

THE GOVERNMENT'S 2030 FUEL POVERTY TARGET IN ENGLAND ARE WE ON TRACK?



CONTENTS

Foreward	3
Executive Summary	4
Fuel Poverty In England	9
Fuel Poverty Target	9
Identifying Those In Fuel Poverty	10
Achieving Sustainable Warmth	10
How Is The Government Meeting The Challenge?	11
Funding Needed To Meet The Target	16
Scenario 1 - Current Funding Commitments	16
Scenario 2 - Reaching The Fuel Poverty Target	18
The Funding Gap	19
Cost-Benefits Analysis Of Additional Government Funding	21
Considerations Of Scheme Design, Funding And Messaging	26
Policy Recommendations	26
Conclusion	31



FOREWARD

Fuel Poverty negatively affects millions of people in England. It takes a toll on the physical and mental health of those affected, and the life-chances of children through its negative educational impact.

Recent shocks in wholesale energy markets have now started to find their way to consumers through increases in retail energy prices, which is set to make the problem worse. The only future-proof solution is to permanently improve the energy performance of fuel poor homes and so reduce the amount of energy needed for those households to stay warm.

For over eight years AgilityEco has helped tens of thousands of vulnerable households a year to reduce their fuel bills, ensuring they live in warm, safe homes. Whilst progress is being made nationally to improve energy efficiency, there remains a long way to go if the Government's own statutory target of improving fuel poor homes to EPC band C by 2030 is to be met.

AgilityEco and Gemserv have worked together to look carefully at current energy efficiency programmes to understand whether there is a gap between the Government's commitments and what is needed to meet the fuel poverty target. We have discovered that the gap is significant – **with a further £18 billion required to retrofit fuel poor homes**. In short, the current commitments need to increase significantly.

But tackling fuel poverty is not just about meeting a target. It also carries a moral imperative and, as this analysis shows, significant economic benefits too. These include increasing the income for those of the lowest means, savings to the NHS because of the health benefits from people no longer living in hazardous homes, and other positive outcomes such as air quality improvements and carbon savings. Everyone wins by retrofitting homes.

We hope this report is a useful contribution to the debate and helps inform the next phase of policy development and Government spending decisions in this important area.



Gearoid Lane
Chief Executive Officer
Agility Eco



Dave Sowden
Low Carbon Partner
Gemserv

EXECUTIVE SUMMARY

PURPOSE AND MAIN CONCLUSION

AgilityEco and Gemserv have conducted this work to shine a light on the need to scale up investment to relieve fuel poverty across the rest of the 2020s, drawing on detailed analysis to inform recommendations for how this can be done.

In 2014 Parliament legislated the fuel poverty target – namely:

“To ensure that as many fuel poor homes as is reasonably practicable achieve a minimum energy efficiency of Band C by 2030.”

The Government, in February 2021, updated the way it measures fuel poverty and under this definition, 3.2 million homes in England were in fuel poverty in 2019*.

We estimate that current, confirmed funding commitments will only tackle 570,000 of these, leaving the remaining 80%+ still in fuel poverty in 2030, and further funding of over £18 billion is needed for fuel poor homes to meet the target if no further action is taken. We also note that current increases in energy prices combined with impacts of the pandemic on low income households are likely to increase the numbers of fuel poor households that need to be supported.

APPROACH

We have estimated what is required, above existing commitments, to meet the 2030 fuel poverty target. In doing so, we have looked at the following parameters that are relevant to tackling fuel poverty:

- ◆ The official statistics on fuel poverty.
- ◆ Targeting efficiency of current and proposed schemes for fuel poverty relief.
- ◆ Available data on the costs of fabric and heating measures to improve fuel poor homes.
- ◆ Current and proposed policy, both funding and regulatory measures.

Using these parameters, we have built a model that estimates the following:

- ◆ How many homes will likely be removed from fuel poverty by current, confirmed policy measures, and the known costs of the programmes to do so.
- ◆ The additional effect of implementing the remaining £2.35 billion of Home Upgrades Grant funding from the £2.5 billion manifesto commitment.
- ◆ The likely effect of regulatory proposals for private rented sector homes to be upgraded to EER Band C before the end of the decade.
- ◆ The likely impact of extending current programmes to 2030 at their current funding levels.
- ◆ The number of homes still to be taken out of fuel poverty and the cost of doing so once all the above is done.

* This report focuses on achieving the fuel poverty target in England only, as there are different definitions and policy instruments in place in the devolved administrations.

KEY FINDINGS

Over 80% of the 3.2 million homes in fuel poverty in 2019 will remain so in 2030, unless action is taken beyond current policy commitments.

The Government's latest statistics report that 3.2 million homes were in fuel poverty in 2019. Our modelling indicates that current policy and manifesto commitments alone will remove just 570,000 homes from fuel poverty, leaving behind 2.6 million, 82% of the 2019 figure.

£18 billion more would need to be invested in fuel poor homes if the 2030 fuel poverty target is to be achieved without action beyond current policy and funding.

Our modelling indicates the average cost to bring a home out of fuel poverty across this period is around £7,300. It is modelled to be lower now (around £6,500) than it will be by the end of the decade (around £8,100) because it is assumed the programmes will tackle the easier and cheaper to treat properties first. To remove almost all the 2.6 million homes that would remain untreated by current policy and programmes would therefore cost an additional £18 billion. It has been assumed that 5% of fuel poor homes (0.2 million) would be considered "not reasonably practicable" to upgrade as part of the fuel poverty target.

Rollover of current government funding levels and implementation of proposals to require private landlords to improve the standard of fuel poor homes will still leave a funding gap of £10 billion, and 1.3 million homes remaining in fuel poverty in 2030.

The Government has consulted on requiring private landlords to upgrade their homes to a Minimum Energy Efficiency Rating of Band C by 2028. **If implemented and enforced**, we estimate this would reduce the direct funding required from Government by £6 billion, and that the rollover of existing funding commitments to 2030 and current run-rates would reduce this by a further £2 billion. These two measures would remove a further 1.2 million homes out of fuel poverty. This leaves 1.3 million homes left to treat at a cost of £10 billion.

Spending on fuel poor homes will need to be part of a larger programme of support to improve the homes of a broad group of low income and vulnerable households.

Spending on fuel poverty is undertaken by Government as part of schemes providing support to a broader group of low income and vulnerable households. For current measure-installation-focused schemes, only 31% of allocated funding is estimated to reach fuel poor homes. If this average value remains unchanged, a further £34 billion will be needed to result in the £10 billion required to meet the fuel poverty target. The Committee for Fuel Poverty has called for sharpening of targeting on fuel poverty and this would reduce the total scheme spend requiredⁱ.

It should be noted, however, that precise targeting of fuel poverty is challenging, not least because many people move into or out of it each year due to changes in their circumstancesⁱⁱ. It is also the case that the benefits from these broader schemes are significant:

- ◆ Reduced bills, warmer homes, and improved health and education outcomes for many more vulnerable households who may not fall into the definition of fuel poverty but are likely to be struggling at the margins or suffering from poor health. We estimate that the £34 billion would improve 4.2 million homes by 2030.
- ◆ Efficient reductions in carbon emissions allowing cost-effective progress towards net zero.
- ◆ Positive returns to the economy – with the wider economic benefits considerably out-weighting the additional cost.
- ◆ Finding this £10 billion additional funding for fuel poverty could result in a net benefit to the economy in the region of £16 billion.

Finding this £10 billion additional funding for fuel poverty could result in a net benefit to the economy in the region of £16 billion.

Our analysis indicates there is a robust economic case for filling all the remaining funding gap to meet the fuel poverty target, with an indicative net return to the economy from doing so of £16 billion.

RECOMMENDATIONS

1 IMPLEMENT EXISTING PROMISES AND PROPOSALS

- ◆ £2.35 billion for the Home Upgrade Grant has yet to be confirmed of the £2.5 billion committed in the current Government's election manifesto. This funding should be announced to ensure confidence among the supply chain and consumers.
- ◆ The Government has proposed to require private landlords to upgrade rented homes to a Minimum Energy Efficiency Rating of Band C by 2028. For fuel poor tenants, help can be provided through existing programmes. This should be implemented and, equally importantly, rigorously enforced.
- ◆ We estimate implementing these existing policies and proposals would reduce the funding gap for fuel poor homes from £18 billion to £12 billion.

2 EXTEND THE CURRENT SCHEMES TO 2030

- ◆ Once Recommendation 1 is implemented, extension of the current schemes to 2030 would reduce the size of the funding gap from the £12 billion above, to £10 billion.
- ◆ In particular, the Energy Company Obligation is confirmed to March 2026, and the Home Upgrade Grant is confirmed to 2026. It would make no sense for these policies to be terminated at that point considering the continued existence of many fuel poor households. Committing to the extension of these schemes at the earliest opportunity will give confidence to all parties.

3 EXPAND THE SCHEMES TO ENSURE THAT £10 BILLION REACHES FUEL POOR HOMES

- ◆ The schemes, once extended, need to be expanded so that a further £10 billion is spent tackling fuel poor homes as well as generating significant broader benefits in their own rights.
- ◆ Unless the schemes target a higher proportion of fuel poor homes (currently assumed to be around 30%), £34 billion would be needed for the £10 billion to reach the homes required to meet the target.

These recommendations are shown in graphical form below.





Gemserv



AgilityEco

FUEL POVERTY

It is estimated that 3.2 million households in England live in fuel povertyⁱⁱⁱ, are unable to afford their energy bills and often must make difficult choices around their energy consumption, sometimes deciding between heating and eating.^{iv} A poorly heated home can have many knock-on effects on its inhabitants. These can range from ill physical and mental health, stress, and anxiety to reduced educational attainment and social isolation.^v

In February 2021, the Government published its strategy for ending fuel poverty in England: 'Sustainable Warmth: Protecting Vulnerable Households in England'. The strategy sets out to ensure fuel poor households have access to sustainable, low-carbon warmth in the transition to 'net zero' carbon. It builds on the previous Fuel Poverty Strategy: 'Cutting the cost of keeping warm- a fuel poverty strategy for England'^{vi}, released in March 2015 in which Edward Davey, then Secretary of State for Energy & Climate Change, stated that he found "it extraordinary in the 21st century that so many homes in our country are so expensive to heat and run". Unfortunately, six years on, this is still the case and 13.4% of households in England are living in fuel poverty.^{vii}

FUEL POVERTY TARGET

The fuel poverty targets, set out in the 2015 and 2021 strategies, set a standard, based on the Fuel Poverty Energy Efficiency Rating (FPEER) system methodology, by which to measure the risk of fuel poverty and the success of alleviating it.

The fuel poverty target is to ensure that as many fuel poor homes as is reasonably practicable achieve a minimum energy efficiency rating of band C, by 2030.

Interim Milestones:

- ◆ as many fuel poor homes as is reasonably practicable to band E by 2020 and
- ◆ as many fuel poor homes as is reasonably practicable to band D by 2025^{viii}

THE FUEL POVERTY ENERGY EFFICIENCY RATING METHODOLOGY (FPEER):

The FPEER methodology builds on the Government's Standard Assessment Procedure (SAP) but also accounts for the impact of policy interventions that directly affect household energy costs. The methodology generates an energy efficiency rating from 0 – 100 which is then translated into an energy efficiency 'band' from G (lowest) to A (highest).^{ix} The FPEER methodology has been used in our analysis as the energy efficiency rating, which results in an improved rating when fuel bills are reduced through financial interventions as well as home improvements.

The Committee on Fuel Poverty has projected that the 2020 fuel poverty energy efficiency rating band E milestone has been missed. According to the latest statistics (released in 2021), by 2019, 97.4% of fuel poor households were living in a property with an energy efficiency rating of band D or E, so in the two bands immediately below the Government's target.^x It is estimated that only half of the 293,000 band F/G fuel poor homes at the start of the 2015 fuel poverty strategy were upgraded to band E or above by 2020.^{xi}

■ Physical characteristics

It is not feasible to physically improve all homes to band C. For example, due to the building materials or style of the property, some homes are difficult to insulate fully without significantly changing their physical appearance or size. Listed buildings can face challenges in becoming more energy efficient in a way that is compliant with the historical character of the building^{xii}

■ Householder preferences

Some householders may not want their home retrofitted. They may be uncomfortable having strangers in their home or are concerned the works will be stressful or are not right for their property. This is often referred to as the “hassle factor”. Alongside this, there is the “trust factor” where householders are wary of “cowboys” - unreliable and untrained tradespeople, who could potentially complete the work to a low standard.

In this paper, we attempt to define what is needed to achieve the Government's fuel poverty target for 2030. By considering what is reasonably practical, identifying the retrofit gap and assessing the Government's current funding commitments. We have identified a significant funding gap which will need to be addressed if the fuel poverty target is to be met.

IDENTIFYING THOSE IN FUEL POVERTY

Identifying those in fuel poverty is challenging. The Fuel Poverty Strategy states that “few people self-identify as living in fuel poverty”. This is backed by research which found that only 55% of people knew what fuel poverty meant.^{xiii} Benefits are often used as the primary proxy for fuel poverty - however BEIS estimates that only around half of fuel poor households are in receipt of benefits. Households that do not receive this support are therefore at risk of being missed and the cost of identifying them is much higher.

Yet, the number of households struggling with energy bills is set to increase this winter because of rising energy market prices^{xiv} and potential increases in energy demand due to social distancing restrictions. It is important to note that many vulnerable and elderly consumers already heat their home for longer and at higher temperatures. Clearly, awareness and identification of fuel poverty are issues that need to be rectified.

In 2019, the Government updated the way fuel poverty is measured with the aim to improve tracking of progress towards the statutory fuel poverty target while reflecting the three key drivers of fuel poverty (low income, energy efficiency and prices). This metric defines a household as fuel poor if it:

- ◆ has a residual income below the poverty line (after accounting for required fuel costs)
- ◆ lives in a home that has an energy efficiency rating below a band c.



ACHIEVING SUSTAINABLE WARMTH

Fuel poverty objectives and funding overlap with low carbon policy. Making homes more energy efficient and reducing health inequalities should be done in ways that also contribute to safety, decarbonisation, and air quality goals. Properly considered policy to reduce fuel poverty should assist in reducing carbon emissions and not hinder decarbonisation efforts.

Low carbon policies have the potential to either help or worsen the situation of those living in fuel poverty. In the Climate Change Committee's 6th Carbon Budget Policies Report, analysis shows that the installation of an electric heat pump (a low carbon alternative) to replace a gas boiler would increase a household's heating costs by around £160/year.^{xv} With heat pumps likely to feature strongly in the UK's net zero pathway, there is a need to ensure that this approach does not exacerbate fuel poverty. Policies and funding which support the deployment of low carbon heating technologies should be designed to address not only the upfront costs but also running costs.

Further to this, BEIS suggests in their Energy White Paper, that energy decarbonisation could cause a household's energy bill to rise by up to £100/year.^{xvi} This analysis suggests that, as well as considering the capital cost of different energy efficiency and heating measures, the running cost of heating also needs to be considered. In particular, the relative prices of different household heating fuels, including the application of taxes and other levies, needs to be properly considered to avoid low carbon policy having the unintended consequence of making fuel poverty worse.

HOW IS THE GOVERNMENT MEETING THE CHALLENGE?

The Committee on Fuel Poverty has acknowledged that the Government has shown commitment to tackling the issues of fuel poverty and climate change holistically. The Government has also taken positive steps forward with funding commitments which include the expansion of the Energy Company Obligation and Warm Home Discount, the provision of the Green Homes Grant, the initial funding of the Social Housing Decarbonisation Fund, and the Sustainable Warmth competition.

TABLE 1 – FUEL POVERTY SCHEMES CONSIDERED IN ANALYSIS

SCHEME/ REGULATION	DETAIL
Winter Fuel Payments	£100-£300 government-paid, once-a-year benefit for those who are eligible. It is intended to cover the higher costs of gas and electricity over the winter months, to help people over a specific age pay their utility bills. However, these payments are not targeted specifically at fuel poor households as eligibility does not encompass income or the condition of the home. This has been accounted for in our analysis.
Cold Weather Payments	Vulnerable individuals will receive £25 for each 7-day period of very cold weather during the winter period.
Home Upgrade Grant (HUG)	£150 million of HUG funding has been made available to local authorities via the Sustainable Warmth competition, potentially a first release from the manifesto commitment to a £2.5 billion Home Upgrade Grant over this Parliament.
Social Housing Decarbonisation Fund	Over £200 million has been committed for the Social Housing Decarbonisation Fund. This will be used to upgrade the least efficient housing. It will be open to all social housing landlords to directly access funding. The manifesto commitment was a total of £3.8 billion over 10 years.
Energy Company Obligation 3 (ECO)	ECO3 aims to support low income, vulnerable or fuel poor households through improvements to a forecast 1.195 million homes including: <ol style="list-style-type: none"> 1. Replacement of 35,000 broken heating systems per year 2. Replacing inefficient heating systems if installed alongside insulation 3. At least 17,000 solid wall insulation installations per year.
Energy Company Obligation 4 (ECO4)	Details of scheme are currently under consultation, but fuel poor homes will be targeted in a similar way to previous ECO phases. The Energy Company Obligation 4 (ECO4) will be extended until 2026, with its value boosted from £640 million to £1 billion a year. However, ECO4 is only forecast in the consultation to improve 305,000 homes across its 4 years.
Green Homes Grant (GHG)	The GHG aimed to invest £2 billion in energy efficiency of households through the Green Homes Grant Voucher and Local Authority Delivery (LAD) schemes. Only the LAD delivery element is now continuing.

Warm Home Discount (WHD)	The Warm Home Discount is a requirement for energy companies to provide a £140 rebate on the energy bill of low income pensioners and other low income households with high energy bills, ensuring continuity for vulnerable or fuel poor consumers. It is also to be continued with a proposed increase to a £150 rebate. The Industry Initiatives element enables installation of energy efficiency measures and provision of advice.
Private Rented Sector Minimum Energy Efficiency Standards (PRS MEES)	Current proposals to strengthen the requirements could drive over £17 billion of investment in energy efficiency through regulatory obligations in the Private Rented Sector.

In total, we estimate that these policies reflect a maximum commitment of £32.4 billion to be spent on homes in England from 2019 (our base-year) to 2030 with £6.6 billion expected to be spent on fuel poor homes - see Table 2 for the results. This figure reflects the ambition of ECO (adjusted for estimated English delivery as a proportion of total GB delivery), HUGs, the Social Housing Decarbonisation Fund, Green Homes Grant, and financial support policies such as the WHD. The Clean Heat Grant Scheme has been considered, estimated at £74 million of funding, however it has been assumed that the upfront grant will have a low take-up rate amongst fuel poor homes, so has not been included in total funding estimates in this analysis.

It is important to note that not all the funding committed to these schemes in Table 1 will be spent on fuel poor households due to many of these schemes having wider eligibility criteria, for example, individuals with health conditions or low incomes who may not necessarily be classified as fuel poor but may be vulnerable. Therefore, only a portion of the total allocated funds will benefit fuel poor households.

It is increasingly challenging to locate and target the right households, and even policy instruments such as ECO which have an explicit objective to address fuel poverty, only manage to deliver measures to a small portion of fuel poor households (29% of ECO recipients are classified as fuel poor by BEIS in the ECO4 Impact Assessment^{xvii}). A further challenge arises as households move into or out of fuel poverty without homes being improved due, for instance, to changing financial circumstances or moving house. There are three key drivers of fuel poverty: energy efficiency, incomes, and fuel prices^{xviii}. Ultimately, the Government does not have a central record of all fuel poor homes, and instead relies on proxies – such as whether the household is in receipt of benefits - to guide eligibility criteria and improve the targeting of funding.

Further additional costs of schemes have been considered as part of the cost-benefit analysis, which may be incurred by suppliers or consumers, or could be addressed by increased government spending, depending on the policy approach taken. These costs include hidden and search costs.

The policies considered improve energy efficiency ratings for properties either through the installation of measures that improve the energy efficiency of a property (such as ECO and HUG), or through fuel bill interventions that reduce energy costs for the consumer (such as the Warm Homes Discount). These two funding types have committed values of £3.7 billion and £2.9 billion respectively for spending on fuel poor homes in England in the period considered. Lower estimates of projected spending have been made for certain policies (details given in Appendix - Table 12), however our analysis has been calibrated to the maximum committed values.

While it seems reasonable to take fuel bill interventions into account while the programme of work to meet the 2030 target is on-going and homes are still being improved, it will arguably be less reasonable to do so after that date when all fuel poor homes should have reached the target, since reaching the target through fuel bill interventions would present a significant ongoing, and repeating, cost. However, fuel bill interventions may still be required after 2030 to support those low income households where the home has not been improved to the target standard.

Importantly, private landlords, through the proposed minimum energy efficiency standard (MEES) of EPC band C and increased measure cost cap of £10,000, could be positioned to contribute substantially towards the costs of meeting the fuel poverty target. BEIS considers that at least 900,000 privately rented homes occupied by low income tenants will be brought up to FPEER band C by 2028 because of the PRS MEES, with a further 360,000 projected to have carried out works which do not reach the target (assuming a 90% compliance rate with the policy). Taking the average per-property-spend of £4,700, this policy could unlock just under £6 billion of investment on the energy efficiency performance of fuel poor homes.

Whilst this takes England closer to the required funding needed to meet the fuel poverty target, our analysis shows that would still leave a significant shortfall in funding and relies on several assumptions regarding the Government's final position on PRS MEES, its enforcement, the extent to which Government may decide to subsidise costs, the housing market response, and the take-up of measures from landlords.

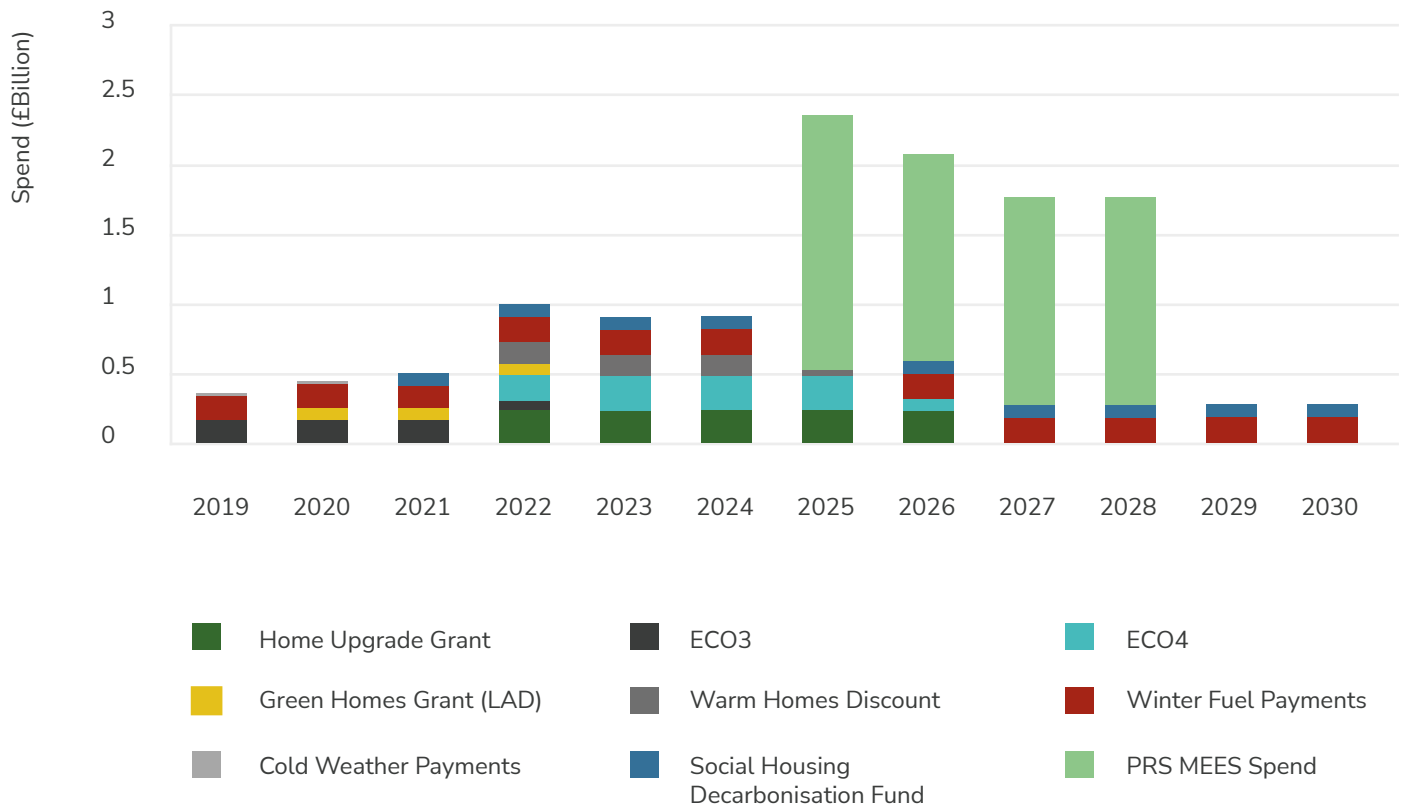
TABLE 2 – FUEL POVERTY SCHEMES CONSIDERED IN ANALYSIS

		FUNDING SPENT ON FUEL POOR HOMES	
POLICY	TOTAL FUNDING AVAILABLE, ENGLAND (£MN)	ASSUMED MAX % OF FUNDING TO BE SPENT ON FP HOMES	MAXIMUM FUNDING TO BE SPENT ON FP HOMES (£MN)
Committed funding in Government policies/ strategies			
Warm Homes Discount	1686	39	657
Winter Fuel Payments	18725	12	2247
Cold Weather Payments	3	11	0
ECO3	1879	29	545
ECO4	3356	29	973
Home Upgrades Grant - committed	150	50	75
Social Housing Decarbonisation Fund	3800	18	701
Green Homes Grant, LAD	500	50	250
Total	30099		5449
Manifesto pledges			
Home Upgrades Grant - manifesto pledge	2350	50	1175
Total with manifesto pledges	32449		6624
Other forecast spending from landlords via PRS regulations			
PRS Minimum Energy Efficiency Standards	15432	38	5922
Grand total	47881		12546

As indicated in Figure 1, the available funding over the coming years has some uncertainty attached, and this can only be an impression of the annual spend. Whilst the proposed increase in funding from 2021 onwards is welcome, it is clear more needs to be done to achieve the fuel poverty targets.

FIGURE 1 - AVAILABLE FUNDING FOR FUEL POVERTY TARGET

FUEL POVERTY SPEND PER ANNUM



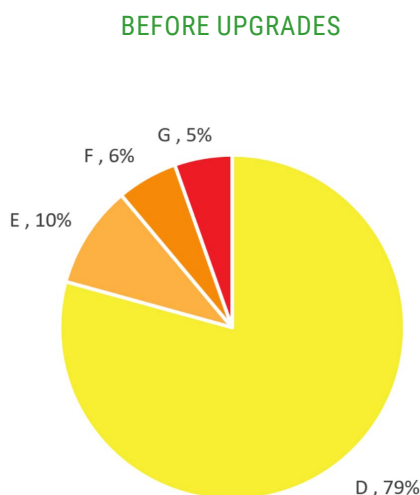


FUNDING NEEDED TO MEET THE TARGET

Our analysis considers two funding scenarios and the impact this could have on achieving the fuel poverty target in England. The methodology is outlined in the appendix.

Most fuel poor households are currently in FPEER band D as shown in Figure 2. This baseline has been used across all the scenarios.

FIGURE 2 - BREAKDOWN OF FPEER BANDS AMONGST FUEL POOR HOMES IN ENGLAND



SCENARIO 1 - CURRENT FUNDING COMMITMENTS

Scenario 1 has been designed to reflect business as usual, with the model calibrated to reflect the scale of government committed spending on the installation of energy efficiency measures in fuel poor homes in England. We estimate that the Government has committed a maximum of £3.7 billion to be spent on fuel poor homes.

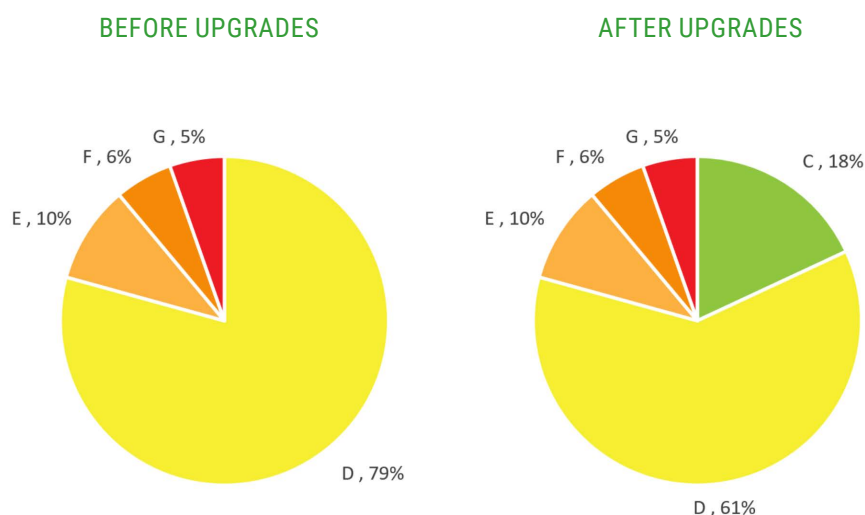
Our model predicts that if all of this is spent on energy efficiency measures in fuel poor homes, 570,000 could be upgraded to a higher FPEER band.

A range of measures is conceptually included in the modelling for this scenario, with options including insulation, heating system upgrades and a plethora of other technologies such as the installation of controls, double glazing, draught proofing, and solar PV*, which when implemented holistically, can substantially lower fuel bills in the low income properties analysed. Our assumption here is based on the calculated average cost of upgrading a property to FPEER band C from a range of bands (D-G), with figures taken from the English Housing Survey^{xix}.

It is important to note that the exact composition of measures is to be determined and will follow from the exact calibration of government incentives, technical restrictions or building characteristics, and consumer preferences.

The installation of all these measures will have a positive impact on FPEER bands - see increased proportion of band C properties in Figure 3 - however, the result is not sufficient to meet the fuel poverty target, with 82% of fuel poor properties remaining below band C after the above measures are installed. These findings confirm that a greater level of investment will be needed if we are to meet the 2030 target.

FIGURE 3 - BREAKDOWN OF FPEER BANDS AMONGST INITIALLY FUEL POOR HOMES IN ENGLAND, BEFORE AND AFTER UPGRADES UNDER SCENARIO 1



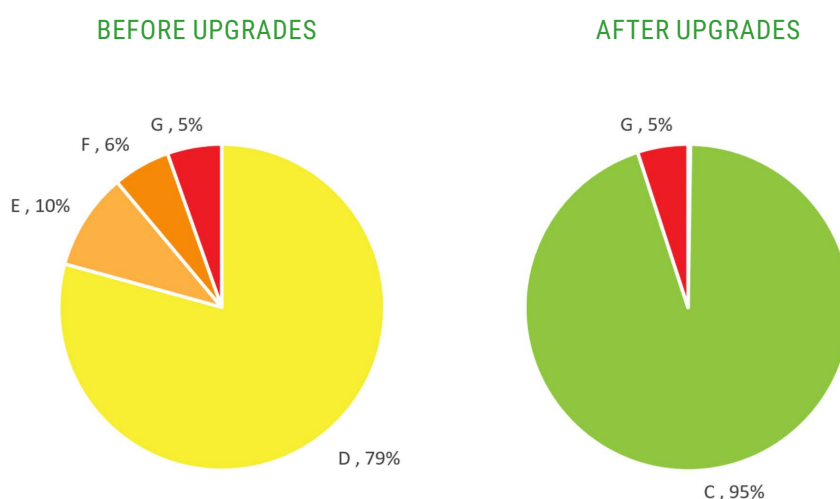
Given the high proportion of fuel poor homes that remain below band C in this scenario, it is clear that a Business-as-Usual approach is not consistent with the government target of ensuring as many fuel poor homes as is reasonably practicable achieve an energy efficiency rating of band C by 2030. Additional funding and thus a greater uptake of energy efficiency measures and heating installations will be needed if the Government is committed to delivering upon this target.

* A full list of possible measures is provided in the methodology section of the appendix.

SCENARIO 2 – REACHING THE FUEL POVERTY TARGET

Scenario 2 models the additional upgrades needed to bring all possible homes to FPEER band C. In this scenario, the higher funding allocation has been calibrated to allow most fuel poor homes to achieve band C or higher. This additional spending leaves 5% of fuel poor properties below FPEER band C by 2030. While this creates a separate challenge around how to support that 5%, we consider that this is broadly consistent with achieving the fuel poverty target, considering the caveat of “as many as reasonably practicable”. Figure 4 indicates these results.

FIGURE 4 - BREAKDOWN OF FPEER BANDS AMONGST INITIALLY FUEL POOR HOMES IN ENGLAND, BEFORE AND AFTER UPGRADES MADE UNDER SCENARIO 2



Our scenario results and modelling approach has set preferences for the deployment of insulation measures which are unambiguously required for fuel poverty/net zero targets and supported by government policy. Insulation measures therefore feature prominently in our modelling, with heating technologies and alternative measures such as controls or solar panels only being included holistically. A reduced focus on heating technologies reflects a growing use of heating system caps in ECO3 and 4, and some uncertainty regarding the take up of low-carbon alternatives. Double glazing has similarly not been prioritised in our scenarios despite having a positive effect on FPEER bands when modelled, due to its higher comparative cost. This is considered to align with types of measures prioritised in policy approaches.

In the modelling for this scenario, properties have been upgraded in two stages. In the first stage, individual insulation measure combinations were selected according to the lowest cost option where average performance would meet FPEER band C. Where modelled upgrades to properties could not bring properties to FPEER band C, generally some measures were still applied to improve the FPEER band from the starting condition. The model assumes the following measures are deployed in fuel poor homes:

- ◆ Over 900,000 loft insulation installs
- ◆ Over 700,000 cavity wall insulation installs
- ◆ Over 600,000 solid wall insulation installs

For the properties that do not meet band C with the above upgrades, a second stage of modelling has been undertaken in which we assume an average cost based on FPEER band, as in scenario 1 (see appendix for detail). This allows for a wider range of measures to be incorporated into the cost and impact of upgrades. The exact number and types of all measures for properties in this scenario are therefore not specified.

The total cost for the installation of measures in this scenario comes to £22 billion, with 3.0 million fuel poor homes upgraded to a higher band. Note that this is an £18 billion difference from the policy and manifesto commitment funding used in scenario 1.

THE FUNDING GAP

It is instructive to compare this estimate of the spend required on fuel poor homes to reach the fuel poverty target, with the level of committed spend across policy and the current Government's election manifesto pledges. As shown in Figure 5 there is a significant gap between the funding required and the funding committed to date to support fuel poor households.

FIGURE 5 - AVAILABLE FUNDING FOR FUEL POVERTY TARGET

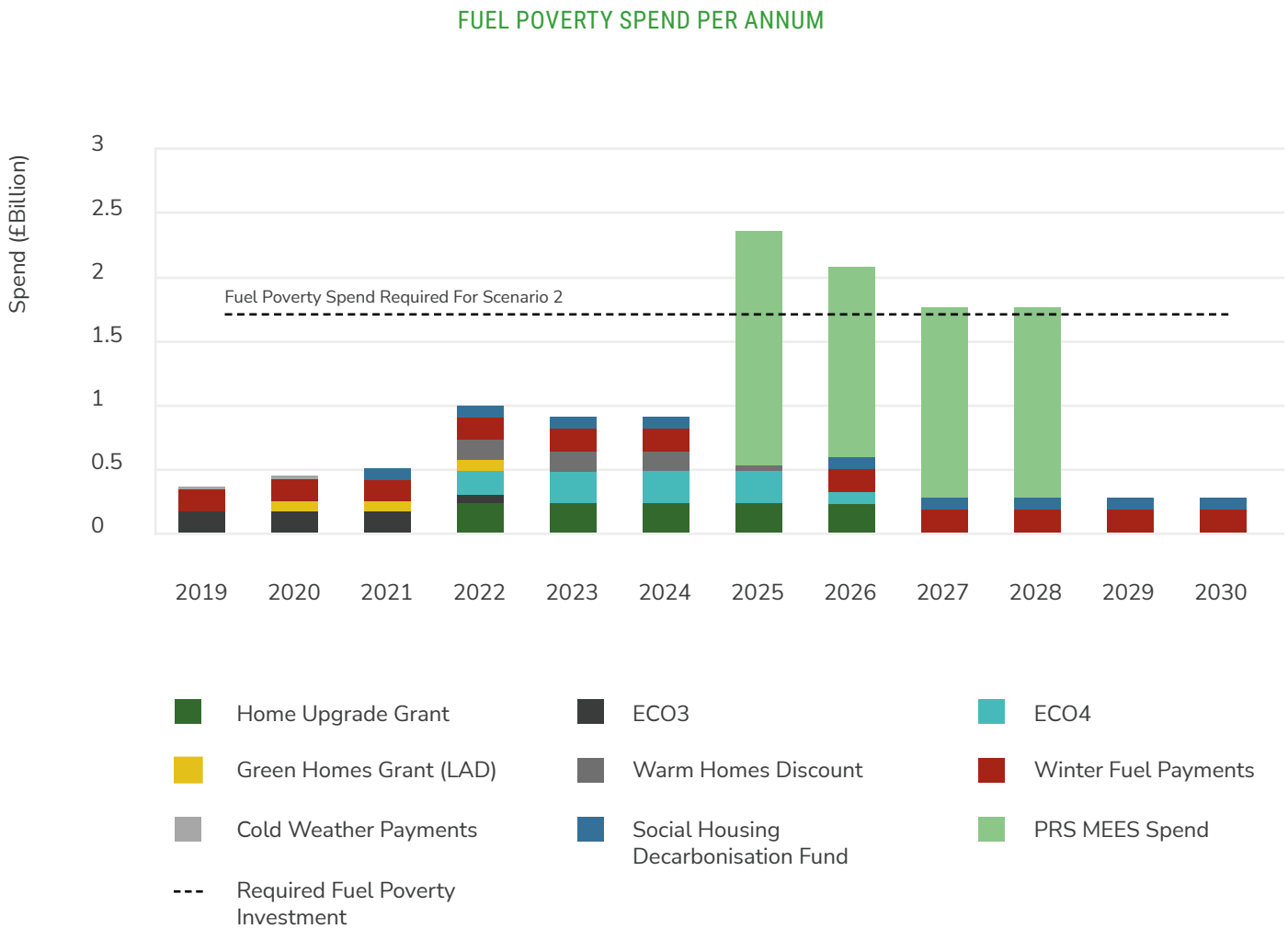
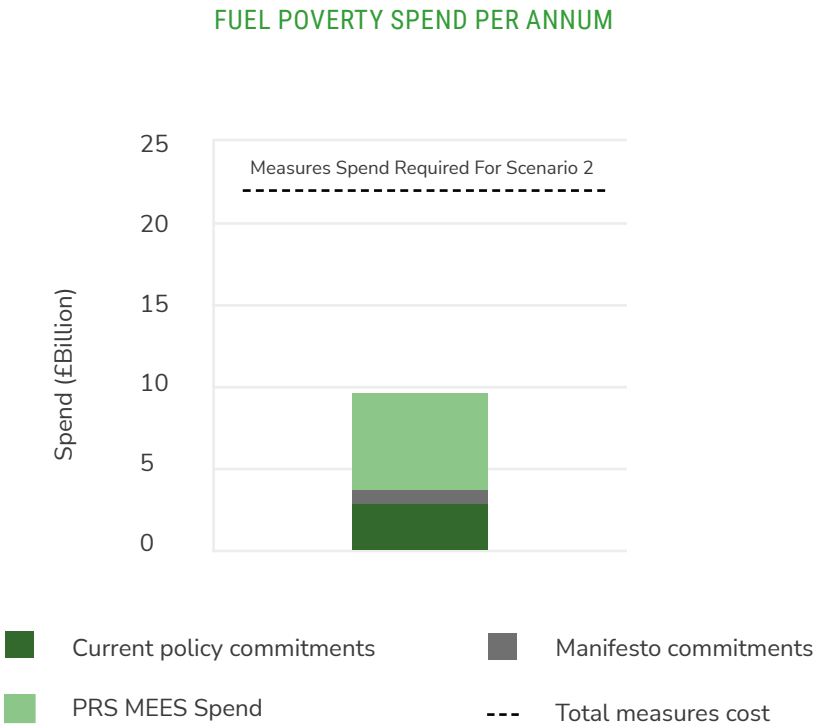


Figure 6 illustrates a £18 billion funding gap between pledged government spending on schemes which promote energy efficiency in fuel poor homes, and the scale of investment needed to upgrade all reasonably practicable fuel poor homes in England to FPEER band C by 2030. As the landlord spend as a result of MEES is uncertain, it has not been included in the funding commitments, thus confirmation of investment is needed to reduce the funding gap.

Note that even this is a best-case scenario. As well as assuming all funding is spent on measures, our analysis favours the installation of more cost-effective measures for achieving the target for each property type, namely loft insulation and cavity wall insulation, in addition to EPC-recommended measures*. Given the drive to meet a wider set of policy objectives, we expect Government funding under HUGs and Sustainable Warmth to be allocated to higher-cost measures such as heat pumps and solar PV. This will place additional pressure on limited Government funding budgets and reduce the intensity of the spend on fuel poverty. We therefore anticipate that sum of at least £18 billion will be required for measures beyond funding already committed. Considering this, careful thought is needed before ruling out support for gas boilers in future policies – some continuing gas boiler support for lower income families might be necessary.

FIGURE 6 - AVAILABLE FUNDING FOR FUEL POVERTY TARGET



* See the methodology section of the appendix for more details.

COST-BENEFIT ANALYSIS OF ADDITIONAL GOVERNMENT FUNDING

Our analysis has been developed with the intention of highlighting the fuller range of benefits and costs associated with increased action on fuel poverty, over and above typical values for installation costs and fuel bills savings, to include hidden and search costs, health benefits, carbon savings, and air quality improvements*.

Table 3 details the results of the assessment under the two scenarios modelled. Both scenarios experience a shift in properties from below FPEER band C to bands C or above, however scenario 1 leaves a significant proportion of properties below band C. Scenario 2 therefore includes additional energy efficiency and heating measures, transitioning a higher proportion of properties to band C or above.

Note that the costs and benefits are discounted over the period considered (to account for more immediate costs and benefits carrying a greater value) – this means the values for total installation costs in Table 3 are lower than the upfront spend values given elsewhere in the report.

For both scenarios, additional fuel bill payments have been included to reflect the support that would be needed to take all homes out of fuel poverty from 2030 – including those that would not meet the target by energy efficiency measures alone.

The costs outlined include spend on fuel poor homes, rather than also including the spending on non-fuel poor homes that results from targeting challenges of schemes. Costs that have not been included in this analysis are administration costs and economic rent. Economic rent may pose a more significant cost than the given hidden and search costs, however this has not been included since the relevance to the cost benefit analysis depends on the policies used to deploy the measure installations. An indication of the possible impact of administration costs is given later in this section.

The net present values (NPVs) for each scenario have been calculated. A positive NPV indicates that the upfront costs are a good investment, where the total benefits exceed the total costs.

* Not all costs have been included, for reasons highlighted in the appendix. Further detail on the development of estimates for the cost benefit analysis is given in the appendix

TABLE 3 - AGGREGATED COSTS AND BENEFITS OF INSTALLATION MEASURES UNDER SCENARIOS 1 AND 2

COSTS AND BENEFITS (VALUES GIVEN IN £ MILLION, DISCOUNTED ACROSS THE PERIOD 2019 TO 2050)	SCENARIO 1 – COMMITTED GOVERNMENT SPENDING	SCENARIO 2 – REQUIRED SPENDING FOR TARGET
Costs		
Installation Costs**	3201	19029
Hidden Costs	188	1116
Search Costs	351	2086
Value of fuel bill payments between 2030-2050 (bringing the remainder of properties to FPEER C)	10802	2647
Aggregated Costs	3740	22231
Aggregated Costs (with fuel bill payments)	14542	24878
Benefits		
Reduced Household Bills	1567	13118
Value of Comfort Taking	235	1968
Value in Carbon Savings	1961	11843
Value of Air Quality Improvements	76	462
Value of Health Benefits	1612	10455
Aggregated Benefits	5451	37846
Overall Net Present Value	+1,711	+15,614
Overall Net Present Value (with fuel bill payments)	-9,091	+12,968

** Installation cost values for scenarios 1 and 2 are discounted from the £3.7 billion and £22.1 billion funding amounts chosen for the scenarios – the difference between which is the £18 billion funding gap referenced in this report.

The results in Table 3 show the NPVs of installation of measures under the two scenarios, determined by subtracting the monetised costs from the monetised benefits between the present and the year 2050 (discounted to account for more immediate costs and benefits carrying a greater value). This assumes an incremental installation of energy efficiency measures between now and 2030, with associated installation costs, hidden costs, and search costs.

Over this period, properties experience a cumulative reduction in heat demand, resulting in fuel bill savings and increased levels of comfort. Additionally, there are reductions in carbon emissions and air pollutants, which also have an associated monetary value. These benefits extend beyond the year 2030, once the installation measures have been maximised, and have been aggregated up to the year 2050.

Fuel payments for the remainder of properties below FPEER C are also included. This contributes a substantial additional cost to scenario 1, for which 82% of fuel poor properties remain below band C, and a much lower additional cost for scenario 2, in which just 5% of fuel poor properties remain below band C. The value of this payment per property is higher for scenario 2, since all properties that remain below FPEER C are in FPEER band G – requiring a greater level of support to bring to the target than properties in higher bands. Further consideration would be needed if the costs were to be optimised between measure installation and fuel bill support. For example, choosing to upgrade FPEER G properties instead of FPEER F properties in scenario 2 may result in a lower cost over the period of the analysis due to lower ongoing fuel bill support being required, despite a higher upfront investment of upgrading lower band properties.

Without including additional fuel bill payments, the NPVs for scenarios 1 and 2 are both positive, indicating the aggregated benefits exceed the costs for both scenarios. A higher NPV for scenario 2 is evident, where a greater number of installations are completed.

With fuel bill payments to allow all properties to meet FPEER C, the NPV for scenario 1 is negative and that for scenario 2 is positive. This means there is a compelling economic case for meeting the fuel poverty target by property upgrades rather than fuel bill support – since scenario 1 has a significant fuel bill payment contribution compared to scenario 2, where a far greater number of installations are carried out.

This cost benefit analysis has not included administration costs – the value of these, amongst other costs, will depend on the policies and mechanisms used to reach the fuel poverty target. As a possible indication, administration costs equivalent to those in ECO4 were modelled, bringing the NPVs with fuel bill payments for scenarios 1 and 2 to -£9.8 billion and +£8.7 billion respectively. These values reveal the significance of policy and mechanism choice, and further support meeting the fuel poverty target through installation of energy efficiency measures rather than fuel bill payments, indicated by NPVs remaining negative and positive for scenarios 1 and 2 respectively.

ESTABLISHING THE BENEFITS OF INVESTMENT IN FUEL POVERTY

The most obvious benefit of energy efficiency deployment is fuel bill savings, via the reduction of energy consumption. In addition, the reduction in energy consumption also leads to decrease in the greenhouse gas (GHG) emissions produced because of the home's energy consumption. Here, we have estimated the GHG emission reductions utilising the Government's Green Book guidance and valuing the reduction in emissions utilising the appropriate cost of carbon.

Alongside the direct benefit of reaching the Government's fuel poverty target, investment in the energy performance of homes also improves health outcomes, lowers air pollution, facilitates improved productivity and educational attainment, and produces wider energy system benefits by reducing the need for investment in capital-intensive renewable and storage technologies.

There is significant research surrounding the health implications of being cold in the home. A research trial, Gentoo's 'Boiler on Prescription' found that, with the installation of energy efficiency measures in a household, the occupants' health was significantly improved after only 6 months. The findings of this research highlight the capacity for reduction in fuel poverty to increase health and reduce strain on the NHS.

The National Institute for Health and Care Excellence (NICE) has also made the link between fuel poverty and poor public health and released a guideline for reducing the risk of death and ill health associated with living in a cold home. One of its key goals is reducing fuel poverty and the risk of fuel debt or being disconnected from gas and electricity supplies.^{xx}

In its interim report to the Government, the Committee on Fuel Poverty recognised the correlation between cold homes and poor health and proposed introducing a new ECO eligibility route known as 'Health Flex'. This could be used by Health and Social Services sectors to directly identify and support those who are on low incomes and whose health is being negatively impacted by living in a cold home.^{xxi} The Government has subsequently proposed a reformed flexible eligibility route which allows NHS referrals suggesting a recognition of these wider benefits. This could be linked to the social prescribing agenda which targets a wide range of people including, those with long-term conditions. Combining these methods of identifying vulnerable people could deliver efficiencies and streamline resources.^{xxii}

Despite this link, the Sustainable Warmth Strategy highlights research gaps in:

- ◆ the effect of housing quality as determinants of cold-related adverse health outcomes.
- ◆ the interaction of socio-economic deprivation and fuel poverty with other potential determinants of vulnerability.
- ◆ child health; and
- ◆ impacts of fuel poverty/poor housing on mental wellbeing.

Although we believe that there is enough evidence to necessitate greater fuel poverty mitigation efforts, we do believe that there is potentially scope for research to bring together this evidence coherently.



Gemserve



AgilityEco

CONSIDERATIONS OF SCHEME DESIGN, FUNDING AND MESSAGING

Experience of past policy changes in the energy efficiency sector suggest predictability and stability in both funding levels and in scheme architecture are important factors. Our report has not considered these in any detail, though we would generally reinforce the importance of stability in the structure of the programmes.

We are also conscious that we are publishing this report in the run-up to COP26, the Spending Review, prior to publication of the Government's Heat and Buildings Strategy, and in the context of a broader policy discussion of how energy efficiency programmes are funded – most notably whether they continue to be funded principally from a levy on electricity bills.

Our recommendations are made independently of such considerations, and we offer no comment or view on them in this report, save that our recommendations and calculations assume “business as usual” with respect to these factors. If things change in the coming weeks and months, we may revisit the analysis if this seems necessary.

This report is therefore based on the assumption that the broad structure of government programmes, and particularly the design of their delivery elements, remains as it is today. This would also be what the industry is used to and would minimise any structural disruption to the supply chain should our recommendations be adopted.

Clear messaging from the Government is also critical. The estimates within this report are ambitious will require expansion of the supply chain and upskilling to ensure quality installations at the rates needed to lift most homes out of fuel poverty before 2030. Therefore, it is essential that policy is not only consistent and expanded but also communicated clearly and effectively.

POLICY RECOMMENDATIONS

1 IMPLEMENT EXISTING PROMISES AND PROPOSALS

- ◆ £2.35 billion for the Home Upgrade Grant has yet to be confirmed of the £2.5 billion committed in the current Government's election manifesto. This funding should be announced to ensure confidence among the supply chain and consumers.
- ◆ The Government has proposed to require private landlords to upgrade rented homes to a Minimum Energy Efficiency Rating of Band C by 2028. For fuel poor tenants, help can be provided through existing programmes. This should be implemented and, equally importantly, rigorously enforced.
- ◆ We estimate implementing these existing policies and proposals would reduce the funding gap for fuel poor homes from £18 billion to £12 billion.

Discussion of Recommendation 1

The current funding commitments are not sufficient to achieve the fuel poverty target even when manifesto pledges not yet fully implemented are included. There is a funding gap of at least **£18 billion** between what has been committed by the Government

and what is required to meet fuel poverty targets. However, the gap will be even larger if the Government does not fully deliver on existing commitments. Therefore, we recommend that all commitments (including manifesto pledges) must be delivered to ensure that the Government do not fall further behind in mitigating fuel poverty.

The MEES offers a route, as noted in our analysis, to reduce this funding gap. When the anticipated impact on landlord investment of the PRS MEES is considered, the funding gap reduces to **£12 billion**. Whilst this is still a significant shortfall, it brings the total investment closer to what is required to meet the 2030 fuel poverty target. Therefore, alongside recommending that committed spend is realised, we also recommend that this investment in achieving the PRS MEES is enforced and properly funded.

However, enforcement action of PRS MEES by local authorities is currently limited as there is a lack of sufficient training and resources to increase capacity for enforcement.^{xxiii} In 2019, the Committee on Fuel Poverty was commissioned to explore what alternative enforcement models could be adopted to achieve the housing stock improvement and reduction in fuel poverty sought from the new MEES and how might they work.^{xxiv} The research found that a key way to improve enforcement in the sector was the build the capacity of local authorities. This is an essential recommendation as the PRS has the worst housing conditions of all tenures with high levels of fuel poverty.^{xxv}

We would also note that the estimated spend within the PRS assumes that no subsidy is accessed by landlords to support the achievement of the minimum efficiency standards. However, if the Government allows landlords to be able to access subsidies/grants to top up their own investment, the gap is likely to be bigger than estimated here, and support mechanisms would need to be expanded even further than this report recommends, to take into consideration this crossover.

2 EXTEND THE CURRENT SCHEMES TO 2030

- ◆ Once Recommendation 1 is implemented, extension of the current schemes to 2030 would reduce the size of the funding gap from the £12 billion above, to £10 billion.
- ◆ In particular, the Energy Company Obligation is confirmed to March 2026, and the Home Upgrade Grant is confirmed to 2026. It would make no sense for these policies to be terminated at that point considering the continued existence of many fuel poor households. Committing to the extension of these schemes at the earliest opportunity will give confidence to all parties.

Discussion of Recommendation 2

The implementation of Recommendation 1 still leaves a significant funding gap. Therefore, to further reduce this, the Government should go beyond its currently committed spend. We propose ensuring all current support mechanisms are extended out to 2030 at least at the funding levels committed on an annual basis today.

We would also wish to reinforce the benefit of the industry already being used to the structure and operation of the current schemes and therefore a preference for their extension with additional funding, and especially for them to be announced well in advance. The alternative of introducing new schemes and policies suddenly to mitigate fuel poverty can create unintended consequences such as complexity in the market as it adjusts to new ways of operating, hiatus, and disruption to existing scheme delivery. The difficulties experienced following the introduction of the Green Homes Grant provide a recent example of this. The stability (albeit subject to on-going improvements) from extending but expanding the existing schemes would create greater confidence and support job creation, investment and growth, all important ingredients in achieving the fuel poverty target.

We estimate the cost of extending ECO4, the Home Upgrade Grant and the Warm Homes Discount across England would be in the region of £7.1 billion in total, and £5.0 billion for the measures-focused schemes* – bearing in mind that only a proportion of this reaches homes strictly defined as fuel poor, with the rest helping many other vulnerable households and delivering other policy benefits.

* Fuel bill support schemes have been assumed to be extended to 2030 in the modelling of upgrades, therefore the extension of the Warm Homes Discount (of the value £2.1 billion to homes in England) is not reflected in the funding gap under Recommendation 2.

3 EXPAND THE SCHEMES TO ENSURE THAT £10 BILLION REACHES FUEL POOR HOMES

- ◆ The schemes, once extended, need to be expanded so that a further £10 billion is spent tackling fuel poor homes as well as generating significant broader benefits in their own rights.
- ◆ Unless the schemes target a higher proportion of fuel poor homes (currently assumed to be around 30%), £34 billion would be needed for the £10 billion to reach the homes required to meet the target.

Discussion of Recommendation 3

Even with current committed spend, enforcement of PRS MEES and an extension of current schemes to 2030, there will still be a gap in funding of **£10 billion** for fuel poor homes to reach the Government's target of achieving a minimum energy efficiency rating of band C by 2030. It is recommended that this shortfall is met by expansion of ECO, LAD, or another existing mechanism.

We have assumed that current targeting rates (the proportion of funding programmes that reaches fuel poor homes) will continue – for the current and pledged combination of schemes, 31 homes are fuel poor for every 100 that receive measures. This means that, unless the schemes target a higher proportion of fuel poor homes, £34 billion would be needed for the £10 billion to reach the homes required to meet the target. However, we acknowledge that improving targeting rates is challenging and that funding is being deployed to vulnerable households and this wider spend is supporting net zero aspirations.

These recommendations are shown in graphical form below.

RECOMMENDATION SUMMARY

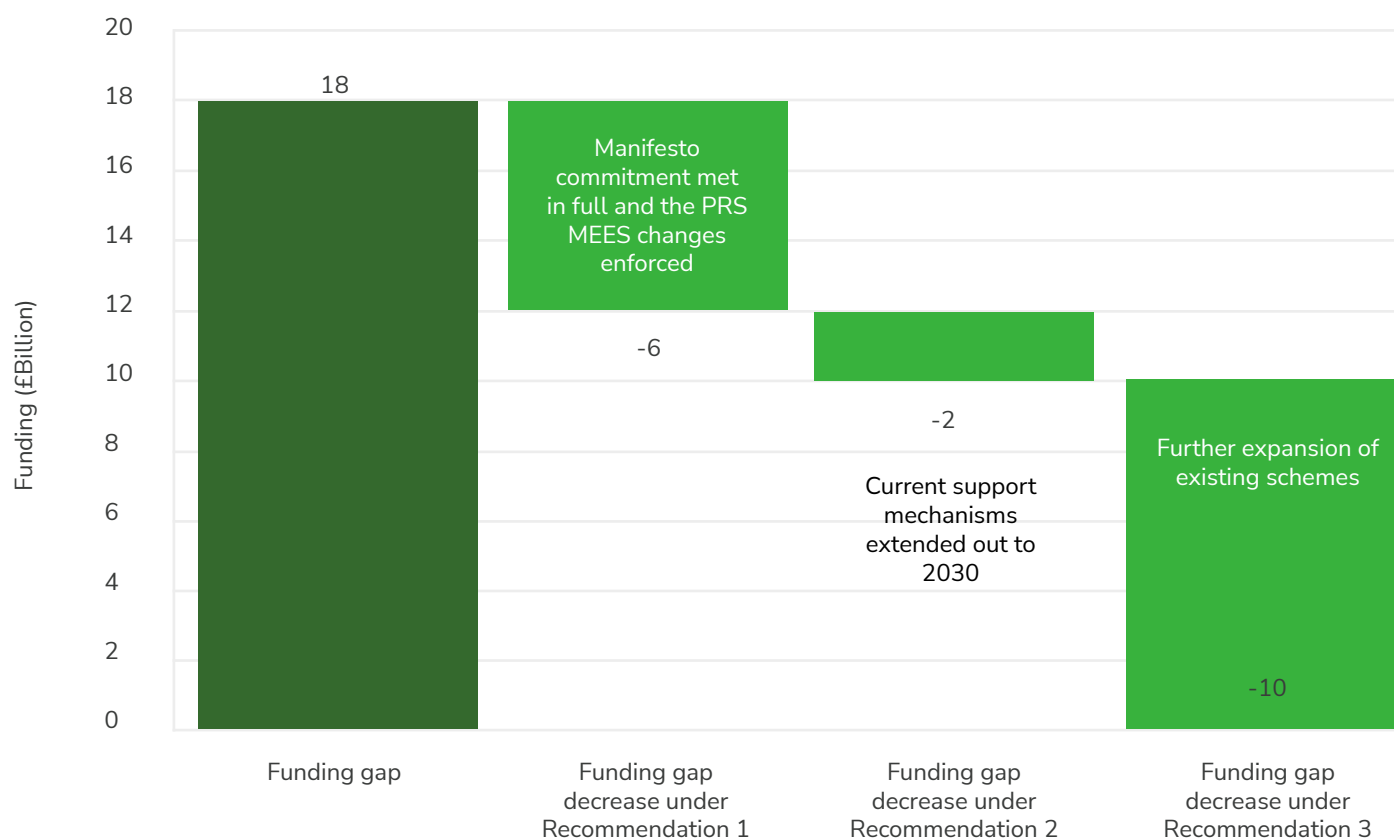


Table 4 gives a detailed breakdown of the funding stages and their effect on homes. Note that this does not include fuel bill payments, only funding for measure installations.

TABLE 4 - BREAKDOWN OF FUNDING STAGES AND EFFECT ON HOMES

FUEL POOR HOMES	
No. of fuel poor homes (2019)	3,180,000
No. of fuel poor homes taken to be not reasonably practicable	159,000
% of fuel poor homes taken to be not reasonably practicable	5.00 %
No. of fuel poor homes remaining to be addressed	3,021,000
Cost to address remaining fuel poor homes	£22,107,481,818
EXISTING POLICIES AND MANIFESTO PLEDGES FUNDING - SCENARIO 1	
No. of fuel poor homes addressed by existing policies and manifesto pledges	574,667
% of fuel poor homes addressed by existing policies and manifesto pledges	18.07 %
Funding for existing policies and manifesto pledge	£3,718,974,400
Average spend per property	£6,472
No. of fuel poor homes remaining to be addressed	2,446,333
Cost to address remaining fuel poor homes	£18,388,507,418
MEES FUNDING*	
No. of fuel poor homes addressed by MEES	915,086
% of fuel poor homes addressed by scheme extensions	28.78 %
Funding for scheme extensions	£5,922,000,000
Average spend per property	£6,472
No. of fuel poor homes remaining to be addressed	1,531,247
Cost to address remaining fuel poor homes	£12,466,507,418

* Indicative stages in reaching scenario 2 – not directly modelled

EXTENSIONS OF CURRENT HUG AND ECO4 TO 2030*

No. of fuel poor homes addressed by scheme extensions	242,371
% of fuel poor homes addressed by scheme extensions	7.62 %
Funding for scheme extensions	£1,973,240,000
Average spend per property	£8,141
No. of fuel poor homes remaining to be addressed	1,288,876
Cost to address remaining fuel poor homes	£10,493,267,418

FINAL FUNDING REQUIRED AFTER EXISTING POLICIES, MANIFESTO PLEDGES, MEES AND SCHEME EXTENSIONS*

No. of fuel poor homes addressed by final recommendation funding	1,288,876
% of fuel poor homes addressed by final recommendation funding	40.53 %
Cost of addressing fuel poor homes through final recommendation funding	£10,493,267,418
Average spend per property	£8,141

* Indicative stages – not directly modelled

CONCLUSION

Our analysis concludes more than twice the current level of committed funding is required before 2030 if the fuel poverty target is to be met. If no further action is taken beyond current confirmed commitments, over 80% of homes that were in fuel poverty in 2019 will remain so in 2030. The funding gap in fuel poor homes is currently £18 billion across that period.

Confirmation of the funding pledged in the Government's manifesto, implementation of proposals to improve private rented sector housing, and extensions of current programmes to 2030 will partly address the problem but will still leaving a funding shortfall of £10 billion for measures installation in fuel poor homes, and over 1 million people still in fuel poverty. Finding that additional funding could result in a net economic benefit (mostly through reduced fuel bills and improved health outcomes) in the region of £16 billion.

It is estimated that £34 billion of funding – more than twice that currently committed – will be needed for measures-focused fuel poverty relief schemes, for that £10 billion to reach those homes that fall within the narrow definition of fuel poor. However, we note the additional help for those outside the strict definition of fuel poor will still achieve significant improvements in the lives of millions of low income or otherwise vulnerable people.



REFERENCES


- i** Warm Home Discount - Better targeted support from 2022. Committee on Fuel Poverty. Available at: [Warm Home Discount - better targeted support from 2022: CFP response to the BEIS consultation \(publishing.service.gov.uk\)](#)
- ii** Special feature article – Do households move in and out of fuel poverty? (2020) Department for Business, Energy, and Industrial Strategy. Available at: [Do households move in and out of fuel poverty.pdf \(publishing.service.gov.uk\)](#)
- iii** Annual Fuel Poverty Statistics in England, 2021 (2020 data) (2021) Department for Business, Energy, and Industrial Strategy. Available at: [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/966509/Annual_Fuel_Poverty_Statistics_LILEE_Report_2021__2019_data_.pdf](#)
- iv** Community Action on Fuel Poverty (2021) FUEL POVERTY Facts and Statistics. Available at: [Community Action On Fuel Poverty - Fuel Poverty \(fuelpovertyresource.org.uk\)](#)
- v** End Fuel Poverty Coalition (2020). Available at: [End Fuel Poverty Coalition – For energy efficient homes, decent incomes, and low cost fuel for low income households.](#)
- vi** Cutting the cost of keeping warm (2015) gov.uk. available at: [cutting_the_cost_of_keeping_warm.pdf \(publishing.service.gov.uk\)](#)
- vii** Annual Fuel Poverty Statistics in England, 2020 (2018 data) (2020) Department for Business, Energy, and Industrial Strategy. Available at: [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/882404/annual-fuel-poverty-statistics-report-2020-2018-data.pdf](#)
- viii** Sustainable warmth: protecting vulnerable households in England (2021) Gov.uk. Available at: [Sustainable warmth: protecting vulnerable households in England \(publishing.service.gov.uk\)](#)
- ix** Fuel Poverty Energy Efficiency Rating Methodology (2014) Department of Energy and Climate Change. Available at: [fpeer_methodology.pdf \(publishing.service.gov.uk\)](#)
- x** Annual Fuel Poverty Statistics in England, 2021 (2019 data) (2021) Department for Business, Energy, and Industrial Strategy. Available at: [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/966509/Annual_Fuel_Poverty_Statistics_LILEE_Report_2021__2019_data_.pdf \(publishing.service.gov.uk\)](#)
- xi** BEIS (2015) Fuel Poverty for England: cutting the costs of keeping warm (2015) gov.uk. Available at: [https://www.gov.uk/government/publications/cutting-the-cost-of-keeping-warm](#)
- xii** BEIS (2021) Sustainable Warmth: protecting vulnerable households in England (2021) Gov.uk. Available at: [Sustainable warmth: protecting vulnerable households in England \(publishing.service.gov.uk\)](#)
- xiii** Home Group takes on big six energy companies on fuel poverty (2020) Inside Housing. Available at: [Inside Housing - News - Home Group takes on big six energy companies over fuel poverty](#)
- xiv** Almost 400,000 more UK homes heading for fuel poverty, campaigners say (2021) The Guardian. Available at: [Almost 400,000 more UK homes heading for fuel poverty, campaigners say | Fuel poverty | The Guardian](#)
- xv** The Sixth Carbon Budget (2020) Climate Change Committee. Available at: [https://www.theccc.org.uk/publication/sixth-carbon-budget/](#)
- xvi** Energy white paper: Powering our net zero future (2020) gov.uk. Available at: [Energy white paper: Powering our net zero future - GOV.UK \(www.gov.uk\)](#)
- xvii** ECO4 Impact Assessment (2021) Department for Business, Energy and Industrial Strategy, p.26. Available at: [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1003740/eco4-consultation-stage-impact-assessment.pdf](#)
- xviii** Special feature article – Do households move in and out of fuel poverty? (2020) Department for Business, Energy, and Industrial Strategy. Available at: [Do households move in and out of fuel poverty.pdf \(publishing.service.gov.uk\)](#)

- xxix** English Housing Survey 2019 to 2020: energy (2021) Ministry of Housing, Communities and Local Government. Available at: [English Housing Survey - GOV.UK \(www.gov.uk\)](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/1000780/English_Housing_Survey_-_GOV.UK.pdf)
- xxx** Excess winter deaths and illness and the health risks associated with cold homes (2015) National Institute for Health and Care Excellence. Available at: [Overview | Excess winter deaths and illness and the health risks associated with cold homes | Guidance | NICE](https://www.nice.org.uk/guidance/ng123)
- xxxi** Committee on Fuel Poverty interim report (2021) Committee on Fuel Poverty. Available at: [Committee on Fuel Poverty interim report 2021 \(publishing.service.gov.uk\)](https://publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1000780/Committee_on_Fuel_Poverty_interim_report_2021.pdf)
- xxxi** Social Prescribing (2021) NHS England. Available at: [NHS England » Social prescribing](https://www.nhs.uk/social-prescribing/)
- xxiii** Enforcing The Enhancement Of Energy Efficiency Regulations In The English Private Rented Sector (2019) Rsm. Available at: [Enforcing the enhancement of energy efficiency regulations in the English private rented sector \(publishing.service.gov.uk\)](https://publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1000780/Enforcing_the_enhancement_of_energy_efficiency_regulations_in_the_English_private_rented_sector.pdf)
- xxiv** Enforcing The Enhancement Of Energy Efficiency Regulations In The English Private Rented Sector (2019) Rsm. Available at: [Enforcing the enhancement of energy efficiency regulations in the English private rented sector \(publishing.service.gov.uk\)](https://publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1000780/Enforcing_the_enhancement_of_energy_efficiency_regulations_in_the_English_private_rented_sector.pdf)
- xxv** English Housing Survey 2019 to 2020: energy (2021) Ministry of Housing, Communities and Local Government. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1000780/Energy_Chapter_3_Annex_Tables_v2.ods




AgilityEco


 [AGILITYECO.CO.UK](https://agilityeco.co.uk)

 GEAROID.LANE@AGILITYECO.CO.UK



Gemserv

MAKING THINGS THAT MATTER
WORK BETTER FOR EVERYONE

 [GEMSERV.COM](https://gemserv.com)

APPENDIX

METHODOLOGY

Property upgrades

Data from the 2018 English Housing Survey (EHS) (the most recent dataset available) was used to inform the choice of archetypes to analyse the housing stock. Archetype characteristics were chosen so as to provide insight into the effect of insulation and heating system measures on energy cost performance of properties of different types. Chosen categories are listed in Appendix - Table 1. Of note are the heating types, where heating systems and fuels have been simplified into two categories. This was deemed necessary in order to reduce the number of archetypes, to decrease cases where archetypes contained very few properties and as such would be less representative of the housing stock. The allocation of heating systems and fuel types between these two categories was done to reflect the pattern of the data, when controlling other variables.

Our research resulted in the development of 284 archetypes. These archetypes were used as the building blocks of the analysis – on which we modelled the impact of typical energy efficiency upgrades.

APPENDIX - TABLE 1 - ARCHETYPE CATEGORIES USED IN ANALYSIS

WALL INSULATION	LOFT INSULATION	AMOUNT OF DOUBLE GLAZING	PROPERTY TYPE	PROPERTY AGE	HEATING TYPE
Solid uninsulated	Under 125mm	More than half	Detached	Pre 1919	High performing ⁱ
Solid insulated	125mm or more	Less than half	Semi/terraced	1919 to 1964	Low performing ⁱⁱ
Cavity uninsulated	Not applicable		Flat	1965 to 1980	
Cavity insulated				Post 1980	
ⁱ Includes condensing/condensing-combination boiler systems with gas fuel, and "no boiler" heating systems with "other" fuel type.					
ⁱⁱ Includes all standard/combination/back boiler systems, condensing/condensing-combination boiler systems with "other" fuel type, "no boiler" heating systems with gas fuel, and all systems with electricity as fuel type.					

Generally, archetypes were removed or combined where they contained a sample of under 10 properties. All properties were assigned to an archetype, but this approach means the archetype did not always match all characteristics of the property. Where combined, priority was given to retain distinction between the measures, i.e., archetypes were not combined across insulated/uninsulated walls (of the same type) or high/low performing heating system categories. For example, priority would be given to combine a Pre-1919 uninsulated solid wall archetype with a 1919 to 1964 uninsulated solid wall archetype, rather than a Pre-1919 insulated solid wall archetype.

Our research resulted in the development of 284 archetypes. These archetypes were used as the building blocks of the analysis – on which we modelled the impact of typical energy efficiency upgrades.

Where data was limited in the EHS, other methods were used to estimate energy performance. Where small sample sizes resulted in unexpected values, values were adjusted according to AgilityEco SAP modelling results. AgilityEco SAP modelling was also used to provide values for the effect of double glazing. To create archetypes to include the amount of glazing, the proportion of properties within each archetype likely to be more or less than half double glazed was estimated. 2017 EHS data including the level of double glazing of properties (the most recent available) was matched to the corresponding properties in the fuel poverty datasets for 2017 and 2018, to determine these proportions for a range of archetypes: all property type and age category combinations. The proportions used in the modelling are given in in Appendix - Table 2.

APPENDIX - TABLE 2 - ASSUMED PROPORTIONS OF PROPERTIES THAT HAVE MORE THAN HALF OF THEIR WINDOWS DOUBLE GLAZED

PROPERTY ARCHETYPES	PROPORTION OF PROPERTIES THAT ARE MORE THAN HALF DOUBLE GLAZED
Flat, Pre 1919	13 %
Flat, 1919 to 1964	44 %
Flat, 1965 to 1980	28 %
Flat, Post 1980	22 %
Detached/semi/terraced, Pre 1919	44 %
Detached/semi/terraced, 1919 to 1964	79 %
Detached/semi/terraced, 1965 to 1980	83 %
Detached/semi/terraced, Post 1980	46 %

EHS energy costs and floor areas for archetypes along with estimates of average fuel cost bill intervention amounts and targeting rates (calculated from data in Appendix - Table 12, values given in Appendix - Table 3) were used to calculate FPEER ratings for each archetype, using the SAP methodology¹. In the model, the average fuel bill intervention amounts and targeting rates have been assumed to remain the same in the future.

APPENDIX - TABLE 3 - AVERAGE FUEL BILL INTERVENTION ASSUMPTIONS

	PROPORTION OF FUEL POOR HOUSEHOLDS THAT RECEIVE THE FUEL BILL PAYMENTS SPECIFIED	AVERAGE ANNUAL VALUE OF FUEL BILL PAYMENTS SPECIFIED (£)
RECIPIENTS OF COLD WEATHER PAYMENTS, WINTER FUEL PAYMENTS AND WARM HOMES DISCOUNT	13 %	377
RECIPIENTS OF COLD WEATHER PAYMENTS AND WINTER FUEL PAYMENTS ONLY	8 %	277
ASSUMED AVERAGES FOR ALL FUEL POOR HOMES	21 %	339

To provide more granular insight into the energy cost performance of properties within each archetype, 2021 EPC data² was used to determine an estimate of proportions of properties on different heating systems. An overview of these proportions is given in Appendix - Table 4. These were combined with fuel cost data from BEIS^{3,4}, system efficiency data from European Commission⁵ and UCL research⁶, and electricity use data from Defra research⁷ to give the distribution of FPEER ratings for different heating systems in each archetype. Fuel costs and system efficiencies used are given in Appendix - Table 5.

APPENDIX - TABLE 4 - PROPORTION OF PROPERTIES IN ENGLAND ON GIVEN HEATING SYSTEMS

HEATING SYSTEM TYPE	Proportion of homes on given heating system
GAS CONDENSING BOILER	73.34 %
GAS NON-CONDENSING BOILER	0.81 %
LPG CONDENSING BOILER	0.74 %
LPG NON-CONDENSING BOILER	0.12 %
HEAT PUMP ⁱ	1.16 %
ELECTRICITY	18.72 %
OIL BOILER	3.28 %
OTHER ⁱⁱ	0.71 %
COMMUNITY SCHEME ⁱⁱⁱ	1.10 %
ⁱ Assumed ASHP ⁱⁱ Assumed coal boiler ⁱⁱⁱ Assumed to be gas condensing boiler (based on fuel types provided in the 2021 EPC data)	

APPENDIX - TABLE 5 - SYSTEM EFFICIENCY AND FUEL PRICE ASSUMPTIONS

HEATING SYSTEM	SYSTEM EFFICIENCY	FUEL PRICE (£/KWH)
Gas condensing boiler	0.90	0.0188
Gas standard boiler	0.75	0.0188
LPG condensing boiler	0.90	0.0785
LPG standard boiler	0.75	0.0785
ASHP	2.60	0.1490*
Electric storage heaters	1.00	0.1490*
Oil boiler	0.75	0.0435
Coal boiler	0.75	0.0418
*Off-peak tariff		

The number of fuel poor/low-income properties was estimated from 2018 EHS data – which is the latest release available to the analysts. This edition features an estimate of 3.52 million homes considered to be in fuel poverty, under the new fuel poverty metric (Low Income Low Energy Efficiency)⁸. The “low income” measure used in the previous fuel poverty metric has been assumed to be equivalent in the new fuel poverty metric, and with FPEER bands as modelled, this returns an estimate of 3.54 million homes in fuel poverty in 2018 – those that are low income and under FPEER C. To use 2019 as a base year for the

analysis, the results of the modelling were scaled to the number of fuel poor homes in 2019: 3.18 million.

In the modelling of measure upgrades, the most suitable upgrade was selected according to a priority order of loft insulation first, then whichever combination of additional measures would bring the property to FPEER C for the lowest cost of installing. Where modelled upgrades to properties could not bring a property to FPEER band C, generally some measures were still applied to improve the FPEER band from the starting condition. Outcomes on the overall numbers of properties in each FPEER band and measure costs were determined. Double glazing upgrades were modelled based on SAP modelling results, and had positive impact on FPEER ratings, but were considered to be too costly to include in the initially modelled upgrades.

In our approach to the analysis, upgrades have been modelled without consideration of the lifetime of existing measures present in properties, and the lifetimes of upgraded measures are assumed to be longer than the 2030 time frame being considered.

Costs of measures were estimated using data from the ECO4 impact assessment⁹ and figures they are based on¹⁰ - values used are give in Appendix - Table 6. Additional costs associated with installations (hidden costs and search costs) were estimated for each measure using additional data from the ECO4 impact assessment. Values used are given in in Appendix - Table 7. More explanation of the nature of these costs is given in the cost-benefit analysis section of this methodology.

APPENDIX - TABLE 6 - MEASURE INSTALLATION COST ASSUMPTIONS

PROPERTY TYPE	CAVITY WALL INSULATION COST (£)	EXTERNAL SOLID WALL INSULATION COST (£)	LOFT INSULATION COST (£)
Small flat (<54m ²)	380	5,300	185
Large flat (>54m ²)	430	6,700	249
Small terrace or semi detached (<78m ²)	494	7,300	205
Large terrace or semi detached (>78m ²)	582	7,950	257
Small detached house (<117m ²)	680	10,200	295
Large detached house (>117m ²)	950	11,500	347

APPENDIX - TABLE 7 - HIDDEN AND SEARCH COST ASSUMPTIONS

	HIDDEN COSTS	SEARCH COSTS ON THE GAS GRID	SEARCH COSTS OFF THE GAS GRID
LOFT INSULATION MEASURE	£135	£190	£430
CAVITY WALL INSULATION MEASURE	£95	£260	£430
SOLID WALL INSULATION (EXTERNAL) MEASURE	£220	£290	£430
PROPORTION OF TOTAL MEASURES COST FOR MODELLED UPGRADES	5.9 %	11.0 %	

Upgrades were also modelled in a separate stage to allow for a wider range of measures and simpler scaling of costs to tailor to the scenarios used. The impact and costs of these were based on data from the English Housing Survey 2019-2020 energy report¹¹ - values given in Appendix - Table 8 – and they conceptually include a wider range of EPC-recommended possible measures. The assumptions of measures and costs behind the values used are given in Appendix - Table 9, taken from the English Housing Survey Technical Report, 2019-20¹². To reflect the assumption that for the worst performing properties, the cheapest to upgrade will be upgraded first, adjusted costs and energy bill savings were calculated for F and G band properties. These are scaled using the proportion of F and G properties upgraded in the scenario considered (scenario 2, as defined in the main body of the report), and the difference between the average values for E and F/G band properties. These adjusted values are given in Appendix - Table 8.

APPENDIX - TABLE 8 - BAND UPGRADE ASSUMPTIONS

INITIAL ENERGY EFFICIENCY BAND OF PROPERTY	AVERAGE COST TO IMPROVE TO AN ENERGY EFFICIENCY BAND C (£)	AVERAGE ENERGY BILL SAVINGS WHEN IMPROVED TO AN ENERGY EFFICIENCY BAND C (£)
D	6,472	179
E	13,285	594
F OR G	18,858	1,339
F OR G (PROPERTIES UPGRADED IN SCENARIO 2)	17,602	1,171
F OR G (PROPERTIES NOT UPGRADED IN SCENARIO 2)	20,389	1,544

APPENDIX - TABLE 9 - EPC MEASURES AND COSTS CONCEPTUALLY INCLUDED IN ADDITIONAL UPGRADES

MEASURE	PRODUCT CHARACTERISTIC DATABASE INDICATIVE COST (MEAN) (£)
Loft insulation	225
Flat roof insulation	1175
Roof room insulation	2100
Cavity wall insulation	1000
Solid wall insulation	9000
Floor insulation (suspended floor)	1000
Floor insulation (solid floor)	5000
HW cylinder insulation	23
Draught proofing	100
Low energy lighting	5 per unit
Cylinder thermostat	300
Heating controls for wet Central Heating system	400
Heating controls for warm air system	400
Biomass boiler	10000
Biomass room heater with boiler	10000
Upgrade boiler, same fuel	2600
Install condensing oil boiler	5000
Condensing gas boiler no fuel switch	5000
Condensing gas boiler fuel switch	5000
Replacement/New storage heaters	500 per unit
Replacement warm air unit	1875
Solar water heating	5000
Double glazing	4900
Glazing replacement	1200
Insulated doors	500 per unit
Photovoltaics	4500
Wind turbine	20000

To estimate what level of additional funding would be needed to bring the remaining properties under the target up to FPEER C through fuel bill interventions, the value of support was assumed to be the same as energy bill savings when upgraded to FPEER C – as given in Appendix - Table 8. This was combined with the number of properties at each of these bands after upgrades.

To scale funding to the total spent, rather than only that on fuel poor homes, the targeting rates of relevant current policies and manifesto commitments were used. As an indication for future funding, an average targeting rate was calculated from currently committed

measures-focused funding – 30.9% of this funding is estimated to be spent on fuel poor homes. This is based on the targeting rates given in Appendix - Table 12.

Cost-benefit analysis

Installation costs have been aggregated and included in the cost-benefit analysis, in addition to *hidden costs* – which account for the ‘hassle’ faced by occupiers owing to disruptive and time-consuming installations. Many of the measures take multiple days to install. Some, such as solid wall-insulation make take weeks to complete and may require residents to move out certain rooms or the property as a whole in extreme circumstances. Hidden costs are therefore calculated as a function of the time required to coordinate the install, prepare the property and oversee the works, and government assumptions have been followed using the ECO4 impact assessment. Search costs have also been estimated to account for the time and resources which need to be invested by solution providers (energy companies, local authorities, installers etc.) to identify and approach fuel poor homes. Again, these costs are based on the Government’s ECO4 impact assessment and supply chain assessment. Whilst future energy efficiency funding may not follow the ECO structure, we anticipate that search costs will be of a similar magnitude and should be included in the cost benefit analysis. We would anticipate that these costs will increase over time. The values used in the model have been given in Appendix - Table 7.

The delivery of energy efficiency measures also incurs an administrative cost under policies such as ECO and the proposed Home Upgrade Grant. To give an indication of the effect of these administration costs, their value in ECO4 was estimated to be 22.2% of measure installation costs, from the ECO4 impact assessment. However, this analysis does not specify the characteristics of the instrument and scheme, therefore they haven’t been included in the main cost benefit analysis.

We have also not included economic rent as an additional cost. In this context, economic rent is any cost to the scheme/Government/taxpayer which exceeds the production cost of installing the energy efficiency measures. For instance, if an installer claims excess subsidy over and above the cost of delivery, economic rent will accrue. It is in essence any excess profits from the deployment of energy efficiency measures and is a feature of many subsidy/grant schemes. As this analysis is policy-agnostic, it is omitted from the calculations.

Health benefits have been estimated using data on the value of health savings for measure installations from the Department of Energy and Climate Change¹³. A value for health saving per energy efficiency band improvement was calculated using average band improvements for cavity wall and solid wall insulation installations. This value was applied to the upgrade results. Values used are given in Appendix - Table 10.

APPENDIX - TABLE 10 - HEALTH SAVINGS ASSUMPTIONS

	HEALTH SAVING (£)
VALUE PER CAVITY WALL INSTALLATION MEASURE	969
VALUE PER SOLID WALL INSTALLATION MEASURE	742
AVERAGE VALUE PER ENERGY EFFICIENCY BAND INCREASE*	2805
*Properties with electric heating systems not included in calculation, due to significantly smaller improvements in energy efficiency, unreflective of other heating systems	

Additional benefits calculated include comfort taking, using an assumption again from the ECO4 impact assessment (15% of the value of energy bill impact), air quality, using the BEIS toolkit¹⁴ referenced in the ECO4 impact assessment, consumer bill reductions, using average figures in the English Housing Survey 2019-2020 energy report (given in Appendix - Table 8), and carbon savings, using carbon prices newly published by BEIS¹⁵. Projected air quality and carbon price values used are given in Appendix - Table 11.

APPENDIX - TABLE 11 - PROJECTED AIR QUALITY DAMAGE COST AND CARBON PRICE ASSUMPTIONS

YEAR	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
AIR QUALITY DAMAGE COSTS FOR GAS (P/KWH)	0.14	0.15	0.15	0.15	0.16	0.16	0.16	0.17	0.17	0.17	0.18	0.18	0.18	0.19	0.19	0.19	0.20	0.20	0.21	0.21	0.22	0.22	0.22	0.23	0.23	0.24	0.24	0.25	0.25	0.26	0.26	0.27
AIR QUALITY DAMAGE COSTS FOR DIRECT ELECTRIC (P/KWH)	0.19	0.19	0.20	0.20	0.20	0.21	0.21	0.22	0.22	0.22	0.23	0.23	0.24	0.24	0.25	0.25	0.26	0.26	0.27	0.27	0.28	0.28	0.29	0.30	0.30	0.31	0.31	0.32	0.33	0.33	0.34	0.35
AIR QUALITY DAMAGE COSTS FOR OIL* (P/KWH)	2.15	2.19	2.24	2.28	2.33	2.37	2.42	2.47	2.52	2.57	2.62	2.67	2.73	2.78	2.84	2.89	2.95	3.01	3.07	3.13	3.20	3.26	3.32	3.39	3.46	3.53	3.60	3.67	3.74	3.82	3.90	3.97
CENTRAL CARBON PRICE PROJECTION (£/TCO2E)	238	241	245	248	252	256	260	264	268	272	276	280	285	289	293	298	302	307	312	316	321	326	331	336	341	346	351	356	362	367	373	378
*"Other" fuel taken as oil																																

APPENDIX - TABLE 12 - ESTIMATED FUNDING SPENT ON FUEL POOR HOMES IN ENGLAND, 2019-2030

POLICY	FUNDING AVAILABLE		FUNDING SPENT ON FUEL POOR HOMES			COMMENT
	TOTAL (£MN)	YEARS OF FUNDING (2019 - 2030)	ASSUMED MAX % OF FUNDING TO BE SPENT ON FP HOMES	MAXIMUM FUNDING TO BE SPENT ON FP HOMES (£MN)	LOWER ESTIMATE OF FUNDING TO BE SPENT ON FP HOMES (£MN)	
Committed funding in Government policies/strategies						
Warm Homes Discount	1686	4	39%	657	329	Value of funding adjusted for assumed English/Welsh FP household split. Assumed improved targeting of fuel poor homes from Govt. consultation - taking 'hit rate' figure to 39%. Lower estimate accounts for reduced WHD payments given a declining number of homes in FP - following the impact of other energy efficiency policies.
Winter Fuel Payments	18725	11	12%	2247	1124	Value of payments considered for England. Assumed that 12% of properties treated are in FP based on Parliamentary briefing (2019). Lower estimate accounts for declining number of homes in FP over period
Cold Weather Payments	3	11	11%	0	0	Value of funding taken from 2019-20 CWP payments (from Social Fund annual report). Adjusted for proportion of English number of payments out of total GB value. Targeting based on proportion of pensioners in fuel poverty.
ECO3	1879	3	29%	545	545	Estimate of targeting figure taken from Committee on Fuel Poverty (CFP) report - note is based on LIHC metric. Adjusted for proportion of ECO measures delivered in England (84%).
ECO4	3356	4	29%	973	853	Estimate of targeting figure taken from ECO 4 Impact Assessment. Lower estimate accounts for projected spending under preferred Option 4 in Impact Assessment. Adjusted for proportion of ECO measures delivered in England (84%).
Home Upgrade Grant - committed	150	5	50%	75	75	Initial £150mn funding confirmed in Sustainable Warmth policy document. Targeting figure taken from CFP report, which concludes that ~50% of low income homes are in fuel poverty.
Social Housing Decarbonisation Fund	3800	10	18%	701	701	18% of social housing households are in fuel poverty in England.
Green Homes Grant, LAD	500	2	50%	250	250	Targeting figure taken from CFP report, which concludes that ~50% of low income homes are in fuel poverty.

Total	30099			5449	3876	
Manifesto pledges						
Home Upgrade Grant - manifesto pledge	2350	5	50%	1175	1175	Manifesto pledge of £2.5 billion. HMT has yet to allocate more than £150mn of initial funding. Assumed 50% of low income homes are fuel poor based on CFP report.
Total with manifesto pledges	32449			6624	5051	
Other forecast spending from landlords via PRS regulations						
PRS Minimum Energy Efficiency Standards	15432	4	38%	5922	5922	900,000 low income homes expected to be taken up to FPEER C by 2030, with an additional 360,000 expected to comply with the regulation, but fail to reach FPEER band C. Note this is assuming a 90% compliance rate and an average spend of £4,700. Total funding estimated using 80% of the PRS being below FPEER C and 30.7% being both low income and under FPEER C, or 1.4 million homes.
Grand total	47881			12546	10973	

REFERENCES

-
- ¹ The Government's Standard Assessment Procedure for Energy Rating of Dwellings (2014) BRE. Available at: https://www.bre.co.uk/filelibrary/SAP/2012/SAP-2012_9-92.pdf
- ² Energy Performance of Buildings Data: England and Wales (2021) Ministry of Housing, Communities & Local Government. Available at: <https://epc.opendatacommunities.org/>
- ³ The Government's Standard Assessment Procedure for Energy Rating of Dwellings (2018) BRE. Available at: https://files.bregroup.com/SAP/SAP-10.0_24-07-2018.pdf
- ⁴ Data tables 1 to 19: supporting the toolkit and the guidance (2021) Department for Business, Energy & Industrial Strategy. Available at: <https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal>
- ⁵ A technical analysis of FTT:Heat - A simulation model for technological change in the residential heating sector (2017) F. Knobloch, et al. Available at: https://ec.europa.eu/energy/sites/ener/files/documents/technical_analysis_residential_heat.pdf
- ⁶ Analysis on abating direct emissions from 'hard-to-decarbonise' homes, with a view to informing the UK's long term targets (2019) S. Foster, et al. <https://www.theccc.org.uk/publication/analysis-on-abating-direct-emissions-from-hard-to-decarbonise-homes-element-energy-ucl/>
- ⁷ THE ROUGH GUIDE to Community energy (2011) D. Clark, M. Chadwick. Available at: <https://www.bre.co.uk/filelibrary/nsc/Documents%20Library/Not%20for%20Profits/Rough-Guide-to-Community-Energy.pdf>
- ⁸ Annual Fuel Poverty Statistics in England, 2021 (2019 data) (2021) Department for Business, Energy and Industrial Strategy. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/966509/Annual_Fuel_Poverty_Statistics_LILEE_Report_2021_2019_data_.pdf (publishing.service.gov.uk)
- ⁹ Consultation stage Impact Assessment ECO4 (2021) Department for Business, Energy and Industrial Strategy. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1003740/eco4-consultation-stage-impact-assessment.pdf
- ¹⁰ CAR Domestic Cost Assumptions – Summary Tables 190716 (2016) Cambridge Architectural Research Ltd. Available at: <https://www.gov.uk/government/publications/domestic-cost-assumptions-what-does-it-cost-to-retrofit-homes>
- ¹¹ *English Housing Survey 2019 to 2020: energy* (2021) Ministry of Housing, Communities and Local Government. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1000780/Energy_Chapter_3_Annex_Tables_v2.ods
- ¹² English Housing Survey Technical Report, 2019-20 (2021) Ministry of Housing, Communities & Local Government. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1000123/2019-20_EHS_Technical_Report_-_Final_Ch_1-7.pdf

¹³ Fuel Poverty: a Framework for Future Action (2013) Department of Energy and Climate Change. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/211180/FuelPovFramework.pdf

¹⁴ Toolkit for valuing changes in greenhouse gas emissions (2021) Department for Business, Energy and Industrial Strategy. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/873679/toolkit-for-valuing-changes-greenhouse-gas-emissions.xlsm

¹⁵ Valuation of greenhouse gas emissions: for policy appraisal and evaluation (2021) Department for Business, Energy and Industrial Strategy. Available at: <https://www.gov.uk/government/publications/valuing-greenhouse-gas-emissions-in-policy-appraisal/valuation-of-greenhouse-gas-emissions-for-policy-appraisal-and-evaluation>