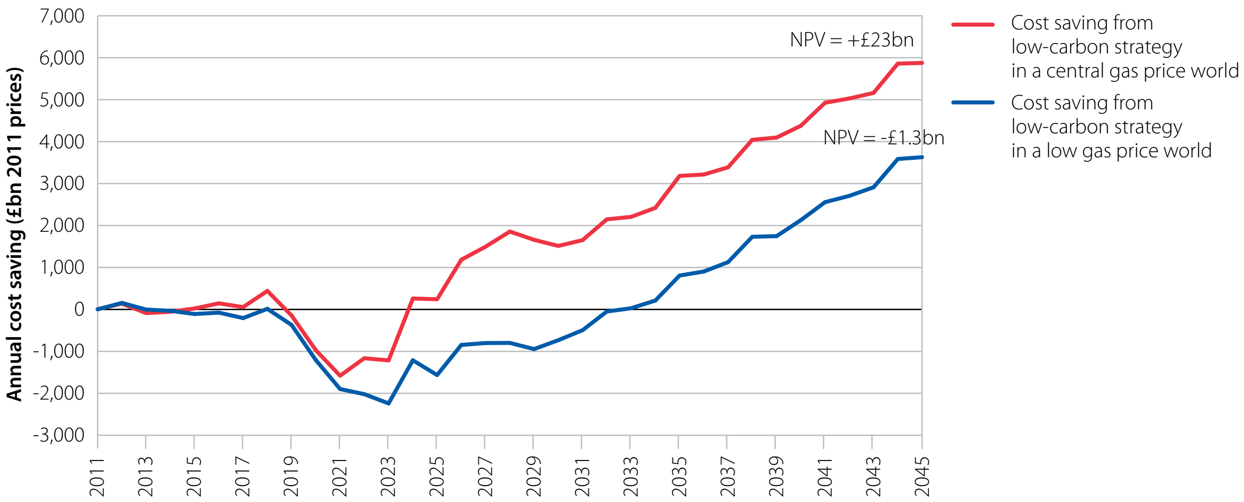
Figure 5.2: Projected global carbon price (2011 to 2050)



Source: UCL Energy Institute (2012) Modelling for the CCC, DECC (2011) IAG Guidance for Policy Appraisal.

Considering gas and carbon prices together, we demonstrated in our June 2012 progress report that an investment strategy during the 2020s that focuses on low-carbon technologies rather than unabated gas is a low-regrets option. The low-carbon strategy involves significant lifetime cost savings if gas prices do not fall and no cost penalty in a less likely case of significantly reduced gas prices (Figure 5.3).

Figure 5.3: Cost saving from investment strategy focused on low-carbon rather than gas during the 2020s – central and low gas price worlds



Source: Redpoint modelling.
Notes: Low-carbon strategy decarbonises to around 40 gCO_2/kWh by 2030. Scenario with investment in predominantly gas achieves 130g CO_2/kWh by 2030. Both scenarios achieve at least 30% renewable generation by 2020 and assume technology policy continues to support minimum levels of offshore wind and CCS in the 2020s. Negative values imply a cost penalty from investing in low-carbon, while positive values imply a cost saving. NPV = Net Present Value, discounted at 3.5%.

This reflects the increasing cost of carbon in a carbon-constrained world and is borne out in a high-level assessment of household bill impacts beyond 2020:

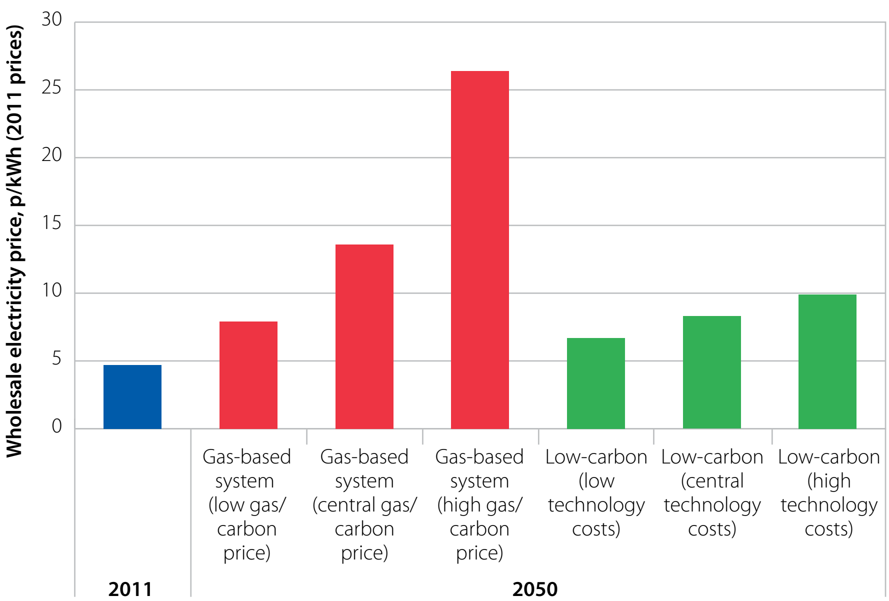
- We project that household energy bills would increase by around £25 further from 2020 to 2030 under a scenario that largely decarbonises the UK power sector through deployment of a portfolio of low-carbon generating technologies by 2030 (e.g. reducing emissions intensity from around 500 gCO_2/kWh currently to around 50 gCO_2/kWh in 2030).
  - The impact of rising carbon prices would be limited in this scenario as under 10% of generation is from unabated gas generation in 2030.
  - Our cost assumptions for nuclear and onshore wind imply that increased generation from these sources would have a limited impact on costs (these cost an average of £85/MWh in the 2020s, compared to £77/MWh for unabated gas generation in 2020 when including the carbon price underpin at £32/tCO_2).
  - Whilst offshore wind is likely to continue to require a cost premium, this is expected to decline to 2030. As a result, extending 2010s deployment of offshore wind through the 2020s would only add a further £13 to bills.
  - Offsetting these effects, support for renewable generation added before 2010 would expire, reducing bills.
- By contrast, if all generation were exposed to a carbon price rising from £32/tCO_2 to £76/tCO_2 (i.e. in line with the Government's carbon price underpin), then household bills would increase by £50 from 2020 to 2030. If the wholesale gas price was also to rise as in the IEA's 'Low Unconventional' case, then bills would rise by a further £70 per household (i.e. by £120 in total).
- Beyond 2030, bills would fall in a low-carbon system as new low-carbon capacity is commissioned at lower cost than the older capacity (assuming learning in deployment leads to cost reductions). In contrast, for a system with a major share of generation from unabated gas, bills would continue to increase as carbon prices continue to rise.

Building in uncertainty around construction costs as well as gas prices and carbon prices suggests that in the long term a low-carbon portfolio is both expected to have lower electricity prices than a system based on unabated gas and will be less exposed to potentially very high prices (Figure 5.4).

- For example, under central assumptions for gas and carbon prices and low-carbon technology costs, wholesale electricity prices would be 5.3 p/kWh (40%) higher in 2050 in a gas-based system compared to a low-carbon system. That would imply higher average household bills, of the order of around £200 per year in 2050. If the rest of the world was also to rely on unabated gas generation then gas prices (and therefore bill increases) are likely to be higher and risks of very dangerous climate change would increase dramatically.
- Under a high scenario for gas and carbon prices, wholesale electricity costs in 2050 would be over three times higher in a gas-based system. This would be equivalent to adding over £600 to the electricity bill for an average dual-fuel household in 2050. Energy bills for commercial and industrial firms would also be substantially higher, with the precise difference depending on the share of wholesale electricity prices within the total energy bill.

Therefore, in the long term, a strategy to develop a low-carbon portfolio has benefits for affordability of household bills and competitiveness of industry.

Figure 5.4: Electricity price projection and uncertainty range (2011 and projected in 2050)



Source: CCC calculations.
Notes: Gas-based system: low scenario - gas price 42p/therm, £100t/CO_2; central scenario - gas price 72p/therm, £200t/CO_2; high scenario - gas price 102p/therm, £500/tCO_2) High / low technology costs in line with our estimates based on Mott MacDonald (2011), for the Renewable Energy Review. Costs are for the full levelised cost of electricity (i.e. they include all subsidies, even though currently these are generally paid outside of the wholesale market)..

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