Building the Future:

The economic and fiscal impacts of making homes energy efficient

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Executive Summary

High energy bills are causing considerable financial hardship in the UK, with millions of people living in fuel poverty. One of the biggest causes of the fuel poverty crisis is the poor condition of the UK housing stock, which is one of the least energy efficient in Western Europe.

Improving the energy efficiency of UK homes is an effective way to bring down energy bills and offers a long term solution to fuel poverty. In addition it is important to carbon emissions reductions, with buildings responsible for almost 37% of all UK carbon emissions[1].

At the same time, the building insulation market contracted by 22% in 2013,[2] as the installation of cavity wall insulation fell by 46%, the installation of loft insulation fell by more than 87%, and the installation of solid wall insulation fell by 30%, compared with the number of measures installed under the Carbon Emissions Reduction Target (CERT) in 2012.[3] The Energy Bill Revolution is calling for a radical new approach to home energy efficiency. They are calling for all low income homes to be given measures by 2025 to bring them up to Band C on an Energy Performance Certificate (EPC)[4] and for all other households to be offered 0% interest loans to improve them to an equivalent EPC standard by 2035, delivered as part of a major infrastructure investment programme.

This report has undertaken detailed modelling to assess the economic, fiscal and environmental impacts of this programme. It concludes that the economic case for making energy efficiency of the UK housing stock a national infrastructure priority is strong.

In addition to making all low income households highly energy efficient, reducing the level of fuel poverty, the modelling has established that this energy efficiency programme would deliver:

- **£3.20 returned through increased GDP per £1 invested by government**
- **0.6% relative GDP improvement** by 2030, increasing annual GDP in that year by £13.9bn
- **£1.25 in tax revenues per £1 of government investment**, through increased economic activity, such that the scheme has paid for itself by 2024 and generates net revenue for government thereafter
- **2.27 : 1 cost benefit ratio** (Value for Money), which would classify this as a "High" Value for Money infrastructure programme
- **Increased employment by up to 108,000 net jobs per annum over the period 2020-2030**, mostly in the service and construction sectors. These jobs would be spread across every region and constituency of the UK.

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[1] Committee on Climate Change, *Meeting Carbon Budgets – 2014 Progress Report to Parliament*, July 2014
[2] Mintel, *Policy changes are putting a chill into the thermal insulation market*, October 2014 http://www.mintel.com/blog/mintel-market-news/policy-changes-are-putting-a-chill-into-the-thermal-insulation-market
[3] Association for the Conservation of Energy, *Energy Bill Revolution: ECO and the Green Deal*, 2014 http://www.energybillrevolution.org/wp-content/uploads/2014/07/ACE-and-EBR-fact-file-2014-06-ECO-and-the-Green-Deal.pdf
[4] Energy Performance Certificates (EPCs) are a measure of the level of energy efficiency of a home. The ratings span from A to G. A-rated homes would have relatively low energy bills, whereas G-rated homes would have high energy bills, and be expensive to heat. An EPC rating of C represents a reasonably good level of energy efficiency. The average EPC rating in England and Wales is currently D. Increasing the energy efficiency rating (or EPC) delivers a warmer, healthier, and more comfortable home for the resident, whilst reducing the energy bills.

- **£8.61 billion per annum in total energy bill savings** across housing stock, after comfort take (includes energy price inflation)
- **Net benefit of £4.95 billion per annum** from the total energy bill savings across the housing stock (after able-to-pay energy efficiency loans repaid)
- **23.6MtCO_2 reductions per annum by 2030**, after accounting for rebound effects. This is roughly equivalent to cutting the CO_2 emissions of the UK transport fleet by one third.
- **Improved health and reduced healthcare expenditure**, due to warmer and more comfortable homes, and improved air quality. For every £1 spent on reducing fuel poverty, a return of 42 pence is expected in NHS savings. [5] [6]
- **A more resilient economy**, less at risk of shocks in gas prices, as the economy becomes less reliant on fossil fuels. Investment in energy efficiency in the domestic sector will result in a 26% reduction in imports of natural gas in 2030, worth £2.7bn in that year.

Background

The government's energy efficiency strategy acknowledges that improving energy efficiency is fundamental to decarbonising the UK economy, combating fuel poverty, maintaining secure energy supplies, reducing domestic energy bills, reducing the need for new electricity generation capacity, and increasing the productivity of businesses. However, successive governments have failed to put in place policies or investment which could realise this opportunity. Within this context, this research seeks to quantify the macro-economic benefits of investing in energy efficiency in the UK building stock, based on the programme objectives of the Energy Bill Revolution campaign. The Energy Bill Revolution is a major alliance campaign to end fuel poverty which is supported by 200 major UK stakeholders.

This study assesses three main areas:

- Quantifying the scale of investment required to upgrade all UK homes to EPC band C by 2035 with all low income homes treated by 2025, and associated energy bill and CO_2 savings from installed energy efficiency measures;
- Modelling tax implications and macro-economic benefits from investment in energy efficiency
- Developing the quantitative and qualitative evidence to support investment in energy efficiency as an infrastructure priority

As such, this analysis represents a comprehensive assessment of the impacts of a substantive programme of investment, considering the (inter-related) impact on macroeconomic indicators and the Value for Money indicators used for infrastructure project assessment in standard cost-benefit analysis.

Domestic energy efficiency retrofit: Investment and bill savings

The domestic energy efficiency retrofit programme presented in this research shows the investment required, and beneficial impacts of improving the energy performance of the whole UK housing stock to EPC band C by 2035. The improvements are financed via grants to low-income homes and interest free 10-year loans to able-to-pay homes. The programme is proposed to be rolled out using a street-

[5] C. Liddell, *Estimating the impacts of Northern Ireland's warm homes scheme 2000-2008*, University of Ulster, 2008, http://eprints.ulster.ac.uk/26173/1/FPcostbenefitsonweb.pdf
[6] Chief Medical Officer, *2009 Annual Report*, 2009. http://www.sthc.co.uk/Documents/CMO_Report_2009.pdf

by-street delivery model[7], starting with areas with a high proportion of low-income households, to ensure effective targeting of low-income homes and to exploit economies of scale.

Discussions with key industry experts and stakeholders have concluded that the level of activity and ramp-up rates presented are realistic, and the industry can scale up to deliver this level of activity. Additional regulatory drivers and financial incentives, such as mandatory energy performance standards, council tax and stamp duty rebates, may need to be considered to drive uptake of energy efficiency retrofits in able-to-pay homes.

The energy bill savings from the energy efficiency programme are shown in Table 0-1.

Table 0-1: Energy bill savings associated with the energy efficiency investment programme

Average energy bill savings for low income homes	**£408 per annum** £245 per annum after accounting for comfort take[8]
Average energy bill savings for able-to-pay homes (after energy efficiency loan repayments)	**£416 before loan repayment** Net benefit of £203 per annum (after able-to-pay energy efficiency loan repaid)[9]
Total energy bill savings across housing stock, after comfort take (includes energy price inflation)	**£8.61 billion per annum** **Net benefit of £4.95 billion per annum (after able-to-pay energy efficiency loans repaid)**

The investment in the retrofit programme, both by the Government and the private sector, are shown by parliamentary term in Table 0-2.[10] The government investment consists of grants for low income homes, covering the installation of measures and cost of carrying out the energy assessments. For able-to-pay homes, the government investment pays for the interest rate subsidy from 8% to 0% over a 10-year loan term, plus the cost of energy assessments[11].

For the first parliamentary term, the total investment required for the low income scheme is £8.1bn, and the government contribution for the able-to-pay scheme is £4.9bn. As an indication of scale, this compares to over £100bn of committed public investment in infrastructure projects over the next parliamentary term (2015-2020), which includes £24 billion for road building, with £16 billion set aside for new roads. The Government has also committed to the building of High Speed 2 (HS2) which is

[7] R Platt, J Aldridge, P Washan, D Price; *Help to Heat: A solution to the affordability crisis in energy*; IPPR Nov 2013.
[8] Homes with fuel poor residents often tend to be under-heated due to the high costs associated with heating. This means that modelling of energy demand and energy savings can be over-estimates, as they do not account for the behaviour and energy use patterns of the residents. It can be that, after energy efficiency measures have been installed, the residents increase the warmth of their homes (due to the reduced costs of achieving the warmer temperature), rather than achieving the predicted energy bill savings associated with energy efficiency. This is known as 'comfort take' – and assumed to account for a 40% reduction in the predicted energy bill savings for the purpose of this research.
[9] This figure represents energy bill savings averaged over a 20-year lifetime for a package of measures. The loan repayment would be twice as large for the first 10 years after retrofit, reducing to £0 thereafter, once the loan has been repaid.
[10] The investment in the retrofit programme is shown by year in Appendix 4 – Programme investments by year.
[11] The interest rate subsidy is calculated as the cost to government of guaranteeing the energy efficiency loans (taking the effective loan interest rate form 8% to 5%) plus the cost of direct subsidies (taking the effective interest rate from 5% to 0%) over a 10-year period

budgeted at £42.6bn for the construction of the rail link, and an additional £7.5 billion for rolling stock.[12]

Table 0-2: Programme investments made by Government and by private sector, for each parliamentary term

Parliamentary Term	Investment in low income scheme (undiscounted) (£bn)	Government contribution to able-to-pay scheme (undiscounted sum of interest payments) (£bn)	Private sector investment in able-to-pay scheme (undiscounted) (£bn)	Government investment in all schemes (undiscounted) (£bn)	Total investment (undiscounted) (£bn)
15/20	£8.1 [13]	£4.9	£13.1	£13.0	£26.1
20/25	£18.1	£8.4	£22.3	£26.4	£48.7
25/30	£0.0	£9.9	£26.6	£9.9	£36.5
30/35	£0.0	£4.2	£11.2	£4.2	£15.3
Total	**£26.1**	**£27.4**	**£73.2**	**£53.5**	**£126.7**

Value for money and tax implications of investing in domestic energy efficiency

The economic scenario analysis was undertaken using Cambridge Econometrics' MDM-E3 model of the UK economy and energy system.

The energy efficiency scenario differs from the baseline in investment expenditure and fuel use as a result of efficiency measures. Investment in dwellings leads to a positive economic impact on industries supplying the construction sector with energy efficiency products. Changes in expenditure on energy affect consumption outlays and thus revenues of consumer-facing industries and their supply chains. The primary impacts that are modelled in this study are:

- Change in investment including expenditure of measures financed through funding provided for low income homes as well as loans for able-to-pay homes.
- Higher energy efficiency of homes leads to lower energy demand and therefore lower energy bills. The reduction in demand for gas in heating (and for gas used in the power sector which is then consumed by homes for heating) would substantially reduce imports of natural gas.
- Lower energy bills (after accounting for comfort take – which leads to a range of health benefits, as discussed in section 4.5) lead to higher expenditure on other goods and services. In the case of able-to-pay homes, this is at first largely offset by loan repayments in the first ten years following treatment.

The Value for Money assessment is summarised in Table 0-3 (the calculations supporting each item are discussed in section 4.2).

[12] HM Treasury, *Investing in Britain's future*, June 2013, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/209279/PU1524_IUK_new_template.pdf

[13] This excludes £2bn Energy Companies Obligation (ECO) funding, expected to be invested by the utilities for 15/16 and 16/17, to meet ECO targets. Assuming similar level of ECO investment per annum to 2020, the additional investment required in the first parliamentary term is £3.1bn.

Table 0-3: Summary of modelling results

Total discounted benefit of energy efficiency investment programme, of which:	£91,186
Discounted net benefit to consumer spending	£60,651
Discounted benefit of net government balances	£9,960
Discounted benefit of net increase in company profits	£15,111
Discounted benefit of net increase in savings	£337
Discounted benefit of reduced emissions	£5,127
Total discounted investment in energy efficiency programme	£40,214
Cost Benefit Ratio (CBR) (total benefit / total investment)	2.27

The Cost Benefit Ratio (Value for Money) indicator of the programme is estimated to be 2.27:1, which classifies the infrastructure programme as "High" Value for Money. The value of health benefits of improved efficiency from the comfort, or warmth, and improved air quality to homes is uncertain to quantify in monetary terms and has therefore not been included in the formal Cost Benefit Ratio. However, there is evidence that significant health benefits will arise which would add to the central estimate of 2.27.

In terms of GDP, the programme would generate a return of £3.20 per £1 invested in energy efficiency measures by government. For value added, the return is £3.00 per £1 invested. In relative terms, as a result of the energy efficiency investments, GDP will be 0.6% higher in 2030.

A net increase in annual employment of up to 108,000 over the period 2020-2030, with most jobs created in the services and the construction sectors.

Investment in energy efficiency in the domestic sector will result in 26% reduction in imports of natural gas in 2030 worth £2.7bn in that year. As the economy becomes more fossil fuel efficient, the more resilient it becomes to shocks in gas prices. A 50% gas price spike in 2030, leads to a 0.2% GDP decrease in the baseline scenario, but only a 0.15% decline in the Energy Efficiency scenario. For consumers directly, the gas price spike leads to an increase in energy bills of £220 per home (in 2030) in the baseline. As a result of the efficiency measures, this is reduced by £60 to £160 per home.

Both the direct impact (construction jobs at the installation sites) and many of the indirect impacts (extra employment generated by the spending of additional wages in the economy) stimulate employment and economic activity in close proximity to the sites where the energy efficiency measures are introduced. Given that the modelling demonstrates a net positive impact on output and jobs in the UK, the impacts are therefore fairly evenly distributed across the country (whether looking at a regional, local, or constituency level): the increase in employment in 2030 ranges between 0.14-0.22% in each of the twelve nations and regions of the UK (against a UK average of 0.19%).

The funding investment and incentivising take-up of energy efficiency measures by governments is self-financing. The increased economic growth leads to higher tax intake, cumulatively £50bn by 2030 or £1.25 per £1 invested throughout the whole period (in discounted terms). In Parliamentary Terms, the government would be slightly worse off in the period 2015-20, but the investments would yield dividends to governments in the 2020-25 period and considerable pay-back in the 2025-30 period.

Table 0-4: Government balances (undiscounted)

Parliamentary Term	Government investment in all schemes (undiscounted) (£bn)	Additional government tax revenue (undiscounted) (£bn)	Net impact on government balance sheet (undiscounted) (£bn)
15/20	£13.0	£11.0	£-1.9
20/25	£26.4	£30.4	£4.0
25/30	£9.9	£28.7	£18.8
30/35	£4.2	not modelled	not modelled
Total	**£53.5**	**>£70.2**	**>£16.7**

Table 0-5: Government balances (discounted)

Parliamentary Term	Government investment in all schemes (discounted) (£bn)	Additional government tax revenue (discounted) (£bn)	Net impact on government balance sheet (discounted) (£bn)
15/20	£11.8	£10.0	£-1.8
20/25	£20.8	£23.8	£3.0
25/30	£6.6	£19.1	£12.4
30/35	£2.4	not modelled	not modelled
Total	**£41.6**	**>£52.9**	**>£11.3**

The wider co-benefits

The energy efficiency programme will contribute towards economy-wide emissions reductions of 23.6MtCO_2 per annum by 2030, after accounting for direct rebound effects. The Committee on Climate Change has predicted the policy gap in emissions reduction targets from the building (residential and non-residential) sector, required to meet the fourth carbon budget in 2025, to be 17MtCO_2.[14] This gap is based on an analysis of the potential across different sectors in the economy and positive action in the buildings sector has been acknowledged as an essential component of meeting our medium to long term carbon targets. The programme modelled in this research delivers 16MtCO_2 pa by 2025, which is a similar scale to the predicted gap.

Improved air quality, warmer and more comfortable homes will improve health and allow for reduced healthcare expenditure. According to recent evidence, for every £1 spent on reducing fuel poverty, a return of 42 pence can been seen in NHS savings. [15] [16]

[14] Committee on Climate Change, *Meeting Carbon Budgets – 2014 Progress Report to Parliament*, July 2014 (Figure 3) http://www.theccc.org.uk/wp-content/uploads/2014/07/CCC-Progress-Report-2014_web_2.pdf

[15] C. Liddell, *Estimating the impacts of Northern Ireland's warm homes scheme 2000-2008*, University of Ulster, 2008, http://eprints.ulster.ac.uk/26173/1/FPcostbenefitsonweb.pdf

[16] Chief Medical Officer, *2009 Annual Report*, 2009. http://www.sthc.co.uk/Documents/CMO_Report_2009.pdf

The programme would result in a more resilient economy, less at risk of shocks in gas prices and less reliant on fossil fuels, as described above.

Investing in energy efficiency – a “high” infrastructure priority

To conclude, the targeted programme of upgrading the energy performance of the housing stock as proposed by the Energy Bill Revolution would generate a threefold return in GDP for every pound invested by government, deliver a high Value for Money infrastructure programme, provide warmer homes with lower healthcare expenditure, provide a long term solution to mitigate fuel poverty, create local jobs, reduce gas imports by a quarter, while creating a resilient economy in the medium to long term and delivering substantial environmental benefits. These benefits can be realised through a programme that will effectively be a net revenue generator for the government, by 2024.

1. Introduction

The government's energy efficiency strategy acknowledges that improving energy efficiency is fundamental to decarbonising the UK, maintaining secure energy supplies, reducing domestic energy bills and increasing the productivity of businesses.[17] The strategy also acknowledges the benefits of energy efficiency in mitigating the health detriments associated with cold homes, purporting energy efficiency as one of the most cost-effective ways of making a sustained reduction in domestic heating costs and removing homes from fuel poverty.

However, successive governments have failed to put in place policies which can meet the scale of opportunity. The building insulation market contracted by 22% in 2013, [18] as the installation of cavity wall insulation fell by 46%, the installation of loft insulation fell by more than 87%, and the installation of solid wall insulation fell by 30%, compared with the number of measures installed under the Carbon Emissions Reduction Target (CERT) in 2012.[19]

The Energy Bill Revolution alliance of 200 national organisations has been advocating for energy efficiency to be made a national infrastructure investment priority with a programme to make every low income home highly energy efficient.

Within this context, this research seeks to quantify the macro-economic costs and benefits of investing in energy efficiency in UK building stock, and to analyse the impact of making energy efficiency an infrastructure priority. The analysis is carried out based on a programme to upgrade all of UK's housing stock to an EPC C standard[20] by 2035, through a combination of grants and low interest loans, with all low income homes treated by 2025.

The study assesses three main aspects:

1. Quantifying the scale of investment required to upgrade all UK homes to EPC band C by 2035, and associated energy bill and CO_2 savings from installed energy efficiency measures;

2. Modelling tax implications and macro-economic benefits from investment in energy efficiency

3. Developing the quantitative and qualitative evidence to assess investment in energy efficiency as an infrastructure priority

As such, this analysis represents a comprehensive assessment of the impacts of a substantive programme of investment, considering the (inter-related) impact on macroeconomic indicators and the Value for Money indicators used for infrastructure project assessment in standard cost-benefit analysis. All monetary values in the report are expressed in 2013 real terms, unless otherwise stated.

[17] Department of Energy and Climate Change, *The Energy Efficiency Strategy: The Energy Efficiency Opportunity in the UK*, November 2012
[18] Mintel, *Policy changes are putting a chill into the thermal insulation market*, October 2014 http://www.mintel.com/blog/mintel-market-news/policy-changes-are-putting-a-chill-into-the-thermal-insulation-market
[19] Association for the Conservation of Energy, *Energy Bill Revolution: ECO and the Green Deal*, 2014 http://www.energybillrevolution.org/wp-content/uploads/2014/07/ACE-and-EBR-fact-file-2014-06-ECO-and-the-Green-Deal.pdf
[20] Energy Performance Certificates (EPCs) gives a home an energy efficiency rating from A (most efficient) to G (least efficient)

2. Investing in domestic energy efficiency

2.1 Energy efficiency investment scenario

The energy efficiency investment scenario that underpins the macro-economic modelling was developed in discussions with the Energy Bill Revolution (EBR) and was informed by a consortium of organisations supporting the campaign. The scenario sets out target dates, minimum energy performance standards and proposed financing routes for delivering a programme of works in both low income and able-to-pay homes. It was developed taking into account the scale of ambition required to deliver meaningful reductions in domestic bills and meet medium term carbon reduction targets as well as the capacity of the retrofitting industry to deliver the expected level of activity.

The scenario builds on the proposals outlined in Citizen's Advice recent paper *'Raising standards, cutting bills'*,[21] and the Institute for Public Policy Research (IPPR) report 'Help to Heat'.[22] It consists of a programme to upgrade all UK housing to EPC band C financed via energy efficiency grants for low income homes and a 0% interest rate loan for able-to-pay homes, both capped at £10k. The £10k cap is indicative, and has been set on basis of ensuring most homes treated can get up to EPC band C. In practise, the cap could be varied depending on the type of housing stock in each local authority area. Previous research has analysed the cost of improving fuel poor and low income homes to various EPC standards. EPC C was chosen as a relatively cost-effective standard for the UK housing stock, while delivering meaningful energy bill savings for residents. Improving all low income homes to EPC C standard is also an effective way to tackle fuel poverty as these households are most vulnerable to energy prices rises. It is worth highlighting that the average EPC rating in England and Wales is currently D and the average rating for a fuel poor home is EPC band E.[23]

A local authority led, street-by-street approach to delivery is intended to ensure effective targeting and drive consumer demand for energy efficiency by engaging households within certain areas, initially low income areas. Trusted local intermediaries market the scheme, provide information and advice and make sure every household receives a free energy efficiency assessment, similar to the current Green Deal assessment. The area-based nature of the scheme would encourage social awareness on the benefits of energy efficiency, as well as reduce costs due to economies of scale. Local bodies would receive funds from national government to oversee the delivery of area-based programmes and make sure programmes are tailored to meet local circumstances, in a similar way to the Green Deal Communities scheme.

Key dates and targets are as outlined below.

[21] W Baker, *Raising standards, cutting bills: Healthy homes: a costed proposal to end fuel poverty through higher standards and fairer funding*, Citizens Advice Bureau, June 2014
[22] R Platt, J Aldridge, P Washan, D Price, *Help to heat: A solution to the affordability crisis in energy*, Nov 2013
[23] Department of Energy and Climate Change, *Annual Fuel Poverty Statistics Report*, 2014

Proposed UK domestic energy efficiency investment scenario

- All low income homes to be retrofitted to EPC C standard by 2025 through energy efficiency grants capped at £10k[24]
- All able-to-pay homes to be retrofitted to EPC C standard by 2035 financed through 10 year interest free loans capped at £10k
- 500,000 low income houses retrofitted per year by 2018[25], with 2 million treated to EPC C standard by 2020.
- One million deep retrofits supported per year by 2020 in able-to-pay homes

The programme ramp-up rates (numbers of homes retrofitted each year) is shown in Figure 2-2. Although the proposed programme sounds ambitious, discussions by Energy Bill Revolution with industry experts and stakeholders have indicated that the level of activity and ramp-up rates presented are realistic, and the industry can scale up to deliver this level of activity. Additional regulatory drivers and incentives, such as mandatory energy performance standards, council tax rebates, and stamp duty incentives, may need to be considered to drive uptake of energy efficiency retrofits in able-to-pay homes.

This is not an entirely new approach. There is precedent in Europe of delivering energy efficiency activity at scale in the domestic sector through a combination of low interest loans and other financial incentives. For instance, in response to the KfW loan and grant programmes for energy efficient new buildings and refurbishments in Germany, the industry was able to ramp up the installation rate of energy efficiency measures from 280,000 homes in 2008 (€6.3bn of loans), to 617,000 homes in 2009 (€8.9bn of loans – of which 65% was allocated for the energy efficiency programme).

2.2 Investment required to upgrade homes to EPC C standard

For the purpose of the macro-economic analysis, the first step was to analyse the investment required to upgrade homes to EPC C standard, and an associated package of energy efficient measures. The energy efficiency measures in the package represent a cost-effective route to achieving the target SAP score, based on a marginal abatement cost (MAC) curve; the most cost-effective measures are prioritised to be installed earlier in a package, before the less cost-effective measures are considered. The upfront investment for the measures, and the split between Government investment and private sector investment from the home, are summarised below (all expressed as investment per home).

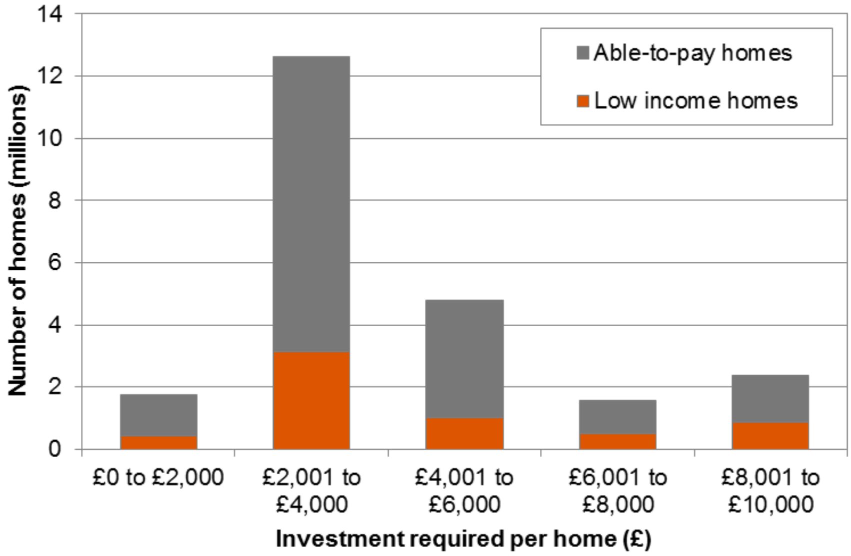
- Low income homes:
  - Investment required to upgrade homes to EPC C: £4,376 (£4,256 for measures, plus £120 energy assessment fee)
  - Government investment: The full £4,376 is modelled to be subsidised by a Government grant

[24] This proposed target is the result of analysis undertaken by the Energy Bill Revolution campaign. For previous work, see the Citizens Advice report, *Help to Heat Mark 2: Cutting energy bills now*, 2014. The campaign includes key industry stakeholders, including from major construction sector organisations, and large social housing landlords.
[25] UCL Energy Institute, *The KfW experience in the reduction of energy use in and CO_2 emissions from buildings: operation, impacts and lessons for the UK*, 2011

- Able-to-pay homes:
    - Investment required to upgrade homes to EPC C: £4,385 (£4,265 for measures, plus £120 energy assessment fee)
    - Government investment support: £1,595 (£1,475 for interest rate subsidies[26] plus £120 energy assessment fee) is modelled to be covered by the government.
    - Investment by the home / private sector: £4,265, modelled to be covered by the home-owner in instalments over 10-years – i.e. the principal loan value of the retrofit works

Figure 2-1 shows the spread of investment within the housing stock for low income homes.

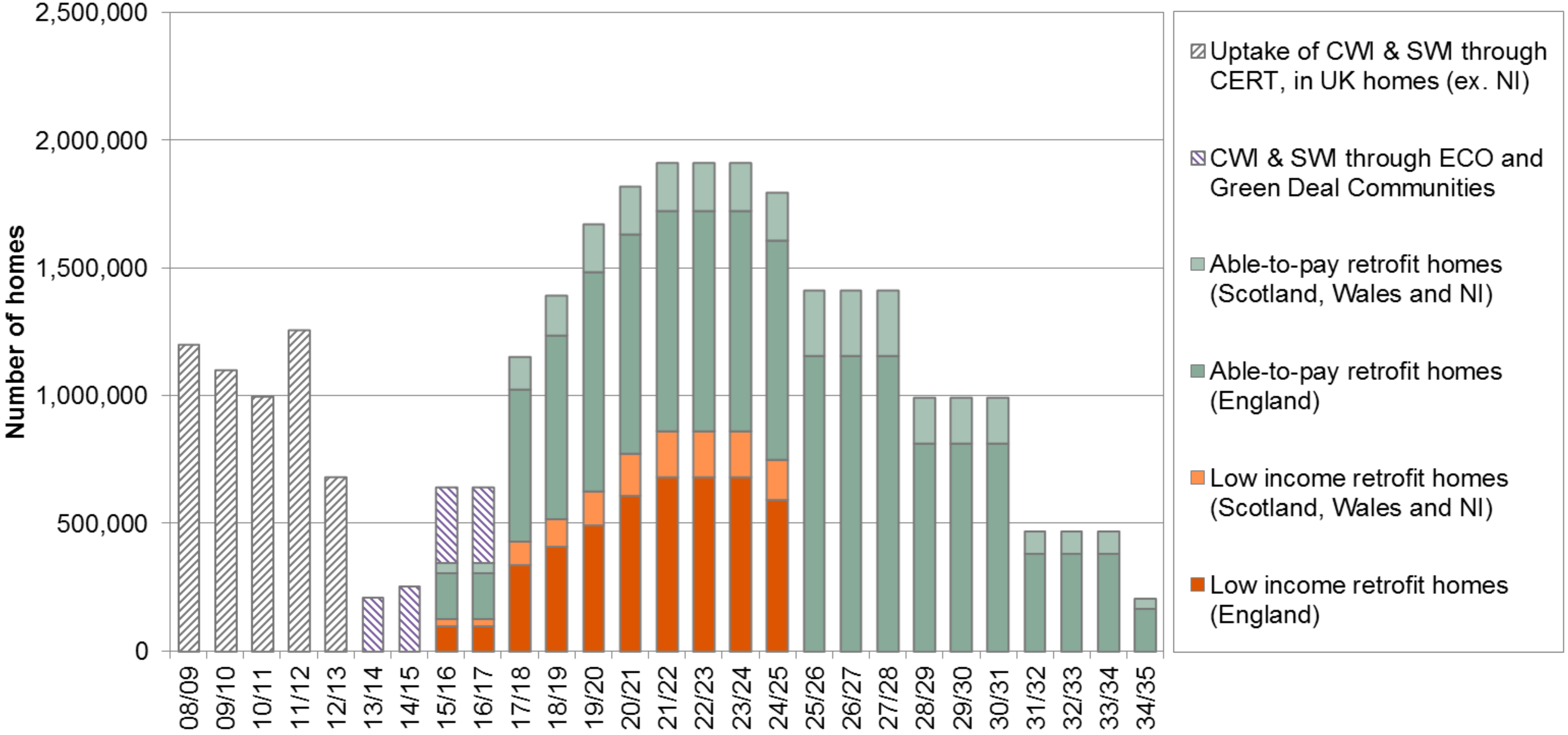
Figure 2-1: Spread of investment within the housing stock



The methodology for calculating the investment requirement is summarised in Section 2.3 and detailed further in Section 6.3. Example packages of measures are shown in Appendix 3 – Technical modelling methodology.

[26] For the able-to-pay homes, the current scenario assumes that the government does not act as the loan provider. Instead, the government is using a combination of guarantees and direct public subsidies to reduce the interest rate to 0%. This is done by the government guaranteeing the debt of the Green Deal Finance Company (reducing the interest rate to the consumer from 8% to 5%), and then directly subsidies the remaining loan interest over a 10-year period (i.e. taking the effective interest rate from 5% to 0%). The total government investment is shown as the undiscounted value of both the guarantee and the direct subsidy and assumed to be incurred in the year the measures are installed. In effect, if the direct subsidy is spread out over the 10-year period, the NPV of the government investment will be smaller.

Figure 2-2: Programme ramp-up rates, in terms of the number of homes retrofitted[27]

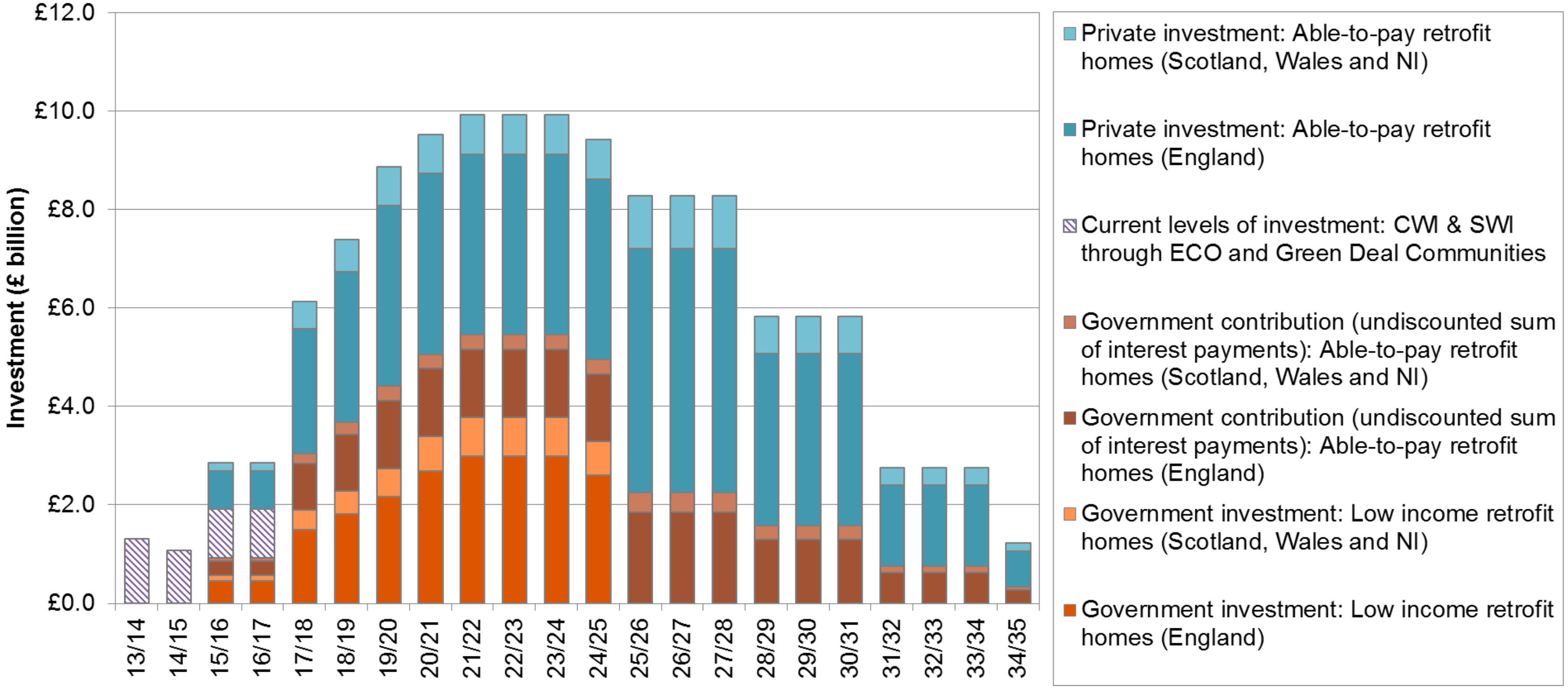


[27] The uptake of cavity wall insulation (CWI) and solid wall insulation (SWI) through the Carbon Emissions Reduction Target (CERT) scheme, in UK homes (excluding Northern Ireland (NI)) is taken from two data sources. For the period 2008/09, it is taken from Energy Saving Trust, *CERT Summary Report (Q16) by Local Authority,* 2012, http://www.energysavingtrust.org.uk/Publications2/Housing-professionals/HEED-PDFs/HEED-publications-for-UK/CERT-reports-Q16/CERT-Summary-Report-Q16-by-Local-Authority
For the period 2012/13 it is taken from DECC, *Statistical release: Experimental statistics, Estimates of Home Insulation Levels in Great Britain: July 2013,* https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/240190/statistical_release_estimates_home_insulation_levels_gb_july_13.pdf

2.2.1 Total investment in upgrading all UK homes

The investment in the retrofit programme each year, by both the Government and the private sector (i.e. investment made by Green Deal Providers or households themselves in energy efficiency improvements), is shown in Figure 2-3 (and shown as a table, in Appendix 4 – Programme investments by year). For the whole UK housing stock, the total Government investment in the low income scheme is £26.1bn, and in the able-to-pay scheme is £27.4bn. In the first two years of the programme, the investment made by the government, and the private sector investment, are each of a similar scale to the current ECO funding.

Figure 2-3: Programme investment by government and the private sector[28]



[28] For the able-to-pay homes, the graph shows the £1,595 investment from the government, in the year that the retrofit works are done. The investment from the private sector in able-to-pay homes is also shown in the year that the retrofit works are done. As a result, the graph shows the up-front investment in retrofit activity, rather than the value of the loan repayments spread over 10 years.

The investment in the retrofit programme, by both the Government and the private sector, is shown by parliamentary term in Table 2-1. For the first parliamentary term, the total investment in the low income scheme is £8.1bn, and the government contribution to the able-to-pay scheme is £4.9bn.

Table 2-1: Programme investment requirements from Government and private sector, by parliamentary term

Parliamentary Term	investment in low income scheme (undiscounted) (£bn)	Government contribution to able-to-pay scheme (undiscounted sum of interest payments) (£bn)	Private sector investment in able-to-pay scheme (undiscounted) (£bn)	Government investment in all schemes (undiscounted) (£bn)	Total investment (undiscounted) (£bn)
15/20	£8.1 [29]	£4.9	£13.1	£13.0	£26.1
20/25	£18.1	£8.4	£22.3	£26.4	£48.7
25/30	£0.0	£9.9	£26.6	£9.9	£36.5
30/35	£0.0	£4.2	£11.2	£4.2	£15.3
Total	**£26.1**	**£27.4**	**£73.2**	**£53.5**	**£126.7**

2.2.2 Domestic energy bill savings

The energy bill savings generated from the energy efficiency retrofit packages are shown in

Table 2-2. As the measures are proposed to be financed using grants for low income homes and interest free loans for the able-to-pay homes, the net energy bill savings are calculated differently for the two groups. Also, the re-bound effect (also termed as comfort take[30]) is likely to impact the net benefit to fuel poor homes. While this phenomenon is as explained below:

- For the low income homes, the savings include in-use factors[31] and a 'comfort take' factor of 40%[32]
- For the able-to-pay homes, the savings include in-use factors and are net of the energy efficiency loan repayments. During the 10 years duration of the loan, some homes may be paying more in loan repayments, than they receive in energy bill savings, as the analysis was done without applying the 'Golden Rule' (savings each year being greater than the loan repayment). However, after year 10, the homes will receive 100% of the savings.

[29] This excludes £2bn Energy Companies Obligation (ECO) funding, expected to be invested by the utilities for 15/16 and 16/17, to meet ECO targets. Assuming similar level of ECO investment per annum to 2020, the additional investment required in the first parliamentary term is £3.1bn.

[30] Once energy efficiency measures are installed, the expected energy savings may not be realised as fuel poor homes can now afford to heat their homes adequately. The proportion of energy savings from energy efficiency measures that are not realised due to homes now heating homes for longer or to a higher temperature is referred to as 'comfort take'. There is a range of important health benefits associated with comfort take, as discussed in section 4.5.

[31] In-use factors have the effect of reducing the predicted energy savings from energy efficiency measures, by a specified percentage per measure. The percentage reduction is based on the application of evidence and research and expert recommendation, as adopted by the Department of Energy and Climate Change for the Green Deal and Energy Companies Obligation.

[32] Programmes such as CESP (that focus on low income areas and are likely to impact a higher number of homes in fuel poverty) allow for a 40% comfort take when predicting CO_2 savings. A similar 'comfort take' factor has been used for the purpose of this analysis and applied to all low income homes as a conservative assumption.

The energy bill savings include energy price inflation over time in line with DECC's central energy forecast scenario.[33]

Table 2-2: Energy bill savings associated with the energy efficiency investment programme

Average energy bill savings for low income homes	**£408 per annum** £245 per annum after accounting for comfort take
Average energy bill savings for able-to-pay homes (after energy efficiency loan repayments)	**£416 before loan repayment** Net benefit of £203 per annum (after able-to-pay energy efficiency loan repaid)[34]
Total energy bill savings across housing stock, after comfort take (includes energy price inflation)	**£8.61 billion per annum** **Net benefit of £4.95 billion per annum (after able-to-pay energy efficiency loans repaid)**

2.2.3 CO_2 savings

The CO_2 savings generated from the energy efficiency retrofit packages are shown in Table 2-3. The CO_2 savings take account of grid decarbonisation over time, in line with the Interdepartmental Analysts' Group Guidance for Policy Appraisal.[35] The yearly profile of carbon savings is shown in Table 4-2.

The Committee on Climate Change has published analysis of the abatement needed to meet the fourth carbon budget in 2025. The predicted 'policy gap'[36] is 10MtCO_2 for residential buildings, and 7MtCO_2 for non-residential buildings, as shown in

Figure 2-4. The programme modelled in this research delivers 16MtCO_2 pa by 2025 (as shown in Table 4-2). This is a similar scale to the predicted gap in emissions reduction from the building sector (both domestic and non-domestic).[37]

The CO_2 savings associated with the energy efficiency programme are shown in Figure 2-3. To put the total CO_2 savings across the housing stock into context, the carbon savings are equivalent to the net annual carbon emissions reductions from 3,840 large (3MW) offshore wind turbines, or 13,380 intermediate (850kW) on-shore wind turbines. Alternatively, the annual CO_2 savings would be equivalent to the annual carbon emissions reductions from removing 10.4m cars (36% of the cars in Great Britain) from the road.[38]

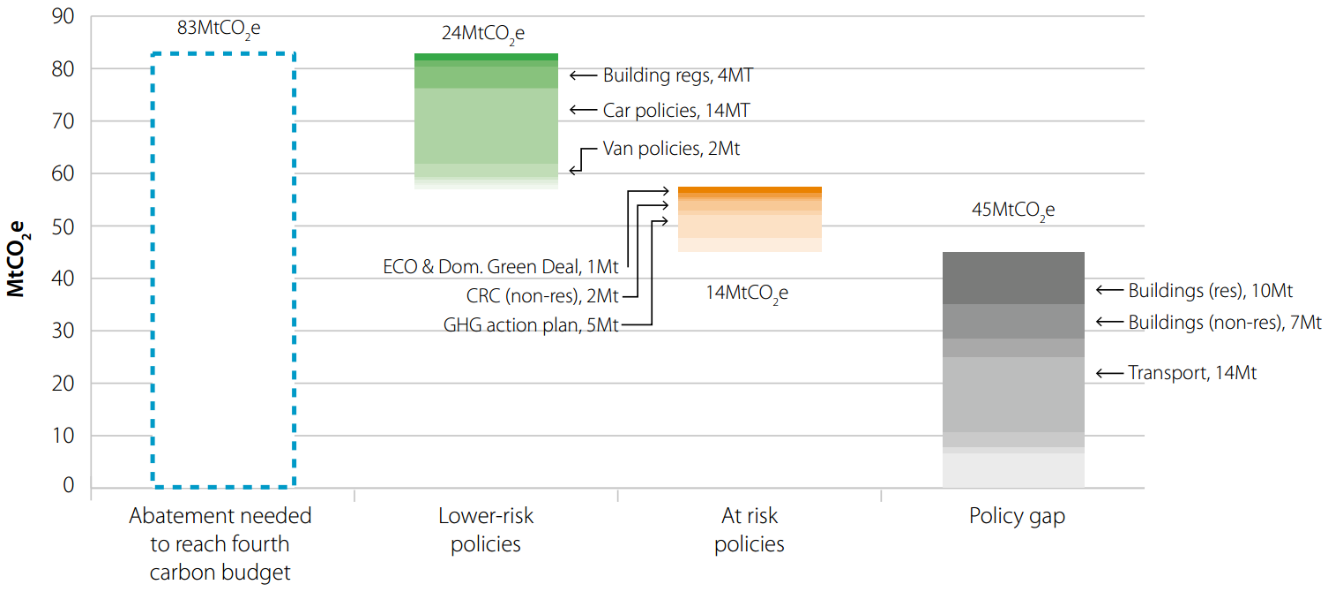
[33] Department of Energy and Climate Change, *Updated energy and emissions projections 2013*, September 2013, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/239937/uep_2013.pdf
[34] This figure represents energy bill savings averaged over a 20-year lifetime for a package of measures. The loan repayment would be twice as large for the first 10 years after retrofit, reducing to £0 thereafter, once the loan has been repaid.
[35] Department of Energy and Climate Change, Inter-departmental Analysts' Group (IAG) Guidance for Policy Appraisal, 2011
[36] The term 'policy gap' is used by the Committee on Climate Change to express the difference between the emissions projections under current policies, and the emissions projected by the cost-effective path that would meet the fourth carbon budget, i.e. the 'gap' in emissions reductions resulting from insufficient policy framework.
[37] Committee on Climate Change, *Meeting Carbon Budgets – 2014 Progress Report to Parliament*, July 2014 (Figure 3) http://www.theccc.org.uk/wp-content/uploads/2014/07/CCC-Progress-Report-2014_web_2.pdf
[38] Calculation based on average CO_2 emissions per km driven, average annual car mileage, and total number licensed cars on the road, taken from the following sources:

To provide a comparison with the average CO_2 savings for individual homes, as shown in Table 2-3, the carbon emissions from one passenger's one-way flight from London to New York, would be approximately 626 $kgCO_2$. [39]

Table 2-3: Carbon savings associated with the energy efficiency investment programme

Total (net) CO_2 savings across economy	**23.6 million tonnes CO_2 per annum**
Average CO_2 savings for low income homes	**1,092 $kgCO_2$ per annum** (655 $kgCO_2$ per annum including comfort take)
Average CO_2 savings for able-to-pay homes	**1,079 $kgCO_2$ per annum**

Figure 2-4: Getting from the DECC pre-2009 policy baseline to the fourth carbon budget in 2025[40]



2.3 Approach to technical modelling and key constraints

The analysis has been carried out using 2012 English Housing Survey (EHS) data to assess the investment required to improve all homes to an EPC C standard. Each home in the EHS dataset is assigned an 'energy archetype', based on its baseline energy consumption and key physical characteristics. Energy efficiency improvement measures are modelled incrementally to determine the

Department for Environment & Rural Affairs, *2013 Government GHG Conversion Factors for Company Reporting*, July 2013, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/224437/pb13988-emission-factor-methodology-130719.pdf
Department for Transport, *National Travel Survey: 2012*, September 2013, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/243957/nts2012-01.pdf
Department for Transport, *Vehicle Licensing Statistics, Great Britain: Quarter 2 2012*, September 2012, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/9290/vls-q2-2012.pdf

[39] Calculation based upon 5,540 km distance, and 113 gCO_2/km for a long distance flight [H. Auvinen, *Average passenger aircraft emissions and energy consumption per passenger kilometre in Finland 2008*, LIPASTO, http://lipasto.vtt.fi/yksikkopaastot/henkiloliikennee/ilmaliikennee/ilmae.htm Accessed 23 September 2014]

[40] Committee on Climate Change, *Meeting Carbon Budgets – 2014 Progress Report to Parliament*, July 2014 (Figure 3) http://www.theccc.org.uk/wp-content/uploads/2014/07/CCC-Progress-Report-2014_web_2.pdf

most suitable package of measures for each archetype. The energy efficiency measures in the package represent a cost-effective route to achieving the target SAP score, based on a marginal abatement cost (MAC) curve; the most cost-effective measures are prioritised to be installed earlier in a package, before the less cost-effective measures are considered. The modelling methodology is explained in detail in Appendix 3 – Technical modelling methodology.

As the analysis is based on English Housing Survey data, it does not provide a detailed picture of the investment requirement to improve homes in the devolved nations. Investment in improving homes in devolved nations has been extrapolated based on average investment in improvement for homes in England.

The £10,000 cap[41] on both grants and interest-free loans is intended to avoid a large amount of money potentially being spent on improving a relatively small number of extremely 'hard-to-treat' homes. As a result of this, some homes are not retrofitted to EPC C standard:[42]

- 15% of low income homes, and 16% of able-to-pay homes, do not achieve EPC band C, due to the limit of investment support per home. This is often due to the home having a particularly poor energy efficiency rating before the retrofit, or in need of solid wall insulation; hence requiring a high level of investment to achieve the minimum performance standard. However, despite the cap, these properties would still see a significant improvement in their energy performance.

[41] The £10k cap is indicative, and has been set on basis of ensuring most homes treated can get up to EPC band C. The cap could be varied in practice, depending on type of housing stock in local areas, and could vary by local authority.
[42] Energy efficiency measures are modelled to be added to the package of measures, until either: the home is modelled to have achieved EPC C, or the package of measures reaches its maximum investment value, before going over the £10k cap.

3. Modelling the macroeconomic impact of energy efficiency investment

3.1 Summary of findings

- In terms of GDP (Gross Domestic Product), Cambridge Econometrics modelling estimates a return of £3.20 per £1 invested in energy efficiency measures by government. In relative terms, as a result of the energy efficiency investments, GDP will be 0.6% higher in 2030 (£13.9bn).
- The investment in funding and incentivising take-up of energy efficiency measures by governments is self-financing. The increased economic growth leads to higher tax intake, cumulatively £50bn by 2030 or £1.25 per £1 invested throughout the whole period (in discounted terms).
- Cambridge Econometrics estimate a net increase in annual employment of up to 108,000 over the period 2020-2030, with most jobs created in the services and the construction sectors.

3.2 Approach to economic modelling

A scenario analysis was undertaken using the MDM-E3 model of the UK economy and energy system. A baseline scenario was set to compare the alternative investment policy scenario against. The baseline scenario was constructed using the latest data from the Office of National Statistics (ONS) to 2012. For the years over 2013-2018, the latest economic projections for all components of final expenditure, income, employment, wages and inflation were obtained from Office of Budgetary Responsibility (OBR)[43] recent economic growth forecast. These OBR growth rates were applied to the latest historical data to obtain a series of consistent projection to 2018. For later years where no official projections were available, Cambridge Econometrics' updated economics forecast was used to extend the projections to 2030. Energy demand projections and end-user domestic prices for gas and electricity were derived from the most-up-to-date central projections from DECC over 2013-2030 (updated in September 2013)[44].

The energy efficiency scenario differs from the baseline in investment expenditure and domestic fuel use as a result of efficiency measures. Investment in dwellings leads to a positive economic impact on industries dependent on the construction sector. Changes in expenditure on energy affect consumption outlays and thus revenues of consumer-facing industries and their supply chains.

Change in overall output also affects government tax intake through several avenues. Impact on consumer expenditure affects consumption tax intake (primarily VAT). Changes in industry revenues are reflected in wages and profits, these in turn affect government revenue through taxation of labour (income tax and national insurance contribution) and profits (corporate tax).

The various measures modelled have different time horizons, which results in different impacts arising from the timing of investments and energy savings:

- Energy efficiency measures affect the construction sector (and supply chain) primarily at the time the measure is implemented

[43] OBR's latest economic projections released in November 2013 were used
[44] https://www.gov.uk/government/publications/updated-energy-and-emissions-projections-2013

- Resulting benefits to consumers, in the form of lower energy bills and improved health persist over the lifetime of the measures[45]
- Capital repayments by able-to-pay homes are evenly spread over a ten-year period after the investment is made.

In order to assess the macroeconomic impacts on the UK economy, the modelling must explain all the relevant flows of income and expenditure in the economy. The main channels (as explained by MDM-E3) are:

- Change in investment includes expenditure of measures financed through funding provided for low income homes as well as loans for able-to-pay homes.
- Higher energy efficiency of homes leads to lower energy demand and therefore lower energy bills. The reduction in demand for gas in heating (and for gas used in the power sector which is then consumed by homes for heating) would substantially reduce imports of natural gas.
- Lower energy bills (after accounting for comfort take) lead to higher expenditure on other goods and services. In the case of able-to-pay homes, this is at first largely offset by loan repayments in the first ten years following treatment.

In total, there is £127.5bn of investment in energy efficiency measures over a 20-year period. This constitutes £73.2bn from able-to-pay homes (supported by £27.4bn of loan support schemes from government) with the rest being funding to low income homes (£26.9bn). This investment thus does not directly affect the spending of low income homes; it does however affect expenditure in able-to-pay homes throughout the period of repayment. By paying for the interest and guarantees, the government makes the loans 27% cheaper on average for able-to-pay homes.

3.3 Macroeconomic benefits of investing in domestic energy efficiency

The combination of the construction stimulus and lower energy bills outweigh the repayment costs, leading to an increase in GDP of 0.6% in 2030 (13.9bn). The reduced expenditure on gas and electricity is displaced by repayment of the capital investment in the energy efficiency measures and, where net savings arise, spending on other goods and services in the economy.

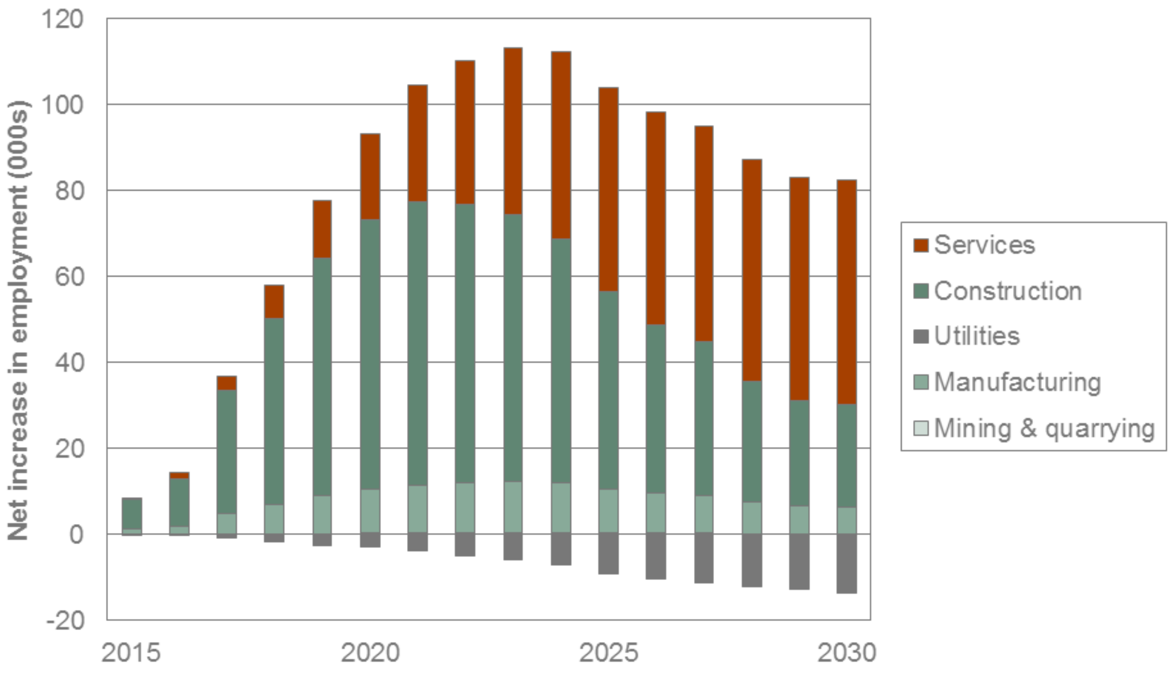
In the short-to-medium term, there is therefore a positive stimulus in the construction sector (and supply chain) to manufacture and install the various energy efficiency measures (at the expense of the gas and electricity sectors, and supply chains). This yields positive macroeconomic benefits, since gas is heavily imported, whereas the demand generated by the energy efficiency programme yields output and jobs in the construction sector and supply chain (which is predominantly UK based).

In the longer term, as the energy savings accumulate, there is a considerable net saving to homes (after paying for the efficiency measures) allowing homes to spend much more on other goods and services in the economy. Although a proportion of these goods and services are supplied by imports, a considerable proportion is supplied by UK based businesses. Towards the end of the period modelled the increased sector output and employment is predominantly in the service sectors of the

[45] The weighted average lifetime of a package of measures comes to 20-years. Some measures have a short lifetime (for example, 10 years for draught proofing), and some measures have a long lifetime (for example, 42 years for cavity wall insulation). Measure lifetimes taken from the Department of Energy and Climate Change guidance document, *Energy Companies Obligation (ECO): Measures Table*, 2014
https://www.ofgem.gov.uk/ofgem-publications/83100/copyofecomeasurestable-mar2014url.pdf

economy (see Figure 3-1). Note that the jobs generated in the construction sector mirror the investment profile in Figure 2-3, while the increasing jobs in services reflects the increasing net savings from the energy efficiency measures over time that can be spent on other sectors of the economy. At the peak, employment increases by 108,000 in 2023 and as the investment stimulus is reduced there is a long term net increase in employment of around 70,000 jobs by 2030.

Figure 3-1 Employment impact, by sector



Overall, the positive economic impact leads to an increase in net employment of around 70,000 new jobs by 2030, most of them in services and some in the construction sector and manufacturing supply chains. There are reductions in employment in utilities. In Jobs, Growth and Warmer Homes, Cambridge Econometrics modelling estimated an additional 127,000 jobs would be generated by the energy efficiency programme by 2027. In the report *Jobs, Growth and Warmer Homes*, the energy efficiency measures were fully funded by government. In the Energy Efficiency scenario in this report, able-to-pay households fund the energy efficiency measures (where they are able to do so) and are only incentivised (not fully-funded) by government. As a result of the self-financing of measures by able-to-pay households the net gains are smaller because the investment in energy efficiency measures is at the expense of consumer spending on other goods and services. The corollary of able-to-pay households investing directly (with support), is that in this analysis the government finances are improved and the measures are fully funded (for both governments and homes).

3.4 Government balance sheet

The positive impact on the economy generates enough additional (net) tax revenue to more than pay for the measures. In discounted terms, there is an additional £50bn in tax revenues by 2030 (compared to the government cost of the programme of £40bn [2015-34] in discounted cash flow terms), bringing in around £1.25 for every £1 spent, such that the programme would be cost effective for the government.[46]

As with any infrastructure programme, this programme requires upfront investment with the economy-wide gains from efficiency generating additional tax revenue over the lifetime of the investments. In undiscounted terms, the infrastructure programme would worsen the government balances by around £1.9bn in the next parliamentary term. However, in the subsequent parliamentary term of 2020-25 the additional revenues would outweigh the investment (and investment support) by government and improve the government balances in net terms by around £4bn. Over the 2025-2030 parliamentary term, the net improvement to the government balance sheet (in real terms) would be £18bn (see Table 3-1 and Table 3-2).

Table 3-1: Government balances (undiscounted)

Parliamentary Term	Investment in all schemes (undiscounted) (£bn)	Additional government tax revenue (undiscounted) (£bn)	Net impact on government balance sheet (undiscounted) (£bn)
15/20	£13.0	£11.0	£-1.9
20/25	£26.4	£30.4	£4.0
25/30	£9.9	£28.7	£18.8
30/35	£4.2	not modelled	not modelled
Total	**£53.5**	**>£70.2**	**>£16.7**

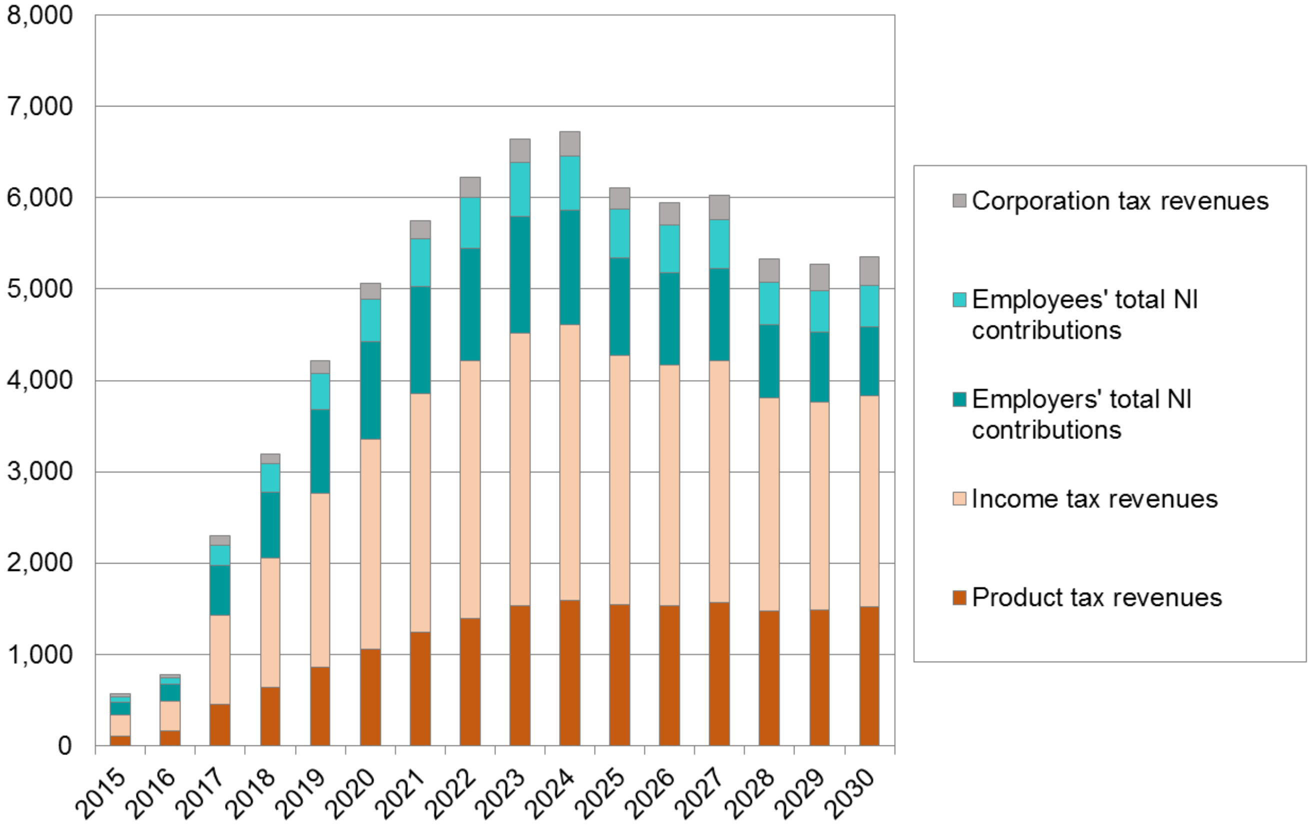
Table 3-2 Government balances (discounted)

Parliamentary Term	Investment in all schemes (discounted) (£bn)	Additional government tax revenue (discounted) (£bn)	Net impact on government balance sheet (discounted) (£bn)
15/20	£11.8	£10.0	£-1.8
20/25	£20.8	£23.8	£3.0
25/30	£6.6	£19.1	£12.4
30/35	£2.4	not modelled	not modelled
Total	**£41.6**	**>£52.9**	**>£11.3**

By 2030, around 43% of the additional tax revenue is from income tax, 28% from taxes on products (e.g. VAT) and 23% from social security contributions and 6% from corporation tax (see Figure 3-2).

[46] Both the revenue and expenditure numbers are discounted using the social discount rate of 3.5%.

Figure 3-2: Net change in government tax revenue (£m)



4. Energy Efficiency – An infrastructure priority

4.1 Summary

There is a strong rationale for treating energy efficiency in UK housing stock as an infrastructure priority:

1) Cambridge Econometrics modelling estimates the Cost Benefit Ratio (Value for Money) indicator of the programme to be 2.27:1, which classifies the infrastructure programme as “High” Value for Money.
2) Improved air quality, warmer and more comfortable homes will improve health and allow for reduced healthcare expenditure, which would add further to the Value for Money indicator.
3) An energy efficiency programme will contribute towards economy wide emissions reductions of 23.6MtCO_2 pa by 2030, after accounting for direct rebound effects, contributing to meeting the fourth carbon budget.
4) Investment in energy efficiency in the domestic sector will result in 26% reduction in imports of natural gas in 2030 worth £2.7bn in that year.
5) As the economy becomes less gas intensive, the more resilient it becomes to shocks in gas prices. A 50% gas price spike in 2030, leads to a 0.2% GDP decrease in the baseline scenario, but only a 0.15% decline in the Energy Efficiency scenario.

4.2 Approach to assessing Value for Money

Macroeconomic modelling, of the sort undertaken here, does not lend itself readily to the concept of welfare since the central indicator of GDP is an aggregate of all production in the economy and does not therefore distinguish what is being produced. The implication of this is that if society became less healthy and required more healthcare expenditure, this would show up as an increase in GDP but would clearly not be a societal benefit.

Consumer spending is a better measure of welfare than GDP but it is not a perfect measure. Real (i.e. adjusted for inflation) consumer spending is a measure of the goods and services that households buy. If it is assumed that households derive utility from what the household buys, then higher spending suggests higher utility. There are, however, various caveats to this and each of them can be considered in the context of this analysis.

- Firstly, homes may increase their spending to try to compensate for some change in circumstances. In a year when the weather is colder, homes spend more on heating, but they are not better off than during the previous (warmer) year. However, in this analysis, between the baseline and scenario modelled there are no changes in external circumstances.
- Secondly, if the increase in spending is financed out of saving or by higher borrowing, homes are not better off even if spending is higher, but again, this is not the case in the scenario analysis presented here; in fact savings are increased (slightly) and so there is an additional net benefit.
- Thirdly, if the increase in spending has been achieved through a subsidy financed by government borrowing, this can be regarded as homes borrowing from the future (because eventually taxes will have to be raised). This too is not applicable in this analysis since governments are able to more than recoup the financing and are better off in net present value

terms as a result of the energy efficiency investment. The net benefit to government (after the investment in the measures) should therefore be included as a net benefit since taxes could otherwise be lowered and consumption further increased.

- Finally, if the increase in spending is financed by lower company profits, homes will eventually be affected through, for example, a reduction in the value of wealth held in equities (e.g. through pensions). This is not the case in this analysis as profits (in real terms) increase and so the discounted net change in profits (after corporation tax) should also be included.

The latter three points all relate to the distribution of income, and show the weakness of assuming that shifts in consumer spending can always be treated as a measure of welfare when income and income distribution are changing. Overall, though, in this context, it is argued that the change in consumer spending (with the other balance sheet adjustements) is a suitable measure of welfare in this context.

4.3 Value for Money

Infrastructure projects are assessed on a Value for Money indicator called the Cost Benefit Ratio (CBR), which represents the ratio of discounted benefits to discounted investments over the lifetime of a project, using the economic tool of Cost Benefit Analysis (CBA). It is an attempt to quantify, in monetary terms, the relative investments by, and benefits to, society. Often the benefits are not monetary and can include things such as health benefits and reduced greenhouse gas emissions. The purpose of the CBA calculation and CBR indicator is to provide a metric that allows for comparison across projects.

The discounted net benefit stream includes:

- the discounted net change in household consumption between scenarios (net of the investment by able-to-pay households)
- the monetised value of the carbon emissions savings using The Treasury's Green Book guidelines.[47]
- the discounted net change in company profits (after corporation tax)
- the discounted net change in government balances
- the discounted net change in consumer savings

The investment by households in the energy efficiency measures reduces household consumption (and is therefore captured as lower discounted net benefits) and so only the government investment stimulus is considered in the discounted net costs (investments) (see Table 4-1).

Following the The Treasury's Green Book guidance, a social discount rate of 3.5% has been applied.

[47] HM Treasury, *The Green Book: Appraisal and Evaluation in Central Government,* 2011
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/220541/green_book_complete.pdf

Table 4-1: Value for Money of the energy efficiency investment programme

Total discounted benefit of energy efficiency investment programme, of which:	£91,186
Discounted net benefit to consumer spending	£60,651
Discounted benefit of net government balances	£9,960
Discounted benefit of net increase in profit	£15,111
Discounted benefit of net increase in savings	£337
Discounted benefit of reduced emissions	£5,127
Total discounted investment in energy efficiency programme	£40,214
Cost Benefit Ratio (CBR) (total benefit / total investment)	2.27

The value of health benefits of improved efficiency from the comfort, or warmth, and improved air quality to homes is uncertain to quantify in monetary terms (estimates from the literature are included in section 4.4) and has therefore not been included in the formal Cost Benefit Ratio. However, there is evidence that health benefits will arise which would add to the central value of 2.27.

Given the uncertainty in calculating CBRs different qualitative assessments are made to the range of plausible CBR, by HMT, such that:

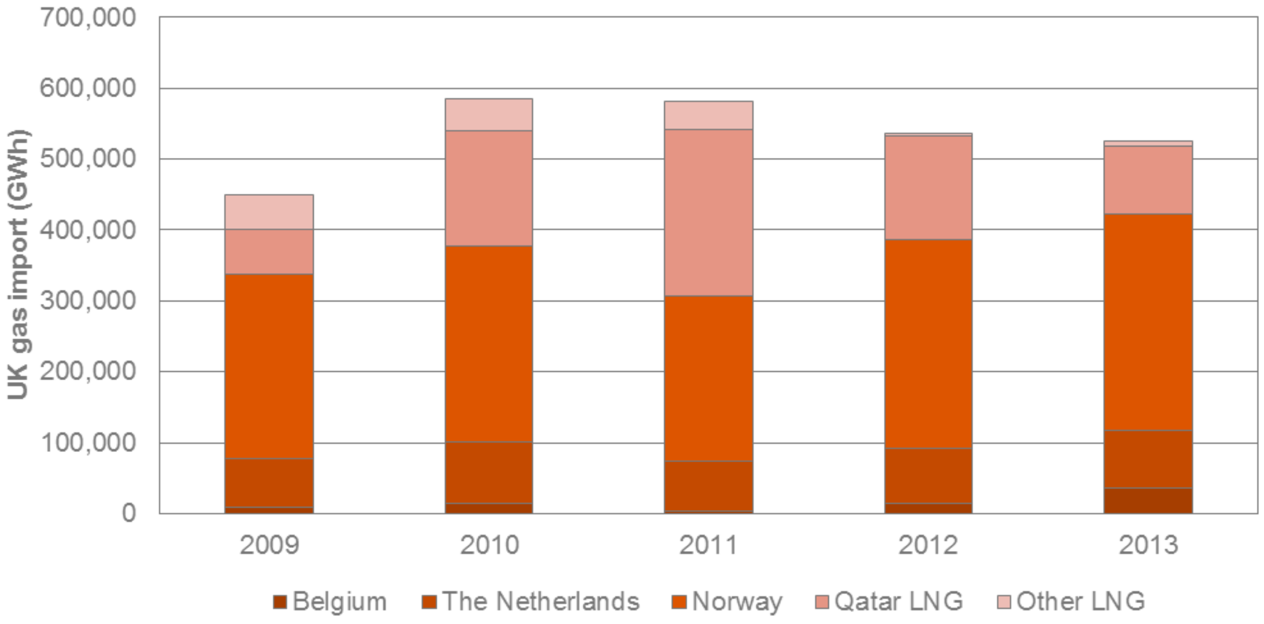
- a CBR between 0 and 1 represents 'poor' Value for Money
- a CBR between 1 and 1.5 represents 'low' Value for Money
- a CBR between 1.5 and 2 represents 'medium' Value for Money
- a CBR over 2 represents 'high' Value for Money

In this context, a programme of investing in energy efficiency measures in homes can be considered a 'high' Value for Money infrastructure programme.

4.4 Improved energy independence and economic resilience

The energy efficiency measures lead to a 19% decrease in natural gas consumption by 2030, which leads to a reduction of 26% in imports worth £2.7bn. Currently, most of the UK's imported gas is sourced from Qatar, in the form of liquefied natural gas (LNG), and from various pipelines to Europe (Norway, Belgium and the Netherlands), see Figure 4-1.

Figure 4-1: UK gas imports by source country



The energy system is also more resilient to gas price volatility as a result of the increased efficiency. In each of the scenarios (baseline and energy efficiency), the impact of a gas price spike in 2030 was assessed. In the baseline, a 50% price hike, led to a 0.2% GDP decrease, but only a 0.15% decline in the Energy Efficiency scenario. For consumers directly, the gas price spike leads to an increase in energy bills of £220 per home (in 2030) against the baseline. As a result of the efficiency measures, this is reduced by £60 to £160 per home.

4.5 Avoided cost of environmental externalities

Economy-wide CO_2 emissions are reduced by around 23.6MtCO_2 pa by 2030, after accounting for direct, indirect and economy-wide rebound effects. For the central estimate of the social cost of carbon (see Table 4-2) this gives a discounted value (over the period 2014-30) of £5.1bn. Most of the emissions reductions come directly from homes reduced consumption of natural gas, but around one-quarter come from the power sector, as a result of reduced demand for electricity.

Table 4-2: Central estimate of the social cost of carbon

	Annual net emissions reduction ($MtCO_2$)	Social cost of carbon (£/tCO_2e)	Annual (undiscounted) benefit of reduced CO_2 emissions (£2013m)	Annual (discounted) benefit of reduced CO_2 emissions (£2013m)
2013	-	3.49	-	-
2014	-	3.59	-	-
2015	0.2	3.67	0.6	0.5
2016	0.4	3.79	1.6	1.4
2017	1.0	3.92	4.1	3.6
2018	2.0	4.22	8.5	7.2
2019	3.2	4.53	14.5	11.8
2020	6.3	4.87	30.7	24.1
2021	8.2	12.01	98.6	74.9
2022	10.2	19.14	194.7	142.9
2023	12.1	26.28	319.3	226.3
2024	14.1	33.41	470.5	322.3
2025	16.0	40.55	649.8	430.0
2026	17.9	47.69	852.0	544.7
2027	19.7	54.82	1,078.5	666.3
2028	21.1	61.96	1,304.8	778.8
2029	22.3	69.1	1,543.5	890.2
2030	23.6	76.23	1,798.9	1,002.3

4.6 Avoided health costs

The benefits of energy efficient homes go beyond simple carbon emissions and energy security arguments, as energy efficiency can improve the health and well-being of residents, thereby reducing excess winter deaths and lower social care costs and the burden on the NHS.

Children and young people

Children living in cold homes are significantly more likely to suffer from respiratory problems, such as asthma and bronchitis.[48] Cold homes have an adverse effect on the educational attainment and emotional wellbeing of young people. Fuel poverty has been linked with mental health complications, as more than 25% of adolescents living in cold homes are at risk of developing multiple mental health problems, compared with 5% of adolescents who have always lived in warm housing.[49]

[48] Marmot Review, *The Health Impacts of Cold Homes and Fuel Poverty*, May 2011 http://www.foe.co.uk/sites/default/files/downloads/cold_homes_health.pdf
[49] Marmot Review, *The Health Impacts of Cold Homes and Fuel Poverty*, May 2011 http://www.foe.co.uk/sites/default/files/downloads/cold_homes_health.pdf

The Disabled and those with health concerns

Many health conditions are aggravated by cold conditions; for example, cardiovascular (such as heart attacks) and respiratory diseases (such as asthma), are caused or worsened by living in cold homes.[50] This can lengthen recovery periods, and extend the costs of care services. The NHS advises that one of the best ways to keep good health during the winter is to stay warm when at home.[51] However, for a person living with disability, there are a range of interlinked issues that make this difficult:[52]

- the typical cost of living for a person with disabilities is 25% higher than average, due to equipment and care
- many are unable to keep active (and hence warm) during the winter months
- rates of unemployment are higher, and people are likely to spend more time at home

The elderly and winter deaths

It is estimated that there were 31,100 excess winter deaths in England and Wales over the winter of 2012/13,[53] and that 30-50% of these were due to cold homes or cold indoor temperatures.[54] The coldest quarter of housing accounted for 3 times the number of deaths than the warmest quarter of housing.[55] Whilst the difference between deaths in winter and deaths in summer is common among other European countries, the difference is much greater in the UK than it is for much colder climates, such as Sweden and Norway.

Most of the winter deaths are among the elderly, and are caused by respiratory conditions, strokes, and heart-attacks, due to cold temperatures. In addition to the excess winter deaths, there are many more people who become ill, requiring hospitalisation and social care.

NHS and health costs

Cold homes can be very damaging to the physical and mental health of the occupants, and the association between poor housing and ill health is well established.[56] The charity supporting elderly people, Age UK, has reported that cold homes are costing the NHS in England £1.36 billion every year in hospital and primary care, due to the impact on older people's health,[57] and this excludes the substantial associated costs of social care services. Research commissioned by the Chartered Institute of Environmental Health (CIEH) in 2008, estimated that the treatment of cold-related illnesses and conditions costs the NHS approximately £1bn per year.[58] It has also been shown that NHS

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[50] Energy Bill Revolution, *The human cost of cold homes*, 2014 http://www.energybillrevolution.org/fuel-poverty/

[51] NHS Choices, *Keep warm, keep well*, 2012 http://www.nhs.uk/Livewell/winterhealth/Pages/KeepWarmKeepWell.aspx

[52] Energy Bill Revolution, *The human cost of cold homes*, 2014 http://www.energybillrevolution.org/fuel-poverty/

[53] Office for National Statistics, *Excess Winter Mortality in England and Wales, 2012/13 (Provisional) and 2011/12 (Final)*, November 2013 http://www.ons.gov.uk/ons/dcp171778_337459.pdf

[54] World Health Organisation, *Environmental burden of disease associated with inadequate housing*, 2011, http://www.euro.who.int/__data/assets/pdf_file/0003/142077/e95004.pdf

[55] Department of Health, *Public Health White Paper*, 2010

[56] Consumer Focus, *Jobs growth and warmer homes*, 2012 http://www.consumerfocus.org.uk/files/2012/11/Jobs-growth-and-warmer-homes-November-2012.pdf

[57] Age UK, *The Cost of Cold*, November 2012 http://www.ageuk.org.uk/Documents/EN-GB/Campaigns/The_cost_of_cold_2012.pdf

[58] V. Mason, *Good Housing Leads To Good Health: A Toolkit for Environmental Health Practitioners,* Chartered Institute of Environmental Health (CIEH), 2008 http://www.cieh.org/uploadedfiles/core/policy/housing/good_housing_leads_to_good_health_2008.pdf

expenditure rises by 2% in the cold months.[59] The NHS budget for 2014-15 is planned to be £108.3bn, meaning that NHS savings potential from an energy efficiency programme is significant.[60] Investing in energy efficiency measures in low income homes is likely to reduce spending in the NHS on cold-related illnesses. The Chief Medical Officer's Annual Report in 2009 estimated that, for every £1 spent on reducing fuel poverty, a return of 42 pence can been seen in NHS savings. [61] [62]

4.7 Benefits to local economy

Our modelling has demonstrated that investing in energy efficiency measures in homes has a number of distinct effects:

- it bolsters employment and output in the construction sector
- it reduces expenditure on energy, and increases expenditure on consumer goods and services.

This has a net impact of creating jobs and output. Furthermore, a large proportion of the jobs created will be closely linked to the locations where the measures are put into homes, bolstering local economies and potentially assisting with the Government's stated aim of spatial rebalancing of the economy. The energy efficiency market currently accounts for over 136,000 jobs in the construction and manufacturing industries.[63] Our modelling estimates an increase of 91,000 additional jobs by 2020 as a result of the programme.

Local jobs

Typically an infrastructure project would generate direct jobs in one specific area or region, due to the fixed location of the project. However, a nationwide retrofit programme would create demand for services across the country, regardless of region. Refurbishing existing homes can be more employment intensive, requiring more labour, and less materials, than the construction of new buildings. The direct construction impact is highly concentrated around the installation location; the skilled tradesmen required to install the energy efficiency measures are distributed across the country, so it is likely that a given home will employ a local worker to install measures. However the boosts to the construction supply chain are likely to be more concentrated in certain areas, where large construction material plants are located. Labour can typically be sourced locally (while materials are often imported from elsewhere). Local businesses are well placed to benefit from this programme as most home improvement work is done by local contractors who have existing relationships with residents and who understand the local housing stock. Therefore, the result would be local jobs, local labour and benefits going to small and medium sized enterprises (SMEs); boosting employment and regional economic growth.[64] There are 142,536 SMEs (1-249 employees) in the construction sector in the UK, employing 876,897 people (an average of 6 employees each).[65]

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[59] Marmot Review, *The Health Impacts of Cold Homes and Fuel Poverty*, May 2011 http://www.foe.co.uk/sites/default/files/downloads/cold_homes_health.pdf
[60] HM Treasury, *Budget 2014*, 2014
[61] C. Liddell, *Estimating the impacts of Northern Ireland's warm homes scheme 2000-2008*, University of Ulster, 2008, http://eprints.ulster.ac.uk/26173/1/FPcostbenefitsonweb.pdf
[62] Chief Medical Officer, *2009 Annual Report*, 2009. http://www.sthc.co.uk/Documents/CMO_Report_2009.pdf
[63] Department of Energy and Climate Change, *Energy Efficiency Strategy: 2013 Update*, December 2013 https://www.gov.uk/government/collections/energy-efficiency-strategy
[64] Department of Energy and Climate Change, *Energy Efficiency Strategy: 2013 Update*, December 2013 https://www.gov.uk/government/collections/energy-efficiency-strategy
[65] Department for Business Innovation & Skills, *Business population estimates for the UK and regions 2013*, October 2013

The Department for Energy and Climate Change stated, as an argument for introducing the Green Deal and Energy Companies Obligation (ECO), that "without further policy intervention, the installation rate of domestic insulation measures are [sic] projected to collapse".[66] It could be argued that the underperformance of the Green Deal, and the reduction in ECO targets, that this is still a distinct threat, especially considering the recent announcement of a leading insulation company that 600 jobs are potentially at risk. [67] The impact on SMEs will take longer to reach the headlines.

The economic benefits of an energy efficiency programme go beyond job creation. The KfW Energy-efficient Construction and Refurbishment programme in Germany in 2010 leveraged €15 of private sector investment in construction and retrofit, and more than €4 went back to the Government in the form of taxes and reduced welfare spending, for every €1 of public funds spent on the programme.[68]

Local economy

The home expenditure impacts will typically be felt in the local area. The reduction in energy usage will lead to a reduction in local jobs in this sector (e.g. engineers maintaining the local energy infrastructure). However, the impact of increasing consumer expenditure on other items is also likely to be felt locally, through increased spending in local shops and locally-based consumer services. Given that the modelling demonstrates a net positive impact on output and jobs in the UK, it is therefore expected that impacts would be fairly evenly distributed across the country (whether looking at a regional, local or constituency level).

Regional modelling results

As the results in Table 4-3 show, this is indeed the case in 2020. At this point in the modelling, the positive boost to the construction sector dominates the macroeconomic impact. Assuming an even distribution of homes requiring energy efficiency measures across the existing housing stock, it can be seen that all regions experience an increase in total employment of between 0.1 and 0.2%. Differences in the absolute increase in employment reflect largely the difference in home density between the regions.

[66] Department of Energy and Climate Change, *Final Stage Impact Assessment for the Green Deal and Energy Company Obligation*, June 2012, https://www.gov.uk/government/consultations/the-green-deal-and-energy-company-obligation
[67] Business Green, *Up to 600 jobs at risk at leading insulation company*, July 2014, http://www.businessgreen.com/bg/analysis/2353736/up-to-600-jobs-at-risk-at-leading-insulation-company
[68] KfW, *Impact on public budgets of the KfW promotional programmes*, 2011

Table 4-3 New jobs in 2020

Region	Additional jobs (000s)	Additional jobs (%)
1 London	10.3	0.19%
2 South East	12.9	0.26%
3 East of England	9.6	0.31%
4 South West	8.4	0.28%
5 West Midlands	8.0	0.28%
6 East Midlands	7.3	0.31%
7 Yorkshire & the Humber	7.3	0.27%
8 North West	9.8	0.27%
9 North East	3.3	0.27%
10 Wales	3.9	0.27%
11 Scotland	7.5	0.26%
12 Northern Ireland	2.6	0.31%
Total	**91.0**	**0.26%**

This result also holds in 2030 (see Table 4-4). By 2030 the number of homes receiving treatment is much smaller than at the peak (indeed the grants to low income homes have stopped altogether, and only able-to-pay homes receiving interest free loans are still being treated), and as a result the increase in construction and manufacturing employment (relative to the baseline) is reduced. However, the benefits of homes reducing expenditure on energy, and increasing spending in other areas, result in boosts to some parts of manufacturing and consumer services, and the increase in jobs relative to the baseline remain relatively evenly-spread across the UK.

Table 4-4 New jobs in 2030

Region	Additional jobs (000s)	Additional jobs (%)
1 London	10.8	0.19%
2 South East	10.6	0.20%
3 East of England	7.4	0.22%
4 South West	6.4	0.21%
5 West Midlands	5.8	0.20%
6 East Midlands	4.4	0.18%
7 Yorkshire & the Humber	5.3	0.19%
8 North West	6.7	0.18%
9 North East	2.0	0.16%
10 Wales	2.2	0.14%
11 Scotland	6.4	0.21%
12 Northern Ireland	2.0	0.22%
Total	**70.0**	**0.19%**

5. Conclusions

The research has demonstrated the significant economic, fiscal and environmental benefits of investing in domestic energy efficiency. The programme recommended by the Energy Bill Revolution would generate a threefold return in GDP for every pound invested by government, deliver high 'Value for Money' as an infrastructure programme, provide warmer homes with lower healthcare expenditure, create local jobs across all UK regions, reduce gas imports by a quarter, while creating a more resilient economy and playing a critical role in ensuring progress towards medium to long term carbon budgets.

These benefits can be realised through a programme that will effectively be cost-neutral in the medium term and a net revenue generator for the government in the longer term. The increased economic growth leads to higher tax intake, cumulatively £50bn by 2030 or £1.25 per £1 invested over the whole period.

The total energy bill savings across the housing stock equal £8.61 billion per annum (after comfort take and energy price inflation have been considered).The net benefit of the energy bill savings is £4.95 billion per annum (after able-to-pay energy efficiency loans repaid).

This programme should therefore be considered as a capital investment infrastructure priority.

6. Appendices

6.1 Appendix 1 – Data sources

Analysis	Data source
Energy efficiency investment scenario	
Housing stock data	Department for Communities and Local Government, *English Housing Survey (EHS)*, 2012
Projecting energy demand/ SAP score	Verco SAP modelling using NHER Plan Assessor software
Projecting energy prices/ fuel bills	Department of Energy and Climate Change, *Updated energy and emissions projections 2013*, September 2013
Carbon factor/ savings	Department of Energy and Climate Change, *Inter-departmental Analysts' Group (IAG) Guidance for Policy Appraisal*, 2011
Comfort take	Department of Energy and Climate Change, *Updated energy and emissions projections 2013*, September 2013
Macroeconomic modelling	
Baseline macroeconomic view	Office of Budgetary Responsibility projections for the UK in the medium-term
Data for key indicators: • GVA and Wages • Employment • Unemployment • Incomes	• Office of National Statistics (ONS) Supply and Use Tables • ONS Workforce Jobs and Business Register and Employment Survey (BRES) • NOMIS: official labour market statistics • United Kingdom National Accounts, The Blue Book

6.2 Appendix 2 – MDM-E3 Model Description

The macroeconomic analysis is based on Cambridge Econometrics' (CE's) model of the UK energy-environment-economy (E3) system, MDM-E3. CE applies MDM-E3 for both scenario analysis and as part of CE's regular energy-economy-emissions forecasting service. It is well-suited for the analysis:

- The model covers the entire UK economy, identifying 87 economic sectors (and 45 explicitly within each of the regions and nations of the UK) and recognising the interdependencies between them (i.e. supply chains); this representation is fully consistent with official UK economic statistics.
- The model has a full representation of the energy system, both in physical flows of energy and monetary terms, with two-way linkages with the economy.
- The model contains behavioural equations to explain final energy demand for more than 20 final energy users.
- The model includes a representation of the UK's power sector by generating technology to explain changes in electricity supply.
- Energy-related emissions are projected as a consequence of energy use.
- The model is a dynamic model, with its behavioural parameters estimated on official UK data. Such a specification allows for non-equilibrium outcomes and path dependency, e.g. the possibility of sustained levels of unemployment in the medium-to-long term, which is a feature of CE's latest economic forecasts

MDM-E3 is used regularly to assess the relationships between economic development and the energy system and, conversely, the impact of energy and carbon reduction policies on the economy.

6.3 Appendix 3 – Technical modelling methodology

The research modelled 2012 English Housing Survey data to assess the investment requirement for improving low income and able-to-pay homes to mid EPC band C standard.

Energy archetypes

Each home in the EHS dataset is modelled as an 'archetype', based on energy consumption and key characteristics, as shown in Figure 6-1. Energy efficiency measures are modelled to be included within a package of measures until the post-retrofit SAP score is close to the target score (mid EPC band C). The energy efficiency measures in the package represent a cost-effective route to achieving the target SAP score, based on a marginal abatement cost (MAC) curve.

Figure 6-1: Verco's 'energy archetype' structure

Dwelling size/type	Semi detached/ end terrace	Terrace Detached	Flats (top floor) Flats (mid floor)
Fuel/boiler type	Gas – condensing boilers Communal heating	Gas – standard boilers	Electric
Wall construction	Cavity filled	Solid	Cavity empty
Loft insulation	High	Medium	Low
Glazing type	Double	Single	
EPC Band	A/B	C/D	E/F/G

Energy efficient measures

The measures modelled are broadly those that are eligible under the current Green Deal mechanism. The list of measures is modelled to be applied to the archetype in sequential order. The order is based on: the energy bill savings payback period, investment requirements of measures, and the level of tenant disruption that is involved with installation. The list of measures is given below, and focusses on the key cost-effective measures that are not too invasive or disruptive to install.

- Cavity wall insulation
- Loft insulation
- Draught proofing
- Hot water cylinder insulation
- Combined heating controls, cylinder thermostats and hot water controls
- Double glazing
- Gas-fired condensing boilers
- No secondary heating post refurbishment

- Flue gas heat recovery devices
- Hot water measures – low-flow taps.
- Solid wall insulation
- High performance external doors
- Under-floor insulation
- Heating ventilation and air-conditioning controls (including zoning controls) (only for semi- / detached homes)
- Triple glazing
- Waste water heat recovery devices attached to showers

Naturally, not all measures are modelled for all archetypes. The measures are only modelled to be installed if they are applicable to the archetype. For example, cavity wall insulation is only modelled for archetypes that currently have empty cavities, and boiler replacement is only modelled for the archetypes with standard gas boilers, and not in those that already have condensing gas boilers. Heating controls are only modelled to be installed to the least energy efficient homes, i.e. those with EPC ratings of E, F, or G. Furthermore, the size of the package is capped based on the total investment. The investment-capping results in very few packages progressing further than the solid wall insulation measure, due to the higher investment requirements of the later measures.

Capping the investment

The SAP improvement targets can, in some cases, result in some high investment measures being included in the package, particularly if the target SAP score is high when compared to the pre-retrofit SAP score of the home. Without a cap on the investment in the retrofit package, 16% of the retrofitted dwellings would receive a package of measures greater than £10,000. Therefore, the capital investment in the package has been limited to a maximum of £10,000. The modelling incorporates this restriction when modelling the package of measures applicable, this decreases the average capital investment for a home, and also decreases the energy performance of that home. This £10,000 grant cap is intended to avoid a large amount of money potentially being spent on improving a relatively small number of extremely 'hard-to-treat' homes.

Calculating energy bill savings and carbon savings

The energy bill savings and carbon savings are calculated based on the SAP modelled reduction in energy consumption. Each energy efficient measure, added to the package sequentially, reduces the overall energy consumption of the home. The relevant in-use factors are incorporated for each measure, accounting for underperformance. For the low income homes, the energy savings are further reduced, by 40%, to account for comfort take.[69]

The energy consumption is converted into energy bill savings using the *Updated Energy and Emissions Projections* (DECC, September 2013), and converted into carbon savings using the *Interdepartmental Analysts' Group (IAG) Guidance for Policy Appraisal* (DECC, 2011).

Distinguishing 'low income' homes and 'able-to-pay' homes

In this research, improving the homes of 'low income' homes and 'able-to-pay' homes, are considered

[69] A comfort take factor of 40% was used for the impact assessment of the Community Energy Saving Programme (CESP), for energy efficient installations in low income areas. [Department of Energy and Climate Change, *Impact Assessment of proposals for implementation of the Community Energy Saving Programme (CESP)*, 2009]

separately. The numbers of 'low income' homes for each modelling archetype are derived from the EHS database.

- Low income homes are modelled to receive grants to cover the full investment in the energy efficiency measures, so that packages can be delivered at zero-cost to the homes.
- Able-to-pay homes are modelled to receive 0% interest energy efficiency loans on the retrofit measures. The investment in the measures is financed by the private sector; the homes themselves.

Geographic coverage

This research only modelled English Housing Survey data. It does not provide detailed breakdowns of the investments required to improve homes in the devolved nations. Investment requirements per home, in the devolved nations, may differ from those identified for England due to the differences in the scale of the problem (for example, a high proportion of Welsh housing is off the gas grid) and differences in the nature of the housing stock (for example, a high proportion of Scottish housing is tenements).

Example packages of measures

Examples of low, medium, and high investment energy efficiency retrofit packages package are shown in Table 6-1. The properties are not to be seen as an 'average flat' or an 'average semi-detached house', but are shown merely as specific examples of package sizes. All three property types are within the low income and able-to-pay groups.

Table 6-1: Example packages of measures

Investment in energy efficiency	Property characteristics pre-retrofit	Retrofit measures	EPC rating change	Year 1 energy bill savings (£)
£691 (low investment)	• Top-floor flat • Electrically heated • Cavity wall (filled) • Low level of loft insulation • Double glazing	• Loft insulation (Top up from 50mm) • Draught proofing	Mid EPC band D to Low EPC band C	£153 (£81 after comfort take)
£4,238 (medium investment)	• Semi-detached • Standard gas boiler • Cavity wall (empty) • Low level of loft insulation • Double glazing	• Cavity wall insulation; • Loft insulation (Top up from 50mm) • Draught proofing • Hot water cylinder jacket • Cylinder thermostats & heating controls • Gas-fired condensing boilers • Secondary heating removal	Mid EPC band D to Mid EPC band C	£507 (£304 after comfort take)
£9,952 (high investment)	• Semi-detached • Condensing gas boiler • Solid brick wall (uninsulated) • Medium level of loft insulation • Double glazing	• Loft insulation (Top up from 150mm) • FGHR devices • All hot water measures • External wall insulation	High EPC band E to Low EPC band C	£202 (£121 after comfort take)

6.4 Appendix 4 – Programme investments by year

Table 6-2: Programme investments by Government and private sector, by year (excludes Energy Companies Obligation (ECO))

Year	In year Government investment in low income scheme (£bn)	Cumulative Government investment in low income scheme (£bn)	In year Government investment in able-to-pay scheme (£bn)	Cumulative Government investment in able-to-pay scheme (£bn)	In year private sector investment in able-to-pay scheme (£bn)	Cumulative private sector investment in able-to-pay scheme (£bn)	In year Government investment in all schemes (£bn)	Cumulative Government investment in all schemes (£bn)	Total in year investment (£bn)	Total cumulative investment (£bn)
15/16	£0.6	£0.6	£0.3	£0.3	£0.9	£0.9	£0.9	£0.9	£1.9	£1.9
16/17	£0.6	£1.1	£0.3	£0.7	£0.9	£1.9	£0.9	£1.8	£1.9	£3.7
17/18	£1.9	£3.0	£1.2	£1.9	£3.1	£5.0	£3.0	£4.9	£6.1	£9.9
18/19	£2.3	£5.3	£1.4	£3.2	£3.7	£8.7	£3.7	£8.6	£7.4	£17.3
19/20	£2.7	£8.1	£1.7	£4.9	£4.5	£13.1	£4.4	£13.0	£8.9	£26.1
20/21	£3.4	£11.5	£1.7	£6.6	£4.5	£17.6	£5.1	£18.1	£9.5	£35.7
21/22	£3.8	£15.3	£1.7	£8.3	£4.5	£22.1	£5.5	£23.5	£9.9	£45.6
22/23	£3.8	£19.0	£1.7	£9.9	£4.5	£26.5	£5.5	£29.0	£9.9	£55.5
23/24	£3.8	£22.8	£1.7	£11.6	£4.5	£31.0	£5.5	£34.4	£9.9	£65.4
24/25	£3.3	£26.1	£1.7	£13.3	£4.5	£35.5	£5.0	£39.4	£9.4	£74.9
25/26	£0.0	£26.1	£2.3	£15.5	£6.0	£41.5	£2.3	£41.7	£8.3	£83.2
26/27	£0.0	£26.1	£2.3	£17.8	£6.0	£47.5	£2.3	£43.9	£8.3	£91.4
27/28	£0.0	£26.1	£2.3	£20.0	£6.0	£53.6	£2.3	£46.2	£8.3	£99.7
28/29	£0.0	£26.1	£1.6	£21.6	£4.2	£57.8	£1.6	£47.7	£5.8	£105.6
29/30	£0.0	£26.1	£1.6	£23.2	£4.2	£62.1	£1.6	£49.3	£5.8	£111.4
30/31	£0.0	£26.1	£1.6	£24.8	£4.2	£66.3	£1.6	£50.9	£5.8	£117.2
31/32	£0.0	£26.1	£0.8	£25.5	£2.0	£68.3	£0.8	£51.7	£2.8	£120.0
32/33	£0.0	£26.1	£0.8	£26.3	£2.0	£70.3	£0.8	£52.4	£2.8	£122.7
33/34	£0.0	£26.1	£0.8	£27.0	£2.0	£72.3	£0.8	£53.2	£2.8	£125.5
34/35	£0.0	**£26.1**	£0.3	**£27.4**	£0.9	**£73.2**	£0.3	**£53.5**	£1.2	**£126.7**