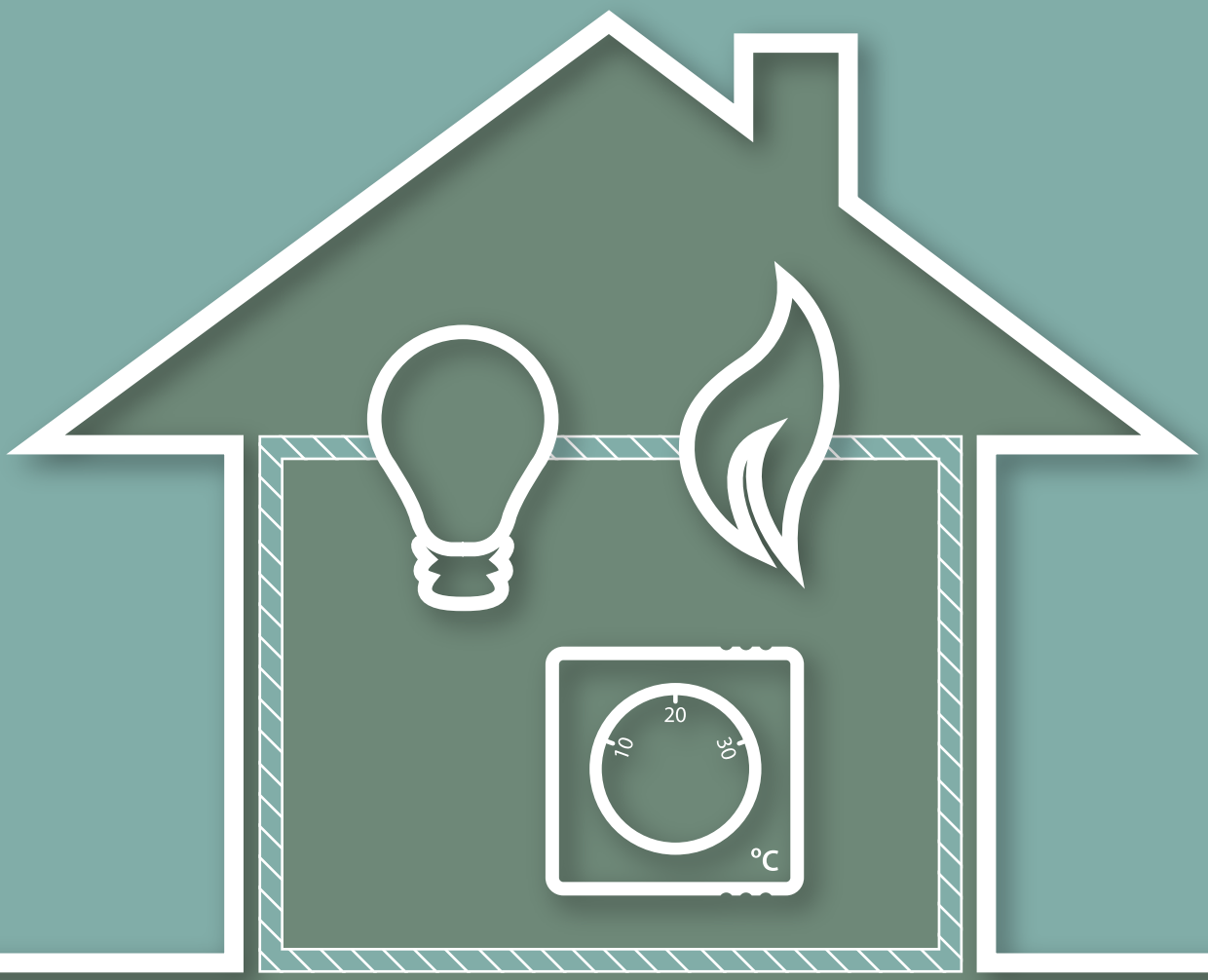
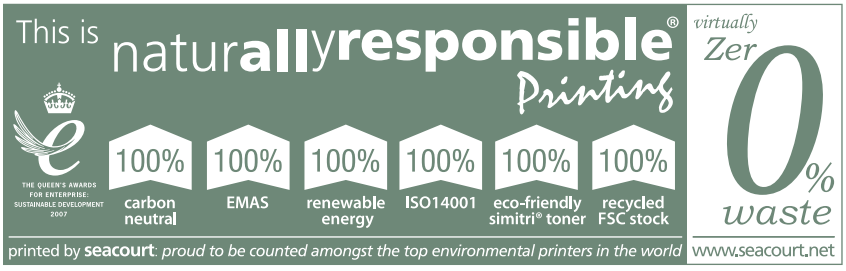
Household energy bills – impacts of meeting carbon budgets

Committee on Climate Change | December 2011





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Committee on Climate Change
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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 meeting carbon budgets

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

Advice requested by Government

We provide ad hoc advice in response to requests by the 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 and July 2011, 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 Lord Adair Turner (Chair), David Kennedy (Chief Executive), Professor Samuel Fankhauser, Sir Brian Hoskins, Professor Julia King, Lord John Krebs, Lord Robert May and Professor Jim Skea.

The Committee would like to thank the core team that prepared the analysis for this report: Alice Barrs, Russell Bishop, Alex Kazaglis, Jonathan Stern and Mike Thompson.

Contents

Introduction and summary 4

1. Current energy prices and bills 9

2. Outlook for electricity bills to 2020 15

3. Outlook for gas bills to 2020 20

4. Outlook for total energy bills 24

Introduction and summary

There is currently much debate on rising household energy bills, and the extent to which this is or will be due to costs of financing low-carbon investments. This note sets out our analysis of energy bill impacts from meeting carbon budgets to date and over the next decade. It includes assessments of price impacts from wholesale gas prices, financing low-carbon investments and energy efficiency measures, together with scope for reductions in energy demand and bills through energy efficiency improvement.

We focus on historic and future energy bill impacts for the typical household:

- **Historic bill increases.** We first consider the period from 2004 to 2010, during which energy bills increased significantly. Our analysis is of actual bills as measured in *nominal prices* (i.e. increases include the effect of general inflation in the economy).
- **Future bill impacts.** We consider the period from 2010 (the latest full year of outturn data for energy consumption) to 2020 (the middle year of the third carbon budget and the year of the UK's target for 15% renewable energy under the EU Renewable Energy Directive). We do not attempt to predict general inflation in the economy, presenting our analysis in *real prices* (i.e. without inflation).
- **Typical households.** Our analysis focuses on the 84% of typical households with gas heating and 'dual-fuel' bills (i.e. bills for both gas and electricity). There are also important minorities with electric heating (9%) and heating from oil, liquid petroleum gas (LPG) or solid fuels (7%); we include a high-level assessment of bill impacts for these groups.

The key conclusions of our analysis are:

- **The change in energy bills since 2004.** The average dual-fuel energy bill for a typical household increased from around £605 in 2004 to £1,060 in 2010. Of the total £455 increase (i.e. 75%, compared to general price inflation of 16% over the same period):
  - By far the largest contributor was the increase in the wholesale price of gas, which added around £290 to bills.
  - Around £75 was due to policies that reduce carbon emissions. This included £30 to support investments in low-carbon power generation, and £45 for funding of energy efficiency improvements in homes, which will also have helped to reduce consumption.
  - Around £70 was due to increasing transmission and distribution costs, and £20 was due to VAT.
  - Therefore, over 80% of the increase was unrelated to low-carbon measures.

- **Energy bills in 2020.** We project that the combined gas and electricity bill for the typical household could increase (in real terms) from £1,060 in 2010 to £1,250 in 2020, if there is limited success in implementing energy efficiency measures.
  - Our best estimate is that policies to achieve a low-carbon economy will add a further £110 to bills in 2020, almost entirely due to support for investments in low-carbon power generation (including renewables) and with a small increase (around £10) required to support energy efficiency measures (including smart meters).
  - The price of gas in 2020 is inherently uncertain. DECC project in their central scenario that the wholesale gas price will increase to 68 p/therm in 2020, from around 60 p/therm today and 44 p/therm in 2010. We estimate that this will add a further £175 to energy bills.
  - An additional £15 per household is likely to be required to cover increased transmission and distribution costs to 2020.
  - Offsetting this, we expect consumption to fall, both because 2010 was an uncharacteristically cold year, and as old boilers are replaced with newer, more efficient models over the next decade.
  - The combination of these effects is a projected total energy bill of £1,250 in 2020, compared to £1,060 in 2010. Within this bill we anticipate total costs of £130 per household for measures to support low-carbon investments and around £60 for supporting energy efficiency improvements in homes.
- **Scope for further energy efficiency improvement.** We identify significant potential for further energy efficiency measures to contribute towards emissions reductions required to meet carbon budgets and to mitigate increases in household energy bills (such that these would be at a similar level in 2020 to 2010).
  - We estimate that there is an opportunity to reduce electricity consumption by around 19% over the next decade through more efficient lighting and appliances.
  - For gas consumption there are likely opportunities for further savings of 6% through building fabric measures (e.g. installing loft and cavity wall insulation) and potentially a further 4% if consumers can be persuaded to use temperature controls more efficiently. We assume a slight increase in heat consumption of 2% to replace waste heat as inefficient electric appliances are replaced.
  - These savings are currently uncertain, and require new policies with stronger incentives to provide confidence that they will be fully achieved. With such new policies, we project an energy bill in 2020 of around £1,085 per household (i.e. broadly at 2010 levels).

- **Non-typical households.**
  - Bill impacts of low-carbon measures to 2020 are likely to be similar for households with oil, LPG or solid fuel heating to those with gas heating.
  - Households with electric heating could be disproportionately affected by future costs of low-carbon measures, given that these will mainly fall on electricity bills not gas bills. This highlights the importance of bringing forward measures to mitigate bill impacts for these 9% of households. The Government has recognised this in the Affordable Warmth elements of the recent Green Deal package, and should continue to develop policies to protect vulnerable households in electrically heated homes and more generally.

Our analysis disproves two often-repeated claims around the costs of low-carbon policies (see Box 1 for a summary of key policies):

1. That energy bills are currently high due to costs of policies to achieve a low-carbon economy. This is not the case – from 2004 to 2010 bills increased primarily in response to increased wholesale gas costs, with only 7% of the increase (i.e. £30 from £455) due to the costs of decarbonising the generation mix, and 10% of the increase (i.e. £45) due to funding improvements to the energy efficiency of homes; together these now make up 8% (£85 from £1,060) of the total energy bill for the typical dual-fuel household.
2. That future huge investments in low-carbon capacity will drive very dramatic increases in energy bills by 2020 (e.g. causing bills to double or even reach £3,000+). This is not the case, and we identify two common errors which, when corrected, give a picture of much smaller increases:
   - Required investment in low-carbon capacity is lower than often quoted. For example, by far the largest required investment is in offshore wind, with a further 12 GW required by 2020 to meet carbon budgets – this would cost around £30 billion, and not the £100 billion widely referred to (the latter being the cost for delivering the 33 GW total resource potential of all sites identified in Rounds 1, 2 and 3).
   - The upfront cost can be misleading. Low-carbon investments with high upfront costs benefit from low running costs (e.g. wind generation does not have to pay for fuel). A correct analysis must therefore consider costs across the lifetime over which projects repay their upfront costs (as in the Government's subsidy mechanism, which is paid per unit of output over 20 years).

Assuming investments based on ambition to deliver carbon budgets (i.e. £30 billion for offshore wind, plus lower investments required for other renewables, nuclear and CCS) and using lifecycle costs, we project a 2020 bill of £1,250 or lower (i.e. far less than double/£3,000).

Box 1: Key policy instruments to deliver energy efficiency and low-carbon power

Current policies to encourage domestic energy efficiency include:

- **Carbon Emissions Reduction Target (CERT):** an obligation on domestic energy suppliers to reduce the CO_2 emissions of households. Suppliers meet their obligations by delivering the uptake of energy efficiency measures.
- **Community Energy Saving Programme (CESP):** an obligation on energy suppliers and electricity generators to improve energy efficiency in areas of low income in Great Britain.

From 2012, these policies will be superseded by new mechanisms:

- **Green Deal:** a financing mechanism which enables organisations to offer domestic and non-domestic consumers energy efficiency improvements at no upfront cost and to receive payments through a charge on the energy bill.
- **Energy Company Obligation (ECO):** an obligation on energy suppliers to replace CERT and CESP from 2013. It will complement the financing mechanism of the Green Deal by targeting consumers on low income and in "hard to treat" housing.

At the EU level, there are additional legally-binding standards to phase out less efficient products (e.g. inefficient lighting) and labelling to improve consumer awareness.

Policies to support low-carbon generation include:

- **Renewables Obligation (RO):** 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.
- **European Union Emissions Trading Scheme (EU ETS) and Carbon Price Floor (CPF):** the EU ETS is a carbon trading system which covers power generators and large industrial users of energy in the EU. The CPF is a UK policy designed to strengthen the carbon price by topping it up to a specified minimum if the EU ETS price is lower.
- **Electricity Market Reform (EMR):** a package of measures to reform the electricity market to deliver low-carbon investment in electricity generation in larger quantities and at lower cost.

We set out our analysis in four sections:

1. Current energy prices and bills
2. Outlook for electricity bills to 2020
3. Outlook for gas bills to 2020
4. Outlook for total energy bills

We also include three annexes, which cover:

1. Non-typical households
2. Gas price sensitivities
3. Funding energy efficiency improvement

We do not attempt a comprehensive comparison with recently published analysis of future energy bills by the Department of Energy and Climate Change (DECC)[1], but we do identify two key differences of scope and approach.

- Where our analysis looks separately at dual-fuel and electrically heated households, the DECC analysis considers an average across all customers. The result is that DECC's analysis implies higher bills across all years than for our 'typical' customers, reflecting relatively high costs of electric heating.
- Where we compare to actual 2010 energy bills, DECC compare to what bills would have been without any low-carbon measures (including those already in place and end-of-life boiler replacements).

We note that both our analysis and the DECC analysis share a conclusion that successful implementation of energy efficiency measures would largely offset costs of financing low-carbon investments and increased gas prices, resulting in bills in 2020 broadly at current levels.

We will update the analysis in this paper in the context of our annual reports to Parliament on progress in reducing emissions, and in line with the requirement in the Climate Change Act to consider the impact of carbon budgets on energy supplies and fuel poverty.

1 DECC (November 2011) Estimated impacts of energy and climate change policies on energy prices and bills.

1. Current energy prices and bills

In considering energy bills, it is important to make a clear distinction between electricity bills and heating bills. For the typical 'dual-fuel' household, electricity accounts for 40% of energy spend (mainly lighting and appliances) whilst 60% of spending is on gas for heating. Though both are driven by underlying wholesale energy costs, retail electricity and gas prices are impacted differently by low-carbon measures, as we set out below.

The following analysis sets out current and future energy bills for the typical 'dual-fuel' customer, recognising that some households will differ from this example (e.g. some houses have electric heating; we consider different household types in section 4 and Annex 1). We cover electricity bills first, and then turn to gas.

(a) Current electricity prices and bills

Electricity bills increased by 60% from 2004 to 2010, due to increases in the retail price paid for electricity.

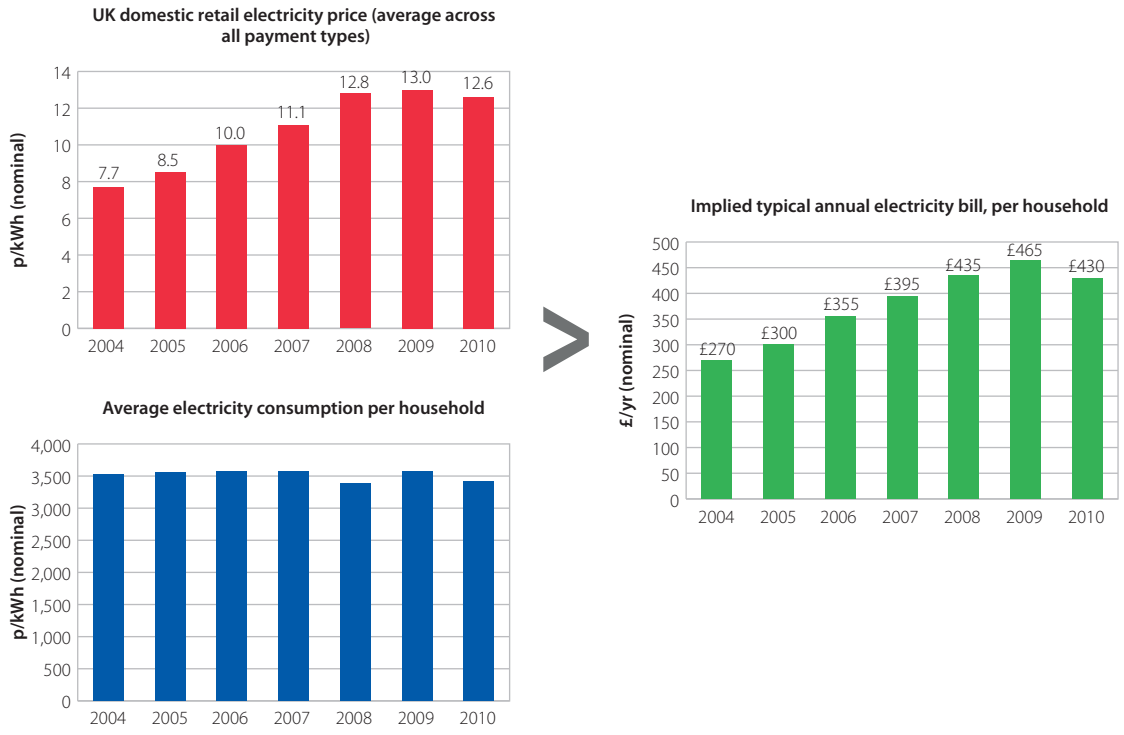
- **Price trends.** Domestic standard retail electricity prices were 12.6 p/kWh in 2010, around 65% higher than in 2004[2], compared to general inflation of 16% over the same period (Figure 1). In January 2011 Ofgem estimated the average price to be 12.8 p/kWh[3]. More recent announcements[4] suggest further price increases in the latter half of 2011, following slight price reductions in 2010.
- **Consumption trends.** Over the same period, consumption for lighting and appliances has remained broadly flat at around 3,400 kWh per household.
- **Bill trends.** As a result, we estimate that the typical bill for domestic consumers has increased by around £160 (60%) from 2004, reaching around £430 in 2010.

The 5.7 p/kWh increase in retail electricity prices from February 2004 to January 2011[5] mainly reflects a change in wholesale generation costs resulting from increased gas prices (Figure 2).

- **Wholesale costs.** Changes in wholesale energy costs (which include both wholesale electricity prices and supplier costs and margins) added just over 3 p/kWh to domestic retail prices since 2004. The wholesale gas price is the key driver of these costs and of retail electricity prices more generally; it increased by 65% over the same period (Figure 3).
- **Transmission and distribution costs.** There have also been small increases in the cost of transmission and distribution, adding around 0.7 p/kWh to retail prices since 2004.

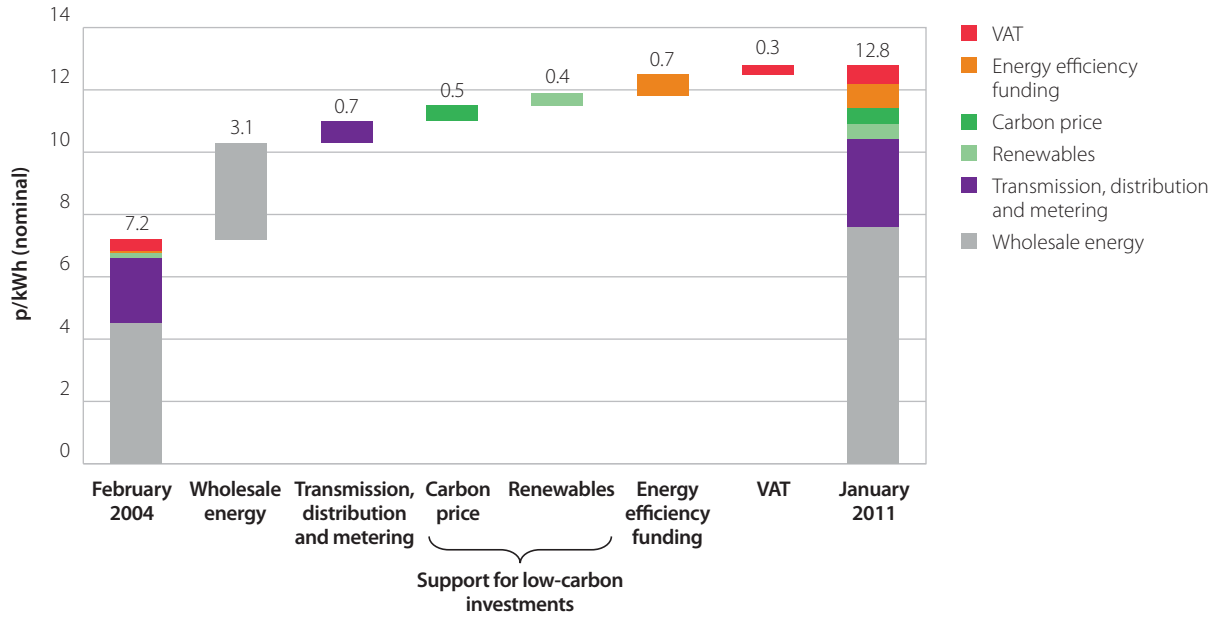
2 CCC calculations based on DECC Quarterly Energy Prices (Table 2.2.1)
3 Ofgem (January 2011) Household Energy Bills explained
4 The 'Big 6' energy suppliers have all announced headline increases in retail electricity prices of 5-16%, effective since August 2011 onwards.
5 Detailed price data is published by Ofgem (rather than DECC) and available on slightly different timing; as such the price breakdown in Figure 2 is not exactly comparable to the prices set out in Figure 1.

Figure 1: UK domestic retail electricity price (average across all payment types), typical electricity consumption and implied typical bill (2004-2010).



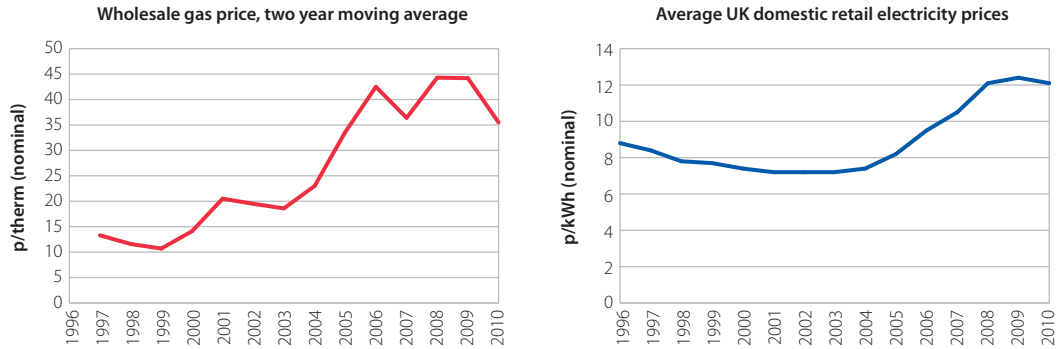
Sources: DECC Quarterly Energy Prices (QEP), Table 2.2.1. DUKES (2011), CCC calculations.
Note: Household bill is rounded to the nearest £5.

Figure 2: Breakdown of the change in domestic retail electricity prices (February 2004-January 2011)



Source: CCC calculations based on Ofgem.
Note: Nominal prices.

Figure 3: Average UK domestic retail electricity price (direct debit) and wholesale gas prices (1996-2010)



Sources: CCC calculations based on DECC Quarterly Energy Prices (QEP) Table 2.2.1, DECC, Platts.
Note: The chart shows a two-year moving average of the gas price to smooth out volatility, and to reflect the time delay in suppliers passing wholesale gas price changes through to retail electricity prices. There are 29 kWh in a therm.

- **Low-carbon policy costs.** These have increased by 1.6 p/kWh since 2004, and contributed around 1.8 p/kWh to the electricity price in 2010. The increases include:
  - Just under 1 p/kWh to support investments in low-carbon capacity, of which 0.5 p/kWh is due to the impacts of the EU ETS carbon price and 0.4 p/kWh due to funding renewables under the Renewables Obligation (RO).
  - 0.7 p/kWh for funding energy efficiency measures (e.g. CERT, CESP).

In 2010, the typical £430 electricity price/bill comprised 60% generation and supply costs (around £255), 22% transmission, distribution and metering costs (around £95), 13% low-carbon policy costs (£58, of which around £17 was due to the carbon price, £16 for renewables and £25 for CERT) and 5% VAT (Figure 2).

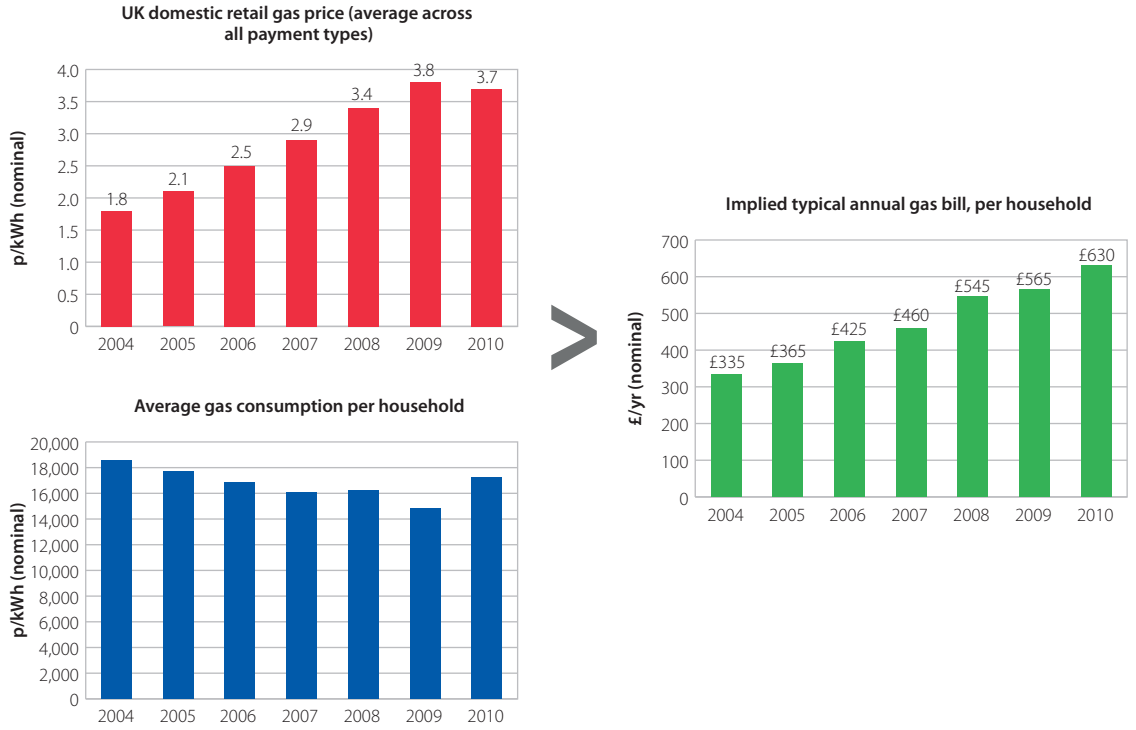
(b) Current gas heating prices and bills

Recent gas bill increases have been driven by retail price increases, partially offset by demand reductions (Figure 4):

- **Price trends.** Domestic retail gas prices in 2010 were 3.7 p/kWh, just over double that in 2004, but slightly lower than in 2009. Significant further increases in retail gas prices have been announced during 2011[6].

6 The 'Big 6' energy suppliers have all announced price increases for their residential gas customers of 15-19% above 2010 prices. These price increases began being effective from August 2011 onwards.

Figure 4: UK domestic retail gas price (all payment types), typical gas consumption and implied typical bill (2004-2010)

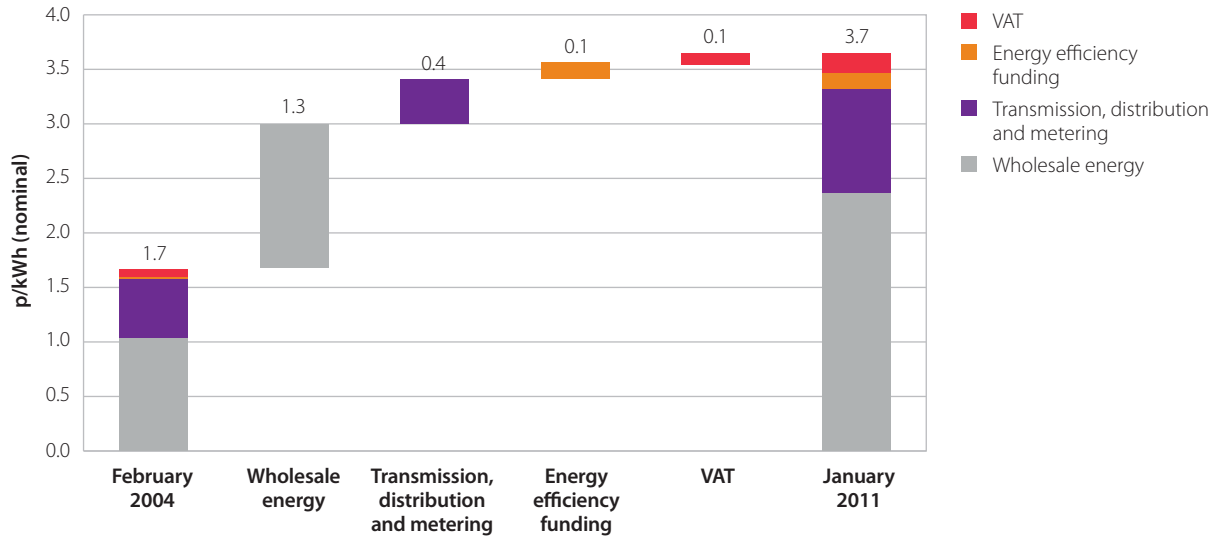


Sources: DECC Quarterly Energy Prices (QEP), Table 2.2.1. DUKES (2011), CCC calculations.
Note: Final 2011 data is not yet available. Supplier announcements suggest that the retail gas price rose by 15-19% in 2011 while consumption is on track to fall 17%, so that the 2011 bill is likely to be similar to that for 2010.

- **Consumption trends.** There was a consistent decline in gas consumption from 2004 to 2009, with consumption falling by 20% for the average consumer. Some of this reduction is likely to be as a result of energy efficiency measures funded through policy schemes. In 2010, consumption rose 16% on the previous year, due to unusually cold weather (average temperatures across the winter months of 2010 were 2°C colder than in 2009); it is highly likely that consumption will have fallen back in 2011 given temperatures through to the end of November[7], and we assume that temperature continues at historic average levels in subsequent years.
- **Bill trends.** We estimate that the typical bill for domestic gas consumers has increased by 90% from £335 in 2004 to £630 in 2010, and will remain at a similar level in 2011 as the impact of milder temperatures on consumption offsets further announced increases in prices.

7 Anecdotal evidence supports this assumption. For example, Centrica reported in November 2011 that average gas consumption amongst their residential customers was down 17% across the first 10 months of 2011 compared to the same period in 2010.

Figure 5: Breakdown of the change in domestic retail gas prices (February 2004-January 2011)



Source: CCC calculations based on Ofgem.
Notes: Nominal prices.

Increased prices have been driven by wholesale gas prices, with low-carbon policy costs making up a smaller portion of bills than for electricity (Figure 5).

- **Price drivers.** Wholesale energy costs (i.e. wholesale gas prices and supplier margins) have increased by around 1.3 p/kWh since 2004. There has also been a small increase in the cost of transmission and distribution (0.4 p/kWh). Costs of low-carbon measures passed on through the gas price relate to funding of energy efficiency improvement, and increased by 0.1 p/kWh from 2004 (i.e. accounting for 7% of the increase in the retail gas price).
- **Price components.** Gas prices/bills are dominated by underlying fuel and supplier costs, followed by transmission and distribution. Low-carbon policy costs for heat are all related to funding energy efficiency improvement in homes and make up a small proportion of the bill (around 4%, or £25 within the typical annual household bill of £630 in 2010).

(c) Current total energy bills

Combining our analysis of electricity and gas bills for the typical dual-fuel household indicates that the average combined bill increased from £605 per household in 2004 to £1,060 in 2010. Of this £455 increase (75%, compared to general inflation of 16% over the same period):

- Around £380 was unrelated to low-carbon measures, with £290 due to increases in wholesale costs reflecting increases in the price of gas and supplier costs and £70 due to increasing transmission and distribution costs, and £20 due to VAT.
- Around £75 was due to low-carbon policy costs, within which it is important to distinguish between costs of £30 towards decarbonising the energy mix through support for investments in low-carbon power generation including renewables, and costs of £45 for funding of energy efficiency measures, without which bills could have increased further over this period.

Our analysis therefore clearly shows that it is not the case that energy bills are currently high due to costs of low-carbon measures. From 2004 to 2010 bills increased by £455 to £1,060, primarily in response to increased wholesale gas costs, with only £30 (7% of the increase and 3% of the bill) due to the costs of decarbonising the generation mix, and £45 (10% of the increase and 5% of the bill) due to funding improvements to the energy efficiency of homes.

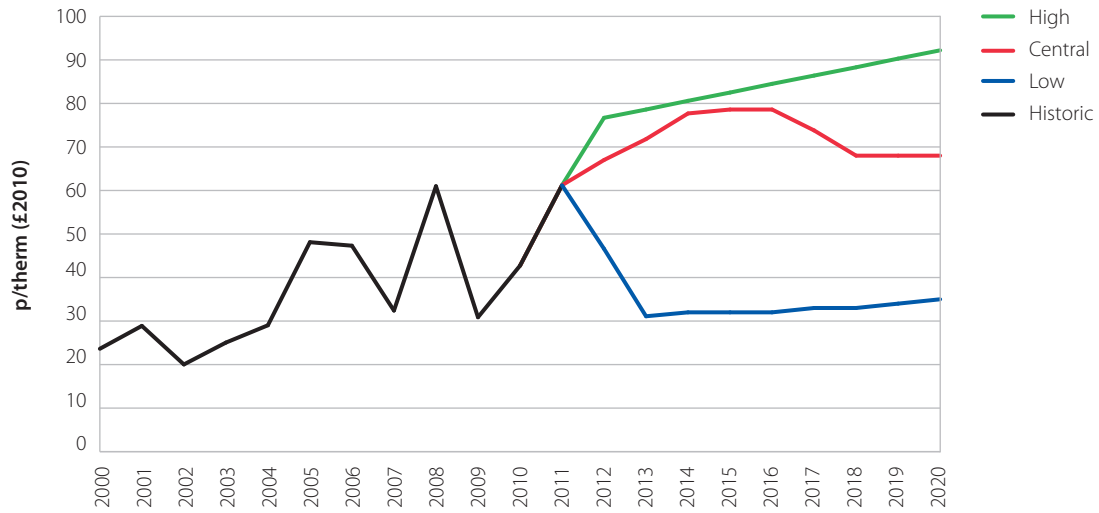
2. Outlook for electricity bills to 2020

(a) Projected electricity prices in 2020

In projecting electricity prices[8], we need to make assumptions on future gas prices, wholesale generation costs, transmission and distribution costs, supply margins and costs of supporting low-carbon investments and energy efficiency:

- **Gas prices.** Projecting wholesale gas prices is inherently uncertain. We focus on DECC's central projection for gas prices, which increases from 44 p/therm in 2010 to 68 p/therm in 2020 (Figure 6); we include gas price sensitivities in Annex 2.
- **Wholesale generation costs.** We assume a wholesale electricity price equal to the cost of gas-fired generation. Based on the DECC central scenario for wholesale gas prices, we estimate a wholesale electricity price of 6.5 p/kWh in 2020 based on a mix of new and old gas-fired plants, which we assume are the marginal (price-setting) plants.[9]

Figure 6: Historic and projected real wholesale gas prices (2000-2020, p/therm)



Source: DECC.
Notes: £2010. Whilst final data is not yet available for 2011, the price for most of the year is known; all three scenarios for future prices therefore assume a price of around 60 p/therm in 2011.

8 Our projections are all in real terms (i.e. they are not scaled up to account for general inflation in the economy), using 2010 prices.
9 The cost of gas generation is defined here as the short-run marginal cost (i.e. cost of burning the fuel) plus an uplift (1.4p/kWh) to cover capital and fixed costs.

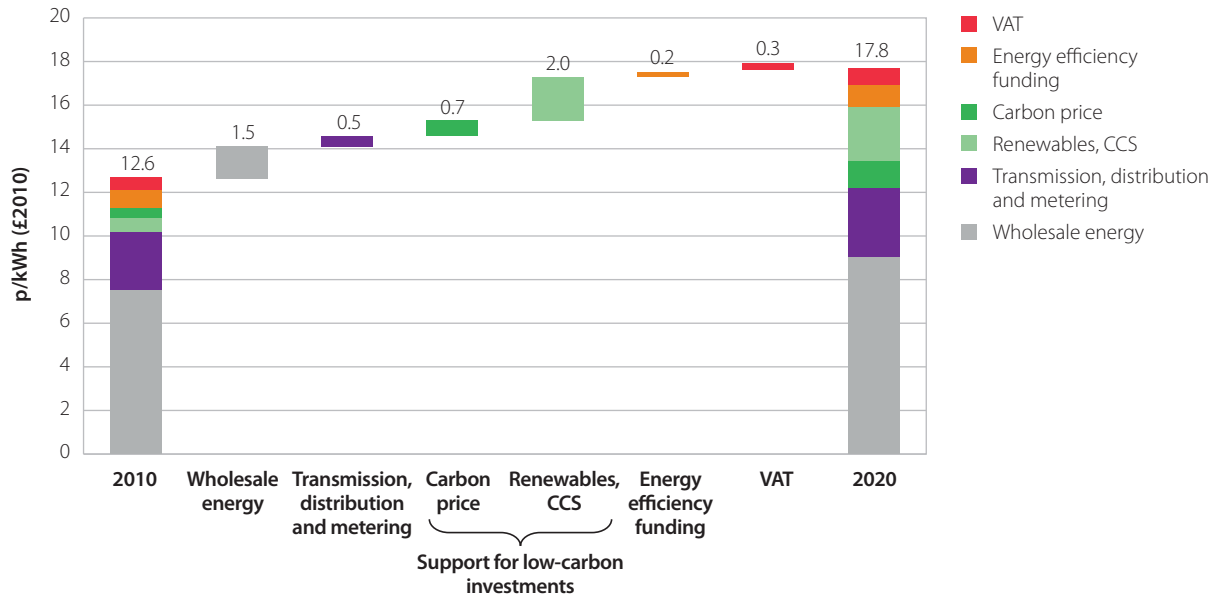
- **Transmission and distribution costs.** We assume that these increase from 2.7 p/kWh to 3.2 p/kWh, primarily to fund replacement and upgrading of existing assets. Costs for connecting offshore wind farms to shore, and grid reinforcement to support investment in onshore and offshore wind, are included in the costs of renewable generation.
- **Supply cost and margin.** We assume these will remain constant at around 2.5 p/kWh, as in 2010, given that they are currently high relative to previous years.
- **Costs of supporting low-carbon generation.** There are a set of costs going forward associated with supporting development and deployment of low-carbon power generation technologies:
  - **Carbon price floor.** We assume a carbon price rising to £30/tCO_2 in 2020, in line with Government policy on the carbon price floor. In the central scenario, this contributes just over 1 p/kWh to the electricity price in 2020. We note that a carbon price of £30/tCO_2 in 2020 (when all EU ETS allowances for the power sector will be auctioned by Government) will raise tax revenue of around £3 billion a year, creating an opportunity for offsetting tax reductions or public spending to mitigate energy bill impacts on households.
  - **Renewable generation.** We assume support for renewables under the Renewables Obligation (RO) in line with the Government's recently published banding consultation to 2016/17. Beyond this, we assume declining support in line with our assessment of cost reductions from our Renewable Energy Review[10]. We also include here the £5 billion investment cost identified by the ENSG[11] for the least-regrets transmission investments required to support renewable deployment. Given these assumptions, support for renewables contributes 2.2 p/kWh to the electricity price in 2020.
  - **CCS demonstration.** We assume costs related to CCS demonstration consistent with the Government's assessment, rising to a 0.3 p/kWh uplift on the electricity price in 2020.[12]
- **Costs of energy efficiency measures.** There are a set of costs going forward associated with measures aimed at improving the efficiency of energy use in homes:
  - **Funding energy efficiency improvement.** In line with proposals in DECC's consultation on the Green Deal and ECO, we assume that costs related to funding of energy efficiency measures remain broadly the same in 2020 as in 2010, contributing just under 1 p/kWh (see Section 3a below).
  - **Smart meters.** We follow DECC analysis, and assume that roll-out of smart meters adds 0.2 p/kWh to the electricity price in 2020. We do not include any savings on metering costs that may result from smart meter installation.

10 CCC (2011) The Renewable Energy Review, available at **www.theccc.org.uk**.
11 Electricity Networks Strategy Group (2009), Our Electricity Transmission Network, A Vision for the Future
12 DECC (2010) Annual Energy Statement. This would be sufficient to fund several demonstration projects costing upwards of £1 billion.

Under these assumptions, we project an electricity price increase over the next decade of 5.2 p/kWh (40% relative to 2010 levels), with 3.0 p/kWh of the increase reflecting increased costs of low-carbon policies (Figure 7).

- **Projected electricity prices.** We project an electricity price of 17.8 p/kWh in 2020; this is a 5.2 p/kWh (40%) increase on 2010 levels. Of the increase, 1.5 p/kWh is due to the increasing wholesale energy (i.e. gas) prices, 0.5 p/kWh is due to increasing transmission and distribution costs, and 3.0 p/kWh is due to increasing low-carbon policy costs (which in turn is split: 2.0 p/kWh increase from funding renewables and CCS, 0.7 p/kWh from the increased carbon price and 0.3 p/kWh from funding smart meters and energy efficiency).
- **Electricity price components.** In 2020, we project that wholesale, transmission and distribution costs will account for around 70% of the electricity price, costs of supporting low-carbon investments will be around 20% and costs of energy efficiency measures will be 5%, with VAT making up the final 5%.

Figure 7: Projected increases in domestic retail electricity prices (2010-2020)



Sources: Source: DECC Quarterly Energy Prices, Ofgem, CCC calculations.
Note: £2010.

(b) Opportunities for energy savings in electricity use

Given the increase in the retail price, without any change in consumption (i.e. if consumption remained at 2010 levels) the electricity bill would increase by £180 (42%) over the next decade, from £430 per household in 2010 to £610 in 2020. Of this change, just over £70 would be due to changes in wholesale, transmission and distribution costs, around £100 due to costs of supporting low-carbon investments and around £10 due to costs relating to energy efficiency measures.

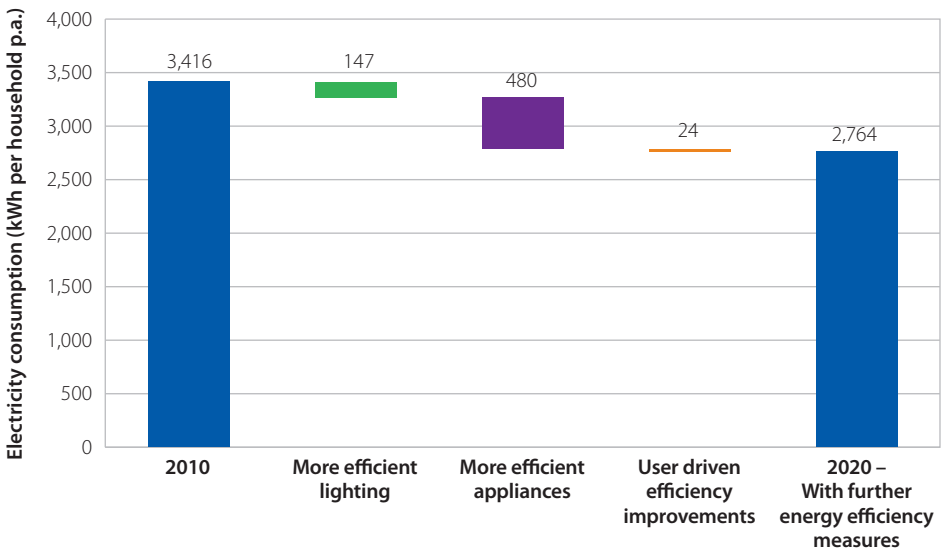
However, there is significant scope to reduce electricity consumption in households through efficient lights and appliances, many of which will save significantly more on energy bills than they cost in initial outlay. There is a small amount of further potential – although it is more uncertain – if households can be persuaded to reduce energy waste, for example by turning off lights in unoccupied rooms and reducing waste heat from washing machines.

Taken together, these measures could reduce average electricity consumption by around 19% in 2020 (Figure 8). Given such a reduction, the projected household bill in 2020 would fall to around £495, compared to £430 in 2010 (Figure 9).

Whether this potential will be unlocked is currently uncertain, with evidence suggesting only limited uptake of the most efficient appliances. For example, in 2010 A++ refrigerators and fridge-freezers accounted for less than 1% of the total stock, and A+ washing machines and dishwashers accounted for only around 8% of the total stock.

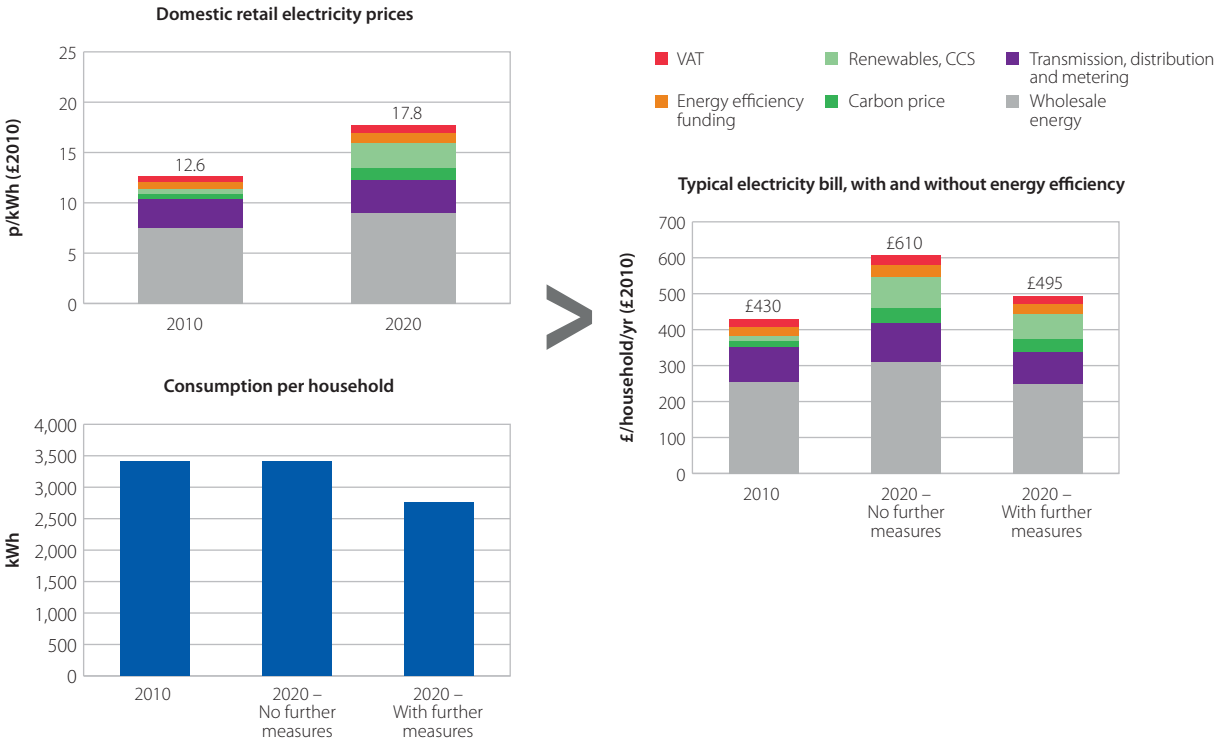
Therefore to provide confidence that energy efficiency improvement will ensue would require introduction of new policies with stronger incentives (e.g. regulating against sale of less efficient appliances, providing fiscal or other financial incentives for purchase of more efficient appliances).

Figure 8: Scope for savings in electricity consumption, average per household (2010-2020)



Source: CCC calculations.

Figure 9: UK domestic retail electricity price, typical electricity consumption and typical bill with and without further energy efficiency measures (2010, 2020)



Sources: CCC calculations.
Note: £2010.

3. Outlook for gas bills to 2020

(a) Projected gas prices in 2020

Given the dominance of wholesale fuel costs in the gas price, this is likely to be the main driver of changes in retail gas prices over the next decade.

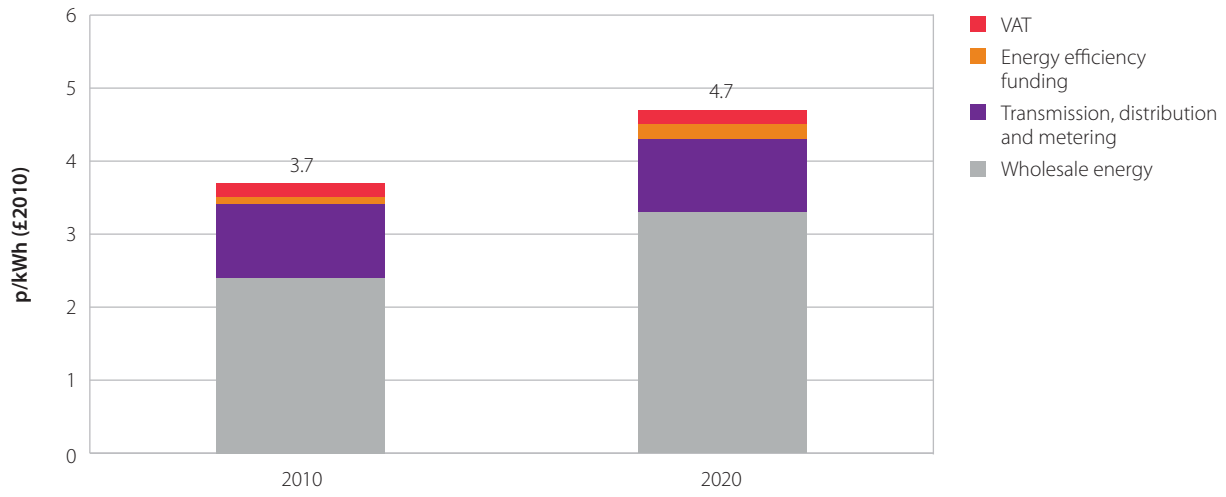
The small low-carbon component of the current price could be sufficient to fund energy efficiency improvement to 2020 depending on detailed design of policies (see Annex 3):

- Current funding for energy efficiency improvement is around £50 a year per customer (split 50:50 on gas and electricity bills), with the bulk of this supporting loft and cavity wall insulation.
- The focus of ongoing energy efficiency improvement in the near term should be loft and cavity wall insulation; all lofts and cavity walls should be insulated by 2015.
- Over time, the focus should shift to solid wall insulation (SWI); we have suggested that an appropriate ambition would be to insulate two million solid walls by 2020, requiring 260,000 installations in 2020.
- Funding at current levels could deliver this ambition, depending on financing costs for the Green Deal (i.e. if this achieves an A credit rating).
- This is also the Government's assumption on funding; the Green Deal and ECO consultation set out that energy efficiency funding would continue at current levels.

Following announcement in the 2010 Spending Review, renewable heat measures are now to be funded from the Exchequer rather than through a charge on bills under proposals for the Renewable Heat Incentive (RHI). Therefore they should not add to 2020 bills.

Under assumptions of a rising wholesale gas price (as in DECC's central case) and broadly constant costs for funding of energy efficiency improvement, we project a retail gas price increase of 1 p/kWh (27%) to reach 4.7 p/kWh by 2020, relative to 3.7 p/kWh in 2010 (Figure 10). Much of this increase has already occurred, with price rises announced by suppliers in the last year suggesting prices in 2011/12 of 4.2-4.5 p/kWh. DECC's wholesale price projection (shown in Figure 6 above) implies that prices may go up further in the next few years before falling back to a level in 2020 that is similar to 2011/12.

Figure 10: Retail gas price (2010 and projected in 2020)



Source: CCC calculations.
Note: £2010.

(b) Opportunities to reduce gas consumption through energy efficiency

Without any change in consumption (i.e. if consumption remained at 2010 levels) the typical annual household gas bill would increase by around £175, from £630 in 2010 to £805 in 2020, driven almost wholly by the increase in the gas price and VAT charged thereon.

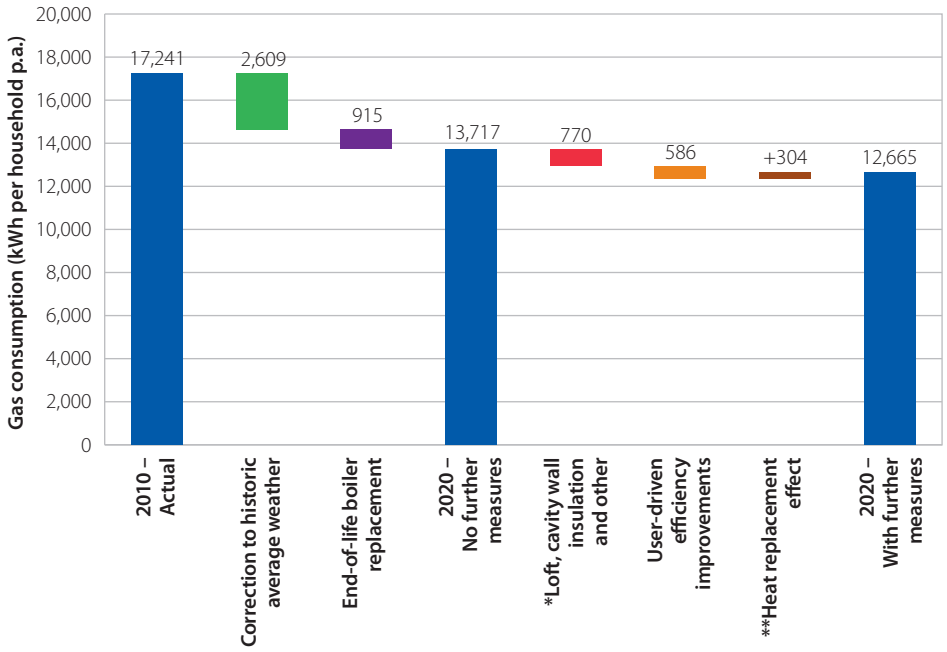
However, we expect consumption to fall in 2020 relative to 2010 without further efficiency measures (Figure 11).

- This is due to the fact that 2010 was an uncharacteristically cold year; adjusting to historic average temperature would reduce consumption by around 15%.[13]
- In addition, there will be replacement of old inefficient boilers over the next decade as these reach the end of their lives; replacing these with newer, more efficient models will reduce consumption by a further 6%.

Together these factors could reduce gas consumption in 2020 by around 20% compared to 2010 levels (i.e. largely offsetting the increase in retail prices), therefore leading to a gas heating bill that is broadly the same in 2020 as in 2010 (£640 – Figure 12).

13 CCC (2011) 3rd Progress Report to Parliament.

Figure 11: Scope for savings in gas consumption, average per household (2010-2020)



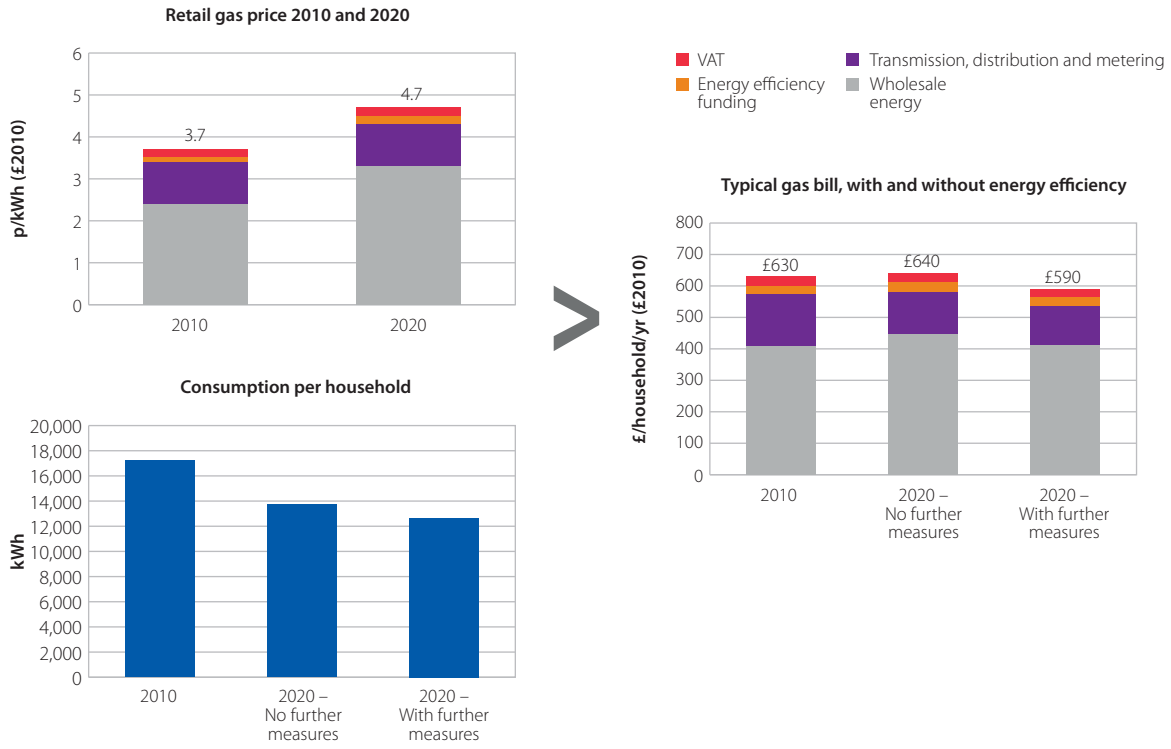
Source: CCC calculations.
Notes: Energy savings per measure are averaged over the household stock and as a result are lower than those that would be experienced by an individual household installation. *Other includes floor insulation, window glazing, floor insulation, doors and air-tightness, and insulated pipework. **As electric appliances become more efficient, waste heat from these appliances is reduced. The heat replacement effect is the slight increase in demand for heating to replace the lost waste heat.

This could be further reduced through additional measures, which together offer scope for a further 8% reduction in consumption in 2020, and therefore a reduction in the typical gas heating bill to around £590 per household in 2020 (Figure 11 and Figure 12):

- Insulation of remaining loft and cavity walls could reduce consumption by 5%.
- Other physical measures such as draft-proofing, insulation of hot water pipes and tanks, and improved glazing could reduce consumption by 1%.
- Installation and use of heating controls (e.g. thermostatic valves on radiators) or turning down the thermostat slightly (e.g. by 1ºC, noting that average internal temperatures in the UK have increased by 6ºC over the last three decades) could save a further 4%.

We also assume a small increase in heat consumption (2%) to replace waste heat as inefficient electric appliances are replaced.

Figure 12: UK domestic retail gas price, typical gas consumption and typical bill with and without measures (2010, 2020)



Source: CCC calculations.
Note: £2010.

Although more reductions (e.g. through solid wall insulation) are possible and desirable to meet carbon budgets, they do not offer opportunities for significant cost savings to households and so we do not include them in this analysis of bill impacts. Households that install these measures are likely to face broadly offsetting energy savings and costs under Green Deal financing, with their resulting bill more or less unchanged.

There has been recent success in delivering loft and cavity wall insulation under the Carbon Emissions Reduction Target (CERT). This will be replaced in 2012 by the Green Deal and the Energy Company Obligation (ECO). Detailed design of these approaches will determine the level of confidence around continued success in insulating lofts and cavity walls. We will provide a detailed assessment of the Green Deal and ECO in the context of our work on local approaches to emissions reduction, to be published next Spring.

4. Outlook for total energy bills

(a) Outlook for energy bills for typical households

We now combine our analysis of typical electricity and gas bills for the 84% of households with gas heating to set out the prospects for total dual-fuel energy bills.

We set out in section 1 that energy bills increased from around £605 per household in 2004 to £1,060 in 2010.[14] Of this £455 increase:

- Around £75 was due to policies that reduce carbon emissions. This included £30 to support investments in low-carbon power generation, and £45 for funding of energy efficiency improvements in homes, which will also have helped to reduce consumption.
- Around £70 was due to increasing transmission and distribution costs, and a further £20 due to VAT.
- By far the largest contributor was the increase in the price of gas, which added around £290 to bills.

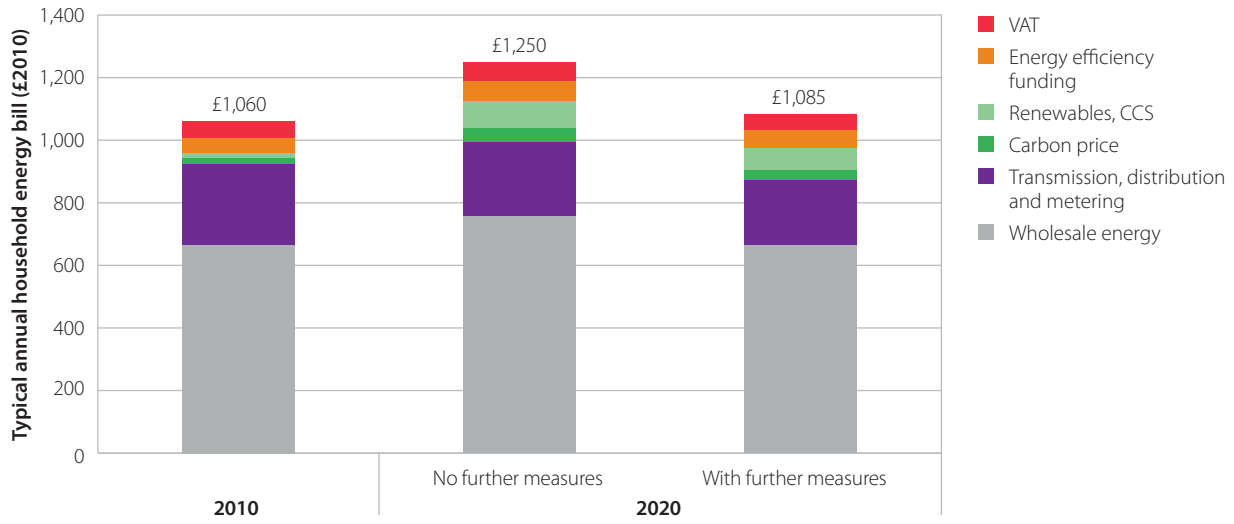
Looking ahead to 2020, our analysis in sections 2 and 3 indicates that if energy consumption were to remain at 2010 levels then energy bills could increase by £355 to over £1,400 in real terms (an increase of around a third), mainly reflecting increases attributable to wholesale gas prices and the costs of supporting low-carbon power generation.

However, we do not consider a scenario with constant energy consumption to be realistic. Gas consumption in 2020 is likely to be 20% lower than 2010 without further measures, adjusting for the cold weather in 2010 and taking into account additional savings from end-of-life replacement of inefficient boilers. Together these would bring energy bills down to result in a 2020 bill of £1,250, compared to the 2010 bill of £1,060 (Figure 13).

- Our best estimate is that policies to achieve a low-carbon economy will add a further £110 to bills in 2020, almost entirely due to support for investments in low-carbon power generation (including renewables) and with a small increase (around £10) required to support energy efficiency measures (including smart meters).
- Under DECC's central scenario the wholesale gas price will add a further £175 to energy bills.

14 This 75% (nominal) increase may be compared to general price inflation of 16% across the economy in the same period.

Figure 13: Projected household energy bill (dual fuel) in 2020 with and without energy efficiency



Source: CCC calculations.

- An additional £15 per household is likely to be required to cover increased transmission and distribution costs to 2020.
- Offsetting this is the lower consumption from adjusting to historic weather and replacing old boilers.
- The combination of these effects is a projected total energy bill of £1,250 in 2020, compared to £1,060 in 2010. Within this bill we anticipate total costs of £130 per household for measures to support low-carbon investments and around £60 for supporting energy efficiency improvements in homes.

Our analysis suggests that further significant energy savings are feasible and desirable, including a 19% reduction in electricity from more efficient appliances, and an 8% reduction in gas consumption through loft and cavity wall insulations, other insulation measures and user-driven energy savings. Together these would bring energy bills in 2020 down to £1,085 (i.e. similar to the 2010 bill of £1,060) (Figure 13).

These reductions are important both for reducing energy bills and reducing carbon emissions; new policies are required to provide confidence that they will be achieved.

Even without these energy efficiency improvements, our analysis demonstrates that it is not the case that future investments in low-carbon capacity will drive very dramatic increases in energy bills by 2020 (e.g. causing bills to double or even reach £3,000+).

We identify two common errors behind such claims:

- Required investment in low-carbon capacity is lower than often quoted. For example, by far the largest required investment is in offshore wind, with a further 12 GW required by 2020 to meet carbon budgets – this would cost around £30 billion, and not £100 billion (the latter being the cost for delivering the 33 GW total resource potential of all sites identified in Rounds 1, 2 and 3).
- The upfront cost can be misleading. Low-carbon investments with high upfront costs benefit from low running costs (e.g. wind farms do not have to pay for fuel). A correct analysis must therefore consider costs across the lifetime over which projects repay their upfront costs (e.g. as in the Government's subsidy mechanism, which is paid per unit of output over 20 years).

Therefore rather than a doubling or more of energy bills over the next decade, our analysis suggests a small increase through a combination of low-carbon investment and increasing wholesale gas prices, offset by reductions in consumption, and with scope for keeping bills broadly at 2010 levels if currently uncertain opportunities for energy efficiency are delivered.

(b) Outlook for total energy bills for non-typical households

The impact of carbon budgets on energy bills for the 7% of households that use oil, LPG or solid fuels as their primary heating source is likely to be similar to or slightly better than for the typical gas-heated household:

- Electricity use will be primarily for lights and appliances, as for gas-heated homes, and as such is likely to see similar impacts.
- There are no plans for low-carbon measures to add to oil, LPG or solid heating bills; our analysis above also indicates that low-carbon measures to 2020 will not materially add further to gas bills.
- Households with LPG or solid heating fuels may be particularly well-placed to benefit from measures under the RHI (e.g. in our analysis for the fourth carbon budget advice we assumed that around 60% of RHI measures were implemented in these 7% of households), offering an opportunity to reduce bills through moving to a renewable heating system, with support funded from the Exchequer.

The 9% of households with electric heating could potentially be more adversely affected than the typical dual-fuel home both by carbon budgets and by future costs not relating to carbon budgets:

- Data on energy consumption for electrically heated homes is not as clearly understood as for dual-fuel households. However, it is likely that these households have electricity consumption that is around three to four times higher than for dual-fuel households, which would imply a total 2010 energy bill of up to around £1,500 (compared to £1,060 for the average dual-fuel household) depending on their tariff arrangements (see Annex 1).
- The largest costs of low-carbon measures affect the retail electricity price rather than the retail gas price. As such, electrically heated households could see their total energy bills increase by significantly more than dual-fuel households to 2020 due to costs of low-carbon measures.
- Households with electric heating could still be exposed to gas price increases through their impact on electricity prices, with a similar impact as for dual-fuel customers. They will also be more exposed to increases in electricity transmission and distribution costs.

It is therefore particularly important that Government develops policies to protect vulnerable households using electric heating. This could be through greater targeting of these households for energy efficiency measures (e.g. as proposed in the Affordable Warmth elements of the Government's Green Deal and ECO proposals) or renewable heat measures under the RHI. Alternatively, it could be through income transfers or preferential tariffs (e.g. exempting electricity used for primary heating from costs of low-carbon measures). Tax revenues accruing from the carbon price could allow such measures without negatively impacting the fiscal balance.

Annex 1: Assessment of non-typical households

Analysis of the 'typical' energy bill potentially masks a wide distribution of use across different households and therefore different impacts of energy bill changes. In this annex we set out our analysis on the impact of price changes on a selection of households that could be impacted differently by energy price changes and opportunities for energy efficiency.

The majority of UK homes are heated by gas (84% or 21 million), with the remainder primarily heated by electricity (9%), oil, liquid petroleum gas (LPG) and solid fuels (7%, common in rural areas). There are also substantial regional variations – for example in Northern Ireland 80% of households are off the gas grid, compared to only 12% in England, 19% in Wales and 21% in Scotland.

Electrically heated households

Electrically heated households are disproportionately exposed to price rises due to higher consumption of electricity. We use an estimate of 11,800 kWh for the average electricity use of electrically heated homes (compared with 3,400 kWh in a dual-fuel house), but note considerable uncertainty over the amount of electricity used:

- Some, but not all, electrically heated households may be identified by their different tariffs:
  - Around 80% of electrically heated households use storage heaters, which have the capacity to use electricity overnight. These households often adopt different tariff structures that provide a lower price for off-peak consumption (e.g. Economy 7 and Economy 10) to encourage consumption when the costs of generation are lower.
  - The remaining 20% use direct electric heating (e.g. fan or bar heaters), and may have a significantly different pattern of consumption that does not allow them to benefit from alternative tariffs.
- Whilst average consumption for customers on these non-standard tariffs is reported by Ofgem (Table A1), this will include some households that do not have electric heating. It is not therefore a reliable proxy for consumption by electrically heated households.
- DECC also publish figures on domestic electricity consumption broken down by category[15]. This suggests an average consumption of around 14,000 kWh for electric heating, but will tend to over-estimate consumption by electrically heated households as it also includes secondary electric heating (i.e. dual-fuel customers who occasionally use an electric heater).
- Given these imperfect sources we adopt the High estimate from the Ofgem figures on non-standard tariffs as a reasonable indication of consumption in electrically heated homes. Consistent with our analysis of dual-fuel households, we adopt the mean (not the median) figure of 11,800 kWh per household per annum.

15 DECC (2010) Energy Consumption in the United Kingdom. Available at: http://www.decc.gov.uk/en/content/cms/statistics/publications/ecuk/ecuk.aspx

Table A1: Electricity consumption from households with non-standard tariffs		
	Median (kWh)	**Mean (kWh)**
Low estimate	2,900	700
Medium estimate	5,000	6,200
High estimate	8,300	11,800
Source: Ofgem (2010) Revision of typical domestic consumption values.		

Bills for electrically heated households will differ depending on whether customers are on standard tariffs or a non-standard tariff that has a lower price for off-peak consumption.

- For customers on a standard tariff, and assuming consumption of 11,800 kWh, bills would be around £1,500 in 2010, rising to £2,100 in 2020. This increase reflects the rising cost of low-carbon measures (around £400) and rising costs of wholesale gas and transmission and distribution (around £200). Energy efficiency could reduce bills by £330 to £1,770 by 2020, including the installation of building fabric measures (loft, cavity wall insulation) and user-driven energy efficiency (e.g. turning down the thermostat).
- For customers on a non-standard tariff, bills will be lower due to the use of electricity over night (space heating and wet appliance demand – around 55% of consumption – can be met over night). For these customers, bills would average around £1,100 in 2010 (i.e. similar to those for the typical dual-fuel household) and rise to £1,620 in 2020. Energy efficiency could reduce bills by £200 to £1,420 by 2020. To the extent that the cost increases assumed in our main analysis are not passed through to off-peak prices the bill increase for these households would be lower (e.g. there may be a lower carbon price impact off-peak, reflecting the lower carbon intensity of overnight generation that includes a greater proportion of nuclear and renewables).

Disproportionate impacts of carbon budgets may also apply (albeit to a lesser extent) to those households without electric heating, but with consumption of electricity above the average level for other reasons. Some of these households may have more opportunities than the average to reduce consumption through more efficient lights and appliances or avoided energy waste. Others, for example those spending more time at home or with a high occupancy rate, may also warrant consideration for policies to help alleviate bill impacts of low-carbon measures.

Oil, LPG and solid fuels

Households heated with oil, LPG and solid fuels typically have higher bills than gas-heated households and as a result energy efficiency savings are likely to be higher.

The impact of carbon budgets on energy bills for these households using oil, LPG or solid fuels as their primary heating source is likely to be similar to or slightly better than for the typical gas-heated household. This is because there are no plans for low-carbon measures to add to the price of oil, LPG or solid heating fuels. These households will also be well placed to benefit from the RHI, particularly those in locations off the gas grid, which offers the opportunity to reduce bills by moving to a renewable heating system.

Annex 2. Gas price sensitivities

Our analysis elsewhere has focused on DECC's central scenario for fossil fuel prices. In this annex we set out alternative fossil fuel price projections and implications for low-carbon costs and bills more generally.

DECC have set out three scenarios for fossil fuel prices (Figure 6):

- **Low** reflects prices equal to the marginal cost of gas production, falling to 35 p/therm in 2020. This scenario is consistent with (for example) slow growth, low demand, market liberalisation and lack of strategic pricing on behalf of producers.
- **Central** reflects a re-linking to oil prices in the short term (rising to $120/bbl in 2015) before reaching a plateau at 68 p/therm in 2020, reflecting steady growth in demand and investment.
- **High** reflects a sustained linkage to oil prices, reflecting considerable growth and lack of investment, reaching 92 p/therm in 2020.

This wide range creates a large uncertainty over future heating costs and future wholesale electricity prices, which we calculate based on the cost of gas-fired generation. Under low gas prices (i.e. 35 p/therm) the cost of gas-fired generation (excluding the carbon price uplift) in 2020 would be around 4 p/kWh, compared with 8.3 p/kWh in the high gas price scenario.

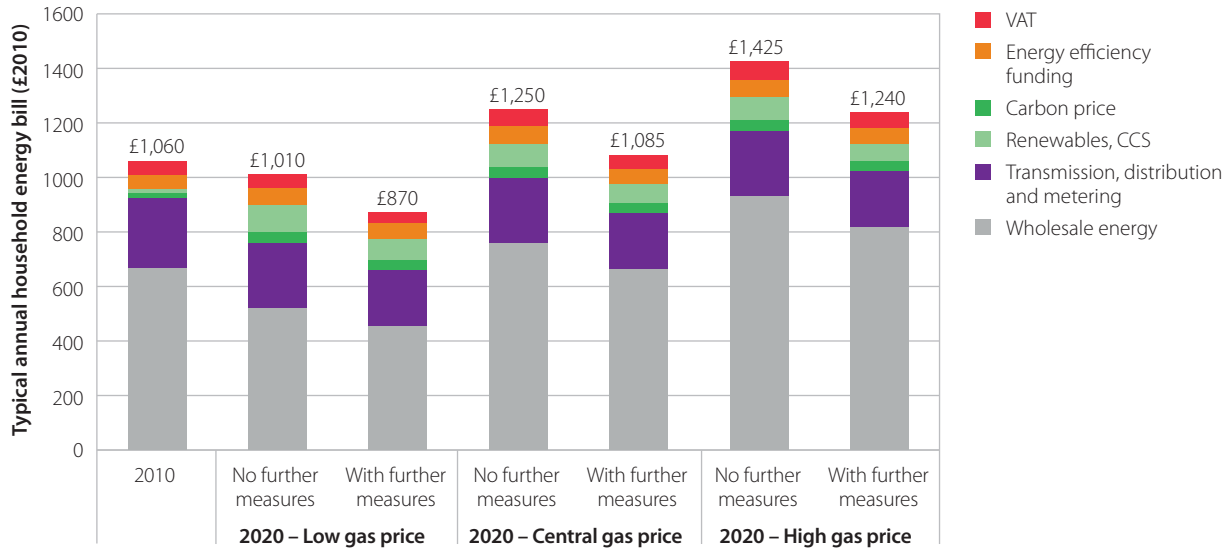
Changing the gas price also impacts on the costs of low-carbon policy, specifically the cost of supporting renewable electricity generation, which is determined by the additional costs over and above the cost of gas-fired generation. We assume that costs to 2016/17 continue to be as implied by the proposed ROC bands[16], with different gas price scenarios affecting the costs of investments for 2017-2020. Under low gas prices, the cost of funding low-carbon investments is slightly higher (i.e. 2.4 p/kWh, compared with 2.2 p/kWh in the central scenario) and under high prices it is lower (2.0 p/kWh). This corresponds to a range for the additional impact of low-carbon measures of £105-£125 per household per year by 2020.

Therefore, different gas price scenarios may not change the order of magnitude of low-carbon costs from the £110 set out in our main document. This reflects that the impact of different gas price scenarios on the costs of gas-fired generation is small compared to the large premium for some low-carbon investments (e.g. with gas-fired generation at 4 p/kWh in the low scenario, rather than 6.5p/kWh in the central scenario, the premium for offshore wind increases from 9 p/kWh to 11.5 p/kWh).

Whilst the impact of low-carbon measures increases slightly at lower gas prices, the overall affordability of bills improve, as the higher environmental cost is more than offset by the reduced cost of gas and gas-fired electricity generation (Figure A1).

16 This assumption reflects that the proposed bands are intended to bring forward renewable generation in the current context of uncertain future gas prices, and that such uncertainty will take some time to resolve even if near-term prices do not behave as in the central case.

Figure A1: Energy bills in 2010 and 2020 under alternative gas price scenarios (with and without further measures)



Source: CCC calculations.
Note: £2010. Rounded to the nearest £5.

Annex 3: Funding energy efficiency

In this annex we consider the potential funding required for energy efficiency measures targeted to meet carbon budgets.

The Government's Green Deal proposals include a financing mechanism where energy efficiency measures would be paid for by a charge on household electricity bills. Our analysis includes the savings from some of these measures, namely loft and cavity wall insulation. The capital cost of these measures is around £300 for loft insulation and £500 for cavity walls, and considerably more for cavity wall insulations in hard to treat homes.

Given the relatively low capital costs and high financing costs that could be required, it is unclear to what extent these would be financed under the Green Deal. However, if these are financed in this way and paid for on household bills, the total energy bill would be increased by around £10 and possibly by as much as £30, depending on the costs of cavity wall insulation.

Some subsidies will be available under the ECO for the most expensive measures (e.g. solid wall insulation) and for fuel poor households to ensure that the charges will be less than the value of the savings they confer. It is these ECO subsidies that will be recovered through consumer bills. These measures do not offer opportunities for significant cost savings to households and so we do not include them in this analysis of bill impacts. Households that install these measures are likely to face broadly offsetting energy savings and costs under Green Deal financing, with their resulting bill more or less unchanged.

Our trajectories for energy efficiency measures to meet carbon budgets focus on low-cost measures such as loft and cavity wall insulations, to be completed by 2015, and require increasing numbers of solid wall insulations, rising to around 260,000 installations in 2020. The level of funding required for energy efficiency in 2020 will therefore primarily be driven by the costs of solid wall insulation.

There are significant uncertainties surrounding the aggregate costs of a major programme of solid wall insulation (SWI). For example:

- The balance between internal and external insulation is uncertain, with internal installations roughly half the cost of external.
- The capital costs for each installation are uncertain. For example, economies of scale mean that the costs of delivering a given energy saving can be up to 25% lower for larger households.
- Financing costs are also crucial, and could increase significantly if the Green Deal does not achieve an A credit rating.
- Implementation barriers may require payment of a larger subsidy than installation costs suggest. This points to the importance of supporting measures (e.g. regulations for rented properties or incentives linked to house sales) to minimise any further compensation required.
- Costs will also increase significantly if a larger proportion of installations are targeted at the fuel poor, requiring full upfront subsidy.

Around £50 per household per year (broadly consistent with current funding levels) would be sufficient to pay for required SWI in 2020 in various scenarios, with a small increase (e.g. £20 per household) potentially needed under higher-cost contingencies:

- £50 per household per year could fund around 175,000 SWI installations in fuel poor households in 2020 (a mix of internal and external installations), and internal insulation in the remaining 85,000 households.
- If the emphasis was shifted towards installations of internal insulation (e.g. to be 100% of SWI ambition in 2020), the full SWI ambition could be targeted at the fuel poor with the same funding.
- A funding increase of £20 per household would allow 200,000 fuel poor houses to be insulated (a mix of internal and external installations), with external solid wall insulation provided to 60,000 non fuel poor households.

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