Meeting the proposed fuel poverty targets

Modelling the implications of the proposed fuel poverty targets using the National Household Model

Report for the Committee on Climate Change

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Executive Summary

In July 2014 DECC published a consultation document on its new Fuel Poverty Strategy for England: "Cutting the cost of keeping warm"[1].

It includes proposals for a legal obligation for as many fuel poor homes as "reasonably practicable" to be raised to a Band C energy efficiency rating by 2030, with interim targets for improving as many fuel poor homes (as reasonably practicable) to Band E by 2020 and Band D by 2025.

Previous work undertaken by the Centre for Sustainable Energy (CSE) for the Committee on Climate Change (CCC) used DECC's National Household Model (NHM) to explore the implications for fuel poverty to 2030 of meeting the fourth carbon budget[2].

Building on this previous work and in light of the Government's Fuel Poverty Strategy consultation, the CCC commissioned CSE to undertake some additional modelling and analysis using the NHM to explore the implications of meeting the new proposed fuel poverty targets.

Method and summary of scenarios modelled

The aim of this research was therefore to:

- Model the proposed fuel poverty targets and interim milestones in England, as set out in the Government's Fuel Poverty Strategy consultation document 2014 (achieving energy efficiency rating Band E by 2020 in all fuel poor homes; Band D by 2025 and Band C by 2030).
- Model a more stringent 'stretch' target to achieve an energy efficiency rating of B in all fuel poor homes by 2030 (with interim targets of D by 2020 and C by 2025).
- Compare the results in terms of impacts on fuel poverty and energy efficiency ratings, and measures needed to meet the targets with the results from the previous work modelling the impact on fuel poverty of the CCC's measures specified in its fourth carbon budget projections to 2030.

Four scenarios were modelled using the NHM as follows:

1) Scenario 1: Achieving the proposed (interim and final) fuel poverty targets at lowest cost.
2) Scenario 2: Going beyond the target: achieving an energy efficiency rating of B by 2030 (with interim targets of Band D by 2020 and C by 2025).
3) Scenario 3: Impact on energy efficiency ratings of simulating the deployment of the CCC 4th carbon budget measures to 2030, with measures distributed at 'random' across the housing stock.

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[1] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/335099/fuel_poverty_consultation.pdf
[2] CSE, 2014. Research on fuel poverty. The implications of meeting the fourth carbon budget. Report to the Committee on Climate Change, November 2014.

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4) Scenario 4: Impact on energy efficiency ratings of simulating the deployment of the CCC 4th carbon budget measures to 2030, with measures targeted at LIHC fuel poor households specifically.

All the modelling and analysis in this study applies to England and the 'Low Income, High Cost' (LIHC) definition of fuel poverty only (consistent with the proposed targets).

The analysis has not sought to explore in any depth what may constitute "reasonably practicable". The model has been programmed to select measures that will achieve the minimum energy efficiency rating on a lowest present cost basis (which takes account of the capital cost of measures and fuel bill savings over the next 5 years). The limitations associated with the inclusion of the term "reasonably practicable" in any fuel poverty strategy are discussed further in the report.

Summary Results

Costs

The results of simulating a scenario using the NHM to identify measures needed to meet the Government's proposed fuel poverty targets to 2030 suggest that a total investment of around £18 billion is needed in some 10.4 million measures (Table A). This includes modelling to identify measures needed to meet each of the interim milestones (2020 and 2025) and the final 2030 target. The average cost per dwelling increases with the targets (from around £3,400 to achieve the 2020 target to £5,800 per dwelling to meet the 2030 target), as does the number of dwellings requiring over £10,000 of investment. This reflects the mix of measures needed to ensure that the increasingly higher standards of energy efficiency are met. In reality, additional factors will further impact on fuel poverty, such as fluctuations in income or changes in occupancy characteristics. Therefore, the costs presented here are likely to be minimum estimates.

Table A. Meeting the proposed fuel poverty target: summary of costs

	2020 Min. Band E	2025 Min. Band D	2030 Min. Band C	Total to 2030
Total measures	1,743,900	4,240,800	4,414,600	*10,399,300*
Total dwellings[a]	487,900	1,552,100	1,939,400	*3,979,400*[c]
Total costs (£bn)	£1.67	£5.10	£11.24	*£18.01*
Average cost per dwelling	£3,420	£3,290	£5,800	*£4,530*
Average annual cost (£m)[b]	£334	£1,021	£2,248	*£1,201*
Dwellings costing >£10k	47,100	165,600	345,500	*558,200*

Table notes:
a) The total dwellings represents the number of households that fit the target criteria in each year (e.g. for the proposed target: fuel poor and below Band E in 2020, fuel poor and below Band D in 2025 and fuel poor and below Band C in 2030).
b) The average annual costs assume the total cost is spread over a 5 year period (e.g. 2015-2020; 2020-2025; 2025-2030).
c) The total dwellings receiving measures over the lifetime of the scenario. This does not represent unique properties, as some households fit the target criteria in more than one target year.

Extending the target to achieve a minimum energy efficiency rating of B in fuel poor households in 2030 requires an additional (compared to the proposed target) £6.45 billion investment in some 12 million measures (Table B). The average cost peaks in the interim 2025 target of achieving a minimum of Band C in all fuel poor dwellings.

Table B. Meeting the proposed fuel poverty target: summary of costs

|	2020 Min. Band D	2025 Min. Band C	2030 Min. Band B	Total to 2030
Total measures	5,900,900	4,470,900	1,698,200	12,070,000
Total dwellings[a]	1,727,600	1,937,100	1,219,700	4,884,400
Total costs (£bn)	£6.83	£11.16	£6.47	£24.46
Average cost per dwelling	£3,950	£5,760	£5,300	£5,010
Average annual cost (£m)[b]	£1,366	£2,233	£1,293	£1,631
Dwellings costing >£10k	236,100	344,200	256,800	837,100

Table notes: As per Table A.

Impact on energy efficiency ratings and fuel poverty

The average energy efficiency rating of fuel poor homes in 2013 is estimated to be Band E (SAP score of 48). As a result of simulating measures to meet the Government's proposed fuel poverty targets (where possible), the average energy efficiency rating of the _remaining_ fuel poor in 2030 is substantially higher at Band C (72); and the overall number of fuel poor households is reduced to some 950,000 (4%, Table C).

Extending the target to achieve a minimum Band B in all fuel poor homes by 2030 results in fewer remaining fuel poor households (810,000), who have a slightly higher average SAP rating of 74 (still Band C). Whilst 38% of the remaining fuel poor in this scenario achieve the target minimum energy efficiency rating (Band B, SAP 81 or higher), the majority fall short of this (Figure A). This suggests there may be a 'problem' group of dwellings that are difficult to treat with the measures available in the model.

Table C. Implications for fuel poor households in 2030 of meeting the proposed and 'stretch' fuel poverty targets

	2013 baseline	Proposed target Min. C by 2030	Extended target Min. B by 2030
LIHC fuel poor count (m)	2.51	0.95	0.81
% of households LIHC fuel poor	12%	4.4%	3.8%
Mean Gap	_£648_	_£545_	_£560_
Aggregate Gap (£m)	£1,625	£518	£452
Average SAP (of LIHC fuel poor)	48	72	74
Average energy bill (of LIHC fuel poor)	_£2,113_	_£2,019_	_£1,990_

Figure A. Distribution of fuel poor households by energy efficiency rating Band in 2030 under different scenarios
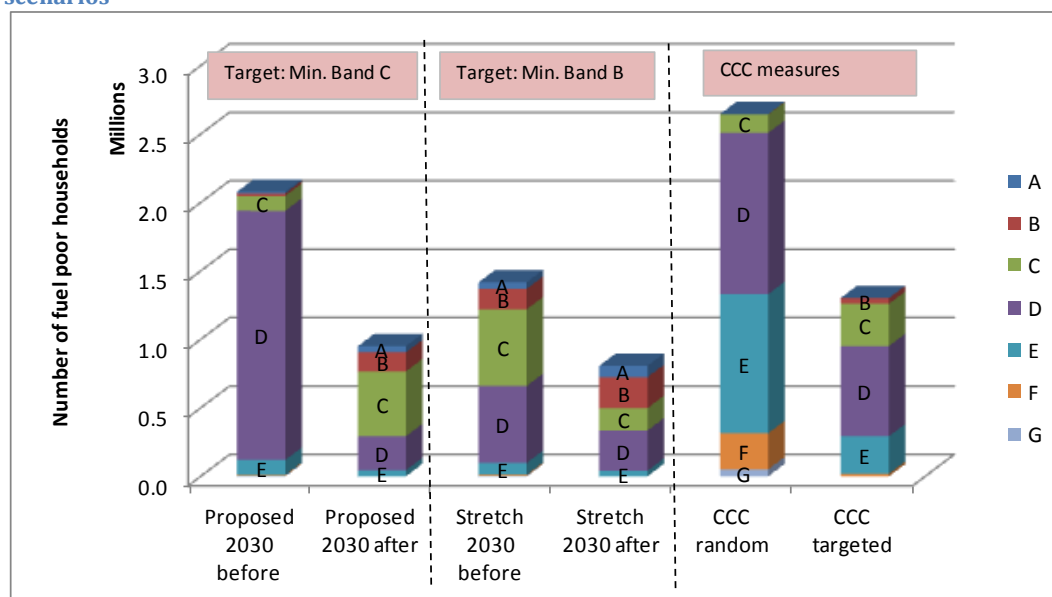
Understanding the implications for the fuel poverty gap

The total fuel poor 'head count' is substantially reduced as a result of simulating measures to meet the Government's proposed fuel poverty targets (and the modelled 'stretch' target), and as a result, the aggregate fuel poverty gap also appears substantially lower in both scenarios compared to the baseline estimate (Table C). The impact on the average fuel poverty gap does not appear quite so stark however (and in fact the average gap appears slightly higher under the 'stretch' fuel poverty target scenario, despite a higher energy efficiency rating being achieved in this scenario). These (slightly misleading) figures are a consequence of the nature of the 'gap' and how it is measured. The fuel poverty gap is a metric applicable only to households in fuel poverty. As a large number of households are lifted out of fuel poverty in these scenarios, the gap figure refers to two quite different subsets of the population.

Table D more clearly shows the impact of the proposed fuel poverty targets on fuel bills and average fuel poverty gap for consistent, discrete subsets of the population. For example, for the 950,000 households that are fuel poor both before and after the simulation of measures, the gap (and required fuel bills) is substantially reduced, from around £830 in 2030 pre-measures, to £545 after (a reduction of over £275). Prior to measures, the average gap of this group appears notably higher (by almost £400) than the average gap for the fuel poor population as a whole (£829 compared to £465). This suggests that these (remaining) fuel poor represent some of the most severely fuel poor households and hence the application of measures and improvements in their SAP rating are insufficient to lift them out of fuel poverty. The average income of this group is over £600 lower than the average income of the whole fuel poor population before measures and of the targeted group of households, suggesting income is an important driving factor in their fuel poverty status.

Table D. Impact on fuel bills and fuel poverty gap in 2030 of achieving the proposed fuel poverty target

|	Count	% Targeted[a]	Average fuel bill		Mean fuel poverty gap[b]		Mean equivalised income
			'Before'	'After'	'Before'	'After'	
Targeted fuel poor households	1,939,400	100%	£1,950	£1,579	£450	*£66*	£8,185
All fuel poor before	2,077,600	93%	£1,962	£1,616	£465	*£107*	£8,147
Remaining fuel poor 'after'	949,800	85%	£2,297	£2,019	£829	£545	£7,575

Table notes:

a) This is the proportion of households that fit the target criteria for the 'stretch' 2030 target and were therefore targeted with measures in the scenario; i.e. fuel poor in 2030 and living in a dwelling below energy efficiency Band C.

b) The fuel poverty gap only applies to fuel poor households. The figures greyed out indicate a group of households not all of whom are fuel poor.

Measures needed to meet the targets

Figure B shows the total (cumulative to 2030) count of the main measures identified in modelling the proposed and 'stretch' fuel poverty targets in the NHM, compared to the number of each measure in the CCC's projections for meeting the fourth carbon budget (Annex I provides a full and detailed comparison of all measure counts). Whilst the CCC's trajectory exceeds both the proposed and 'stretch' fuel poverty target estimates (by some margin on most measures) the potential for these measures to alleviate fuel poverty is dependent on how these measures are targeted (i.e. measures reaching the fuel poor) and paid for.

Figure B. Main measures identified in the modelling to meet the proposed and 'stretch' fuel poverty targets as a proportion of the total count in the CCC's fourth carbon budget projections
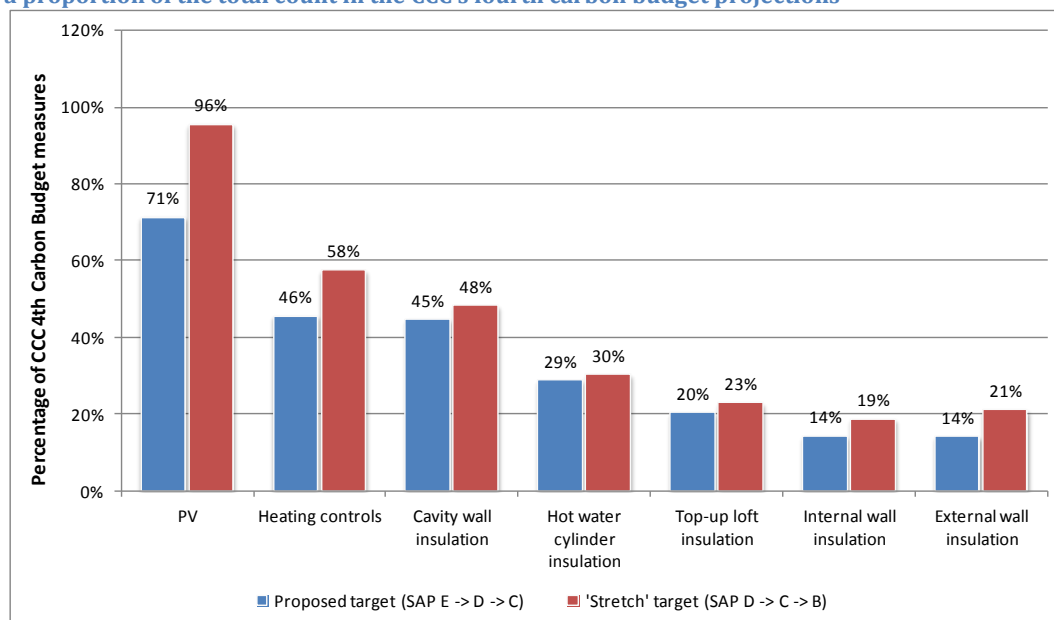
Overall, the fuel poor represents approximately 12% of the population in 2013 whilst approximately 19% of the total measures from the CCC's fourth carbon budget projected mix are required to meet the fuel poverty targets to 2030. In particular, the modelling suggests that the majority of the solar PV identified in the CCCs projections will have to be installed in fuel poor homes to achieve the

proposed targets. In addition, cavity wall insulation, internal and external solid wall insulation, top-up loft insulation and heating controls feature highly in the requirements for meeting the proposed fuel poverty targets. The results highlight and provide further evidence of the need to ensure fuel poor households are targeted with measures to fully insulate and 'future-proof' their homes.

Discussion and modelling caveats

This research employs one particular modelling tool and a number of assumptions and inputs, all of which have implications for the results (including the mix of measures identified for meeting the targets, costs of investment and impact on fuel poverty). Two important caveats to note include:

- The costs included in the modelling reflect estimated capital costs of measures (at the time of the research) only. There are a number of additional costs associated with delivering an effective energy efficiency and fuel poverty alleviation programme, such as administrative and search costs (finding target households). These can be significant. Similarly, the costs do not allow for any potential 'economies of scale' or price reductions over time.

- No costs of measures have been passed on to consumers. In effect the scenarios assume therefore that there is a state-funded scheme in place to support the installation of measures needed to meet the proposed fuel poverty targets. Based on the scale of intervention and national infrastructure required to improve the conditions of fuel poor households, it seems likely that some state funding will be required to meet the proposed targets. However, the recent pattern of energy policy is converse to this, with policy costs increasingly being passed on to consumers through electricity and gas bills. If this is the case, fuel poverty levels would likely appear worse than those presented here.

Conclusion

The results from modelling the potential to meet the Government's proposed fuel poverty targets using the NHM identifies some 10.4 million measures, at a total (cumulative) cost to 2030 of over £18 billion. Whilst the average energy efficiency rating of the fuel poor in 2030 is increased in line with the proposed target (Band C), nearly 300,000 fuel poor households remain in properties below this threshold.

Over the lifetime of the scenario used in this study some 2.7 million different (unique) dwellings are targeted with measures by 2030 (Table E). Of these, however, a number receive measures in more than one target year. This is a consequence of the tiered structure of the proposed targets. Targeting the fuel poor in the least energy efficient homes first makes sense. However, the low initial proposed target of Band E means that the improvements are insufficient to lift a number of homes out of fuel poverty. These dwellings therefore remain both fuel poor and below the second interim target of a minimum energy efficiency rating of Band D. Hence these households have to be targeted again to ensure the 2025 target is met. Similarly, achieving the minimum Band D does not guarantee a dwelling will not find itself still in fuel poverty in 2030, and hence could potentially be targeted a third time for the final 2030 target.

As Table E shows, for the proposed target, a third of all fuel poor homes are targeted twice, either in consecutive target years or non-consecutive target years (i.e. 2020 and 2030). A further 6% (172,000 households) are targeted with measures in all three target years. This 'repeat targeting' is exaggerated in the 'stretch' 2030 target which sees over 450,000 dwellings being targeted with measures in all three target years.

Table E: Number of households repeatedly targeted

	Proposed Target (EPC E-D-C)		Extended Target (EPC D-C-B)	
	Count	%	Count	%
one year only	*1,662,800*	*61%*	*1,562,300*	*52%*
two consecutive years	**828,800**	**30%**	**781,600**	**26%**
two non-consecutive years	**72,100**	**3%**	**196,300**	**7%**
all three years	**171,600**	**6%**	**455,500**	**15%**
Total targeted more than once	*1,072,600*	*39%*	*1,433,400*	*48%*
total unique dwellings	*2,735,300*	*100%*	*2,995,600*	*100%*

These results highlight the potential inefficiency of the tiered approach to improving the housing stock. This level of repeat targeting has important implications in terms of the added costs associated with getting measures into target households (e.g. finding the eligible households, assessing what work is needed, convincing them to take up the measures, undertaking the work, 'hassle' costs to the household etc).

The results from the modelling applied here suggest over 1 million dwellings would need visiting more than once to meet the interim and proposed fuel poverty targets, with 170,000 receiving three sets of interventions (i.e. in each of the proposed target periods). What would seem a far more effective approach (economically, socially and environmentally) would be to drop the interim lower energy efficiency targets and go straight to achieving a higher rating in targeted dwellings. Therefore whilst the worst rated properties could still be targeted first these dwellings should be improved to a minimum energy efficiency rating of (at least) Band C straight away.

The implications of adopting this 'straight to Band C' approach, in terms of measures needed, costs and impact on fuel poverty levels are not conclusive from the scenarios modelled here. Additional research is needed to simulate a scenario in which fuel poor households are targeted to achieve a minimum energy efficiency rating of Band C straight away, without the interim, staggered targets. However, the results shown here from modelling the proposed fuel poverty targets and an additional 'stretch' target do indicate that whilst the costs of achieving a higher level of energy efficiency may be initially higher, in the longer term this should represent a more cost-effective approach, with avoided costs associated with repeat targeting and getting measures into target households. Improving the energy efficiency of these dwellings to a minimum of C would also offer these households (and future occupants) greater protection from rising energy costs (fuel poverty 'future proofing'). In addition to amending the approach to delivery, a new fuel poverty strategy should encompass a workable definition of 'reasonably practicable that looks beyond costs to include consideration of the wider benefits associated with ensuring affordable warmth and healthy living environments.

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1   Introduction

1.1   Background

In July 2014 DECC published a consultation document on its new Fuel Poverty Strategy for England: "Cutting the cost of keeping warm"[3].

It includes proposals for a legal obligation for as many fuel poor homes as "reasonably practicable" to be raised to a Band C energy efficiency rating by 2030, with interim targets for improving as many fuel poor homes as reasonably practicable to Band E by 2020 and Band D by 2025.

Previous modelling and analysis by the Centre for Sustainable Energy (CSE) for the Committee on Climate Change (CCC) explored the implications for fuel poverty to 2030 of meeting the fourth carbon budget[4]. This modelling used DECC's National Household Model (NHM) to simulate fuel price rises and the deployment of energy efficiency and low carbon heating measures across the UK housing stock to 2030, according to the CCC's projections of measures needed to deliver emissions savings in the residential sector. The results showed that, with effective targeting and appropriate policy design, these measures could go some way towards alleviating fuel poverty, without adversely affecting the emissions reductions achieved.

Building on this existing work and in light of the Fuel Poverty Strategy consultation, the CCC commissioned CSE to undertake some additional modelling and analysis using the NHM to explore the implications of meeting the new proposed fuel poverty targets.

1.2   Research aims, objectives and outputs

1.2.1   Aim

The aim of this research is to use the NHM to explore:

- The implications of meeting the proposed fuel poverty targets and interim milestones in England, as set out in the Government's Fuel Poverty Strategy Consultation document 2014 (achieving a minimum energy efficiency rating in all fuel poor homes of Band E by 2020; Band D by 2025 and Band C by 2030).

- The implications of setting more stringent ('stretch') targets to achieve a minimum energy efficiency rating of B in all fuel poor homes by 2030, with interim targets of D by 2020 and C by 2025.

- The potential for measures identified by the CCC as necessary to meet the fourth carbon budget in the residential sector to help deliver the fuel poverty targets.

1.2.2   Objectives

This research uses the NHM to model the potential implications of meeting the Government's proposed fuel poverty targets, and a 'stretch' fuel poverty target in England, including quantification and analysis of:

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[3] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/335099/fuel_poverty_consultation.pdf
[4] CSE, 2014. Research on fuel poverty. The implications of meeting the fourth carbon budget. Report to the Committee on Climate Change, November 2014.

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(i). The number of fuel poor households that fit the fuel poverty target criteria in each of the interim target years (2020 and 2025) and in 2030;

(ii). The measures (number, types and costs) needed to meet the interim milestones and overall target;

(iii). The impact of these measures on fuel poverty status and energy efficiency ratings.

Additional scenarios and analysis were implemented to explore:

- The impact on energy efficiency ratings of fuel poor households in 2020, 2025 and 2030 of simulating the CCC's projections of measures needed to meet the fourth carbon budget, where measures are installed at random across the UK housing stock;
- The impact on energy efficiency ratings of fuel poor households in 2020, 2025 and 2030 of simulating the CCC's projections of measures needed to meet the fourth carbon budget, where measures are targeted at the LIHC fuel poor.

1.2.3   Outputs

For all scenarios, a summary report is generated using the NHM. These have been provided to the CCC in an Excel spreadsheet to show:

- The overall impact on fuel poverty rates, the average and aggregate fuel poverty gap and energy efficiency ratings for England;
- Fuel poverty rates and energy efficiency ratings by different household types[5].

All the modelling and analysis in this study applies to England and the 'Low Income, High Cost' (LIHC) definition of fuel poverty only (consistent with the proposed targets).

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[5] Consistent with analysis undertaken in the previous research for the CCC, results are presented for different household types, including rural; electrically-heated, oil-heated and bottled-gas heated; pre-1919 dwellings; purpose-built flats; and prepayment meter households.

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2   Method

This research utilises existing tools and functionality available in the NHM, supplemented with some further developments, including bespoke reporting outputs and newly created modelling scenarios. For more information about the NHM, see Annex III.

2.1   Modelling the proposed fuel poverty targets in the NHM

As part of the proposed new fuel poverty targets, DECC have developed a specific methodology for calculating the energy efficiency of fuel poor households for the purpose of measuring progress against the target. The new 'Fuel Poverty Energy Efficiency Rating' (FPEER) is based on the Standard Assessment Procedure (SAP), but with adjustments to reflect energy bill interventions that would not currently be reflected in SAP but directly affect the cost of energy. At present, two policies - namely the Warm Home Discount (WHD)[6] and Government Electricity Rebate (GER)[7] – are relevant in assessing the FPEER.

The NHM is already programmed to calculate the SAP rating for every dwelling in the housing stock dataset. Calculating the FPEER simply requires deducting the value of any direct energy cost interventions (in this case the WHD and/or GER as appropriate) from these modelled fuel cost values (calculated using SAP methodology) to give new modelled energy costs for the house. These energy costs are then adjusted for floor area as per the SAP methodology to generate an index (1-100) which is used in generating the energy efficiency rating[8].

2.2   Scenarios

As outlined in the research objectives, this study involves simulating a number of different scenarios in the NHM to explore the implications of meeting the proposed fuel poverty targets; an extended 'stretch' target; and the impact of the CCC's projected measures on energy efficiency ratings of fuel poor households.

Each of these scenarios is described in more detail below.

Scenario 1: Achieving the proposed (interim and final) fuel poverty targets at lowest cost

A new scenario was written in the NHM for the purpose of this research to explore the mix of measures that may be needed to meet the proposed fuel poverty targets in England.

The scenario identifies the LIHC fuel poor living in dwellings below the target energy efficiency threshold in 2020, 2025 and 2030 respectively (see Table 2.1). The model then selects measures that will increase the energy efficiency rating of the dwelling to the target for that year. Measures are

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[6] The Warm Home Discount delivers support to over 2 million households per year, mainly in the form of direct monetary discounts on the electricity bills of low income households in or at risk of fuel poverty.

[7] The Government Electricity Rebate scheme was proposed in 2013 as part of the Government's package of measures to reduce household energy bills by £50 on average over the following two years. The GER was proposed to run for a two year period over 2014/15 and 2015/16, providing a £12 rebate to all domestic electricity account holders in Great Britain.

[8] For full details on the FPEER methodology, see: DECC, 2014. Fuel Poverty Energy Efficiency Rating Methodology. Available at:
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/332236/fpeer_methodology.pdf

selected from a pre-defined list and on a 'cost-effective' basis, defined according to the least net present cost calculation (see Box 2.1).

If a dwelling cannot achieve the minimum energy efficiency target with the measures available in the model, measures will be chosen to achieve the greatest increase in rating possible, again with the most cost-effective solution(s) being selected.

Scenario 2: Going beyond the target: achieving an energy efficiency rating of B by 2030 (with interim targets of Band D by 2020 and C by 2025)

A second new scenario was constructed exactly as above but with the target energy efficiency set at achieving a minimum in LIHC fuel poor households equivalent to: Band D by 2020; Band C by 2025; Band B by 2030.

This scenario therefore shows the implications for fuel poverty of a setting a higher target than is currently proposed and provides an indication of the mix of measures needed to achieve this.

Table 2.1. Proposed target energy efficiency ratings for fuel poor households modelled

SAP rating and FPEER

The proposed 2030 target and interim milestones in the Government's Fuel Poverty Strategy consultation document (2014) are intended to work with the FPEER, rather than SAP score for assessing the energy efficiency rating. The modelling implemented here includes calculation of the FPEER. However, at present the only policies that impact on the FPEER do not extend to the period of the proposed target or interim milestones (both the WHD and GER are due to end in 2015/16). No assumptions have been made about policies offering rebates on energy bills in the future, hence beyond 2016 the SAP rating and FPEER are identical. For simplicity, the "SAP score" is therefore referenced in the results and analysis.

		EPC Rating	SAP Score	
		A	92 plus	
		B	*81 – 91*	⇦ *2030 target*
DECC proposed targets ('Scenario 1')	2030 ⇨	**C**	**69 – 80**	⇦ *2025 target*
	2025 ⇨	**D**	**55 – 68**	⇦ *2020 target*
	2020 ⇨	**E**	**39 – 54**	
		F	21 – 38	
		G	1 – 20	

Stretch target ('Scenario 2') (brace spanning 2030, 2025, 2020 target rows)

Box 2.1. NHM scenario: meeting the proposed fuel poverty targets

The key stages and assumptions applied in modelling the proposed fuel poverty targets and an extended target in the NHM are outlined below.

Stage 1. Identifying the target households

At the start of each target year (2020, 2025 & 2030) for every dwelling in the NHM England housing stock dataset the model calculates:

- Fuel poverty status under the LIHC definition
- FPEER and SAP rating of the dwelling

The LIHC fuel poor in dwellings below the target energy efficiency threshold for that year are then targeted with measures to increase the FPEER (SAP) rating to the minimum requirement as follows:

Stage 2. Identifying measures to meet the minimum energy efficiency threshold

- For each targeted household, the model simulates the application of measures chosen from over 10,750 different combinations[9] (packages) consisting of:
  - Wall insulation (at most one of CWI, External SWI, Internal SWI); and
  - Floor insulation (at most one of solid floor insulation or timber insulation); and
  - Heating system (at most one of a gas boiler, oil boiler, storage heater, biomass boiler, ASHP or GSHP); and
  - Optionally loft insulation top-up to 270mm; and
  - Optionally double glazing; and
  - Optionally low-energy lighting; and
  - Optionally a PV panel[10]; and
  - Optionally draught stripping to 100%; and
  - Optionally a time, temperature zone control and TRVs; and
  - Optionally hot water tank insulation

Stage 3. Selecting measures

- From all the possible (combinations of) measures identified by the model that improve the FPEER (SAP) to be greater than or equal to the target threshold for that year, the package which has the <u>minimum present cost</u> is selected (see Box 2.2 below).

- If no package of measures improves the FPEER (SAP) to be greater than or equal to the target threshold (i.e. the target cannot be met with the measures available in the model), then the package which maximises the energy efficiency rating (gets as close to the target as is possible) is selected, again choosing the most cost-effective approach.

- Once a measure or package of measures has been selected, the physical characteristics of the dwelling are adjusted accordingly. The required spend on energy is recalculated to take account of these improvements and identify whether the household now has energy costs below the LIHC threshold – i.e. whether the household is lifted out of fuel poverty as a result of improvements in its SAP score. At this stage the 'high cost' threshold is not adjusted to reflect the change in the national median fuel cost. This adjustment is made in the next year (and all future years) of the simulation however, hence fuel poverty status of any one dwelling can continually shift as fuel prices change over time and some households receive improvement measures.

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[9] A house can only receive each measure once during the entire simulation.

[10] In the absence of sufficiently detailed data on roof orientation, it is assumed that 60% of the housing stock is suitable for PV.

Box 2.2. Calculating lowest present cost and what is 'reasonably practicable'?

The present cost is calculated to take account of the capital cost of the measure(s) and future energy bills (allowing for the impact of these measures), discounted at 10% over a 5 year period. Future bills are calculated using the current simulation year fuel prices (thereby assuming the household cannot predict future fuel price changes).

Selecting measures: a worked example

Example 1 – least cost package of measures selected

Dwelling A is fuel poor and has a current SAP score of 30.

It is targeted in the first interim fuel poverty target year to receive measures that will bring it up to a minimum of Band E (SAP score of 39).

The model tries all possible combinations of packages and identifies two that will achieve the minimum SAP score. Of these, Package 2 has the lowest present cost. This package is therefore selected.

	Now/ Do nothing	Package 1	Package 2	Package 3
Capital costs of package [C]	£0	£100	£1,000	£200
Annual fuel costs with measures [F]	£1,000	£900	£500	£950
Present cost*	£3,685	£3,417	£2,843	£3,701
Current SAP	30	30	30	30
Attainable SAP with measures	30	38	40	41
Package considered?	No - doesn't achieve min. SAP target but other options do	No - doesn't achieve min. SAP target but other options do	Yes	Yes
Winning option	✘	✘	✔	✘

* This is the sum of the capital cost of measures and the annual household fuel costs over the next 5 years discounted at a rate of 10%:
[Present cost = (F*0.9) + (F*(0.9^2)) + (F*(0.9^3)) + (F*(0.9^4)) + (F*(0.9^5)) + C]

Example 2 – 'maximum SAP' package of measures selected

Dwelling B is also fuel poor and has a current SAP score of 30.

It is targeted in the first interim fuel poverty target year to receive measures that will bring it up to a minimum of Band E (SAP score of 39).

The model tries all possible combinations of packages but none will achieve the minimum SAP score.

Of the options identified, the Package that delivers the greatest SAP score – Package 3 - is selected.

	Now/ Do nothing	Package 1	Package 2	Package 3
Capital costs of package [C]	£0	£100	£1,000	£200
Annual fuel costs with measures [F]	£1,000	£900	£500	£950
Present cost	£3,686	£3,417	£2,843	£3,701
Current SAP	30	30	30	30
Attainable SAP with measures	30	32	34	38
Package considered?	Yes	Yes	Yes	Yes
Winning option	✘	✘	✘	✔

Implications of the present value calculation: what is 'reasonably practicable'?

The discount rate applied in this modelling is relatively high at 10% and the impact on future energy bills has only been considered over a 5 year period. This approach biases (places greater relative emphasis on) the capital costs of the measures, rather than future energy bills in selecting measures. Changing these parameters will therefore affect the mix of measures identified to meet the targets.

In the absence of any clear definition of what is "reasonably practicable", this approach could arguably be considered so, particularly from the householder's point of view (i.e. they give less consideration to future energy bills and care more about capital outlay in the present).

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Scenario 3: Impact on energy efficiency ratings of simulating the deployment of the CCC 4th carbon budget measures at '<u>random</u>' across the housing stock

This scenario was developed as part of a previous research study for the CCC that sought to model the implications for fuel poverty to 2030 of meeting the fourth carbon budget.

The CCC has its own assumptions and projections of measures considered necessary to deliver the emissions savings in the UK residential sector to meet the fourth carbon budget. A scenario was constructed in the NHM to simulate the deployment of these measures to 2030 across the UK housing stock 'at random'. In this scenario there is no targeting or enforced criteria determining which households receive measures (beyond certain physical property constraints). The random allocation therefore means that some fuel poor households will receive measures and hence some changes in fuel poverty levels are evident.

The scenario was modified for the purpose of this research to be consistent with the methodology applied in modelling the proposed new fuel poverty targets (see Box 2.3 for information on the implications of these changes) and with the addition of new reporting outputs to show the average SAP rating and FPEER for the LIHC fuel poor in England in the baseline year (2013) and for 2020, 2025 and 2030.

Scenario 4: Impact on energy efficiency ratings of simulating the deployment of the CCC 4th carbon budget measures <u>targeted at LIHC fuel poor households</u>

As above, this scenario was developed as part of the previous work for the CCC, modelling the impact of meeting the fourth carbon budget on fuel poverty to 2030. This scenario uses the same projections of measures as specified in the CCC's timeseries for meeting the fourth carbon budget, but simulates deployment across the UK housing stock on a 'targeted' basis. The scenario identifies LIHC fuel poor households in every year of the simulation and prioritises allocation of measures that will deliver the greatest reduction in fuel bill to these households. Any measures remaining are then distributed at random across the rest of the housing stock.

As with the 'random allocation' scenario, this scenario was modified for the purpose of this research to be consistent with the methodology applied in modelling the proposed new fuel poverty targets and with the addition of new reporting outputs to show the average SAP rating and FPEER for the LIHC fuel poor in England in the baseline year (2013) and for 2020, 2025 and 2030.

Box 2.3.Modelling and comparability of NHM outputs

This research study builds on previous work by CSE for the CCC that modelled the impact of meeting the fourth carbon budget on fuel poverty to 2030. The previous study used the NHM to develop a number of different scenarios to simulate the deployment of measures as specified in the CCC's timeseries to 2030 for meeting the fourth carbon budget in the residential sector. Two of these scenarios have been used again as part of this research but with some modifications and developments to some of the underlying methods to align with those needed to model the proposed new fuel poverty targets. (For example, the previous study used SAP2009 methodology whilst the proposed new targets specify SAP2012). These modifications are such that the outputs presented here will not be entirely consistent with those in the previous project.

3   Results

The results from the two scenarios modelling the implications of the proposed and an extended 'stretch' fuel poverty target, as simulated using the National Household Model, are summarised below. This includes simulations to model:

1. **The proposed fuel poverty targets** as set out in the Government's Fuel Poverty Strategy Consultation document (2014[11]) to ensure that: *as many fuel poor households as is reasonably practicable achieve a minimum energy efficiency standard of Band C by 2030, with interim milestones of achieving Band E by 2020 and Band D by 2025*.
2. **An alternative, 'stretch' target**: to achieve a minimum energy efficiency standard in fuel poor households of Band B by 2030, with interim milestones of achieving Band D by 2020 and Band C by 2025.

Results from the simulations of the CCC's fourth carbon budget measures projections are also shown where relevant for comparison.

3.1   Achieving a 2020 interim target

3.1.1   Targeted households

Modelling fuel poverty to 2020 (in the absence of any energy efficiency improvements to the housing stock[12], but with expected fuel price increases applied[13]) results in an estimated 2.6 million households being classed as LIHC fuel poor in 2020, with an average fuel poverty gap of £717 and a total, aggregate gap of over £1.86 billion (Table 3.1).

Table 3.1. Fuel poverty in England in 2013 and 2020

	2013 baseline	2020
LIHC fuel poor count (m)	2.5	2.59
% of households LIHC fuel poor	11.7%	12.1%
Mean Gap	£648	£717
Aggregate Gap (£m)	£1,625	£1,859
Average SAP (of LIHC fuel poor)	48	48
Average annual fuel costs (of LIHC households)	£2,113	£2,320

Of the 2.6 million households estimated to be fuel poor in 2020, around 19% (488,000) are in the target EPC Bands (F and G-rated dwellings) for the 2020 proposed interim fuel poverty target (Table 3.2). Extending the target to achieve a minimum of Band D by 2020 encompasses far more fuel poor households, as almost half are in Band E (Table 3.3). In total, some 67% of the estimated fuel poor population in 2020 live in E, F or G-rated dwellings.

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[11] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/335099/fuel_poverty_consultation.pdf

[12] This represents a 'counterfactual' scenario in which it is assumed no improvements are made to the housing stock beyond the baseline year, which is 2013 in this study. It does not therefore implement any existing policies, some of which are expected to deliver measures over the timeframe of the scenarios (e.g. Green Deal and ECO).

[13] Fuel price projections are consistent with the CCC's to 2030.

Table 3.2. Households targeted in 2020 under the proposed and 'stretch' fuel poverty targets

Target	Targeted households	Number of households	% of total fuel poor households
Proposed target: *E by 2020*	**Fuel poor in F & G in 2020**	487,900	19%
Stretch target: *D by 2020*	**Fuel poor in E, F & G in 2020**	1,727,600	67%

Table 3.3. Estimated distribution of the LIHC fuel poor households in 2020 by EPC Band

EPC Band	Distribution of LIHC fuel poor in 2020
A 92 plus	0%
B 81 – 91	0%
C 69 – 80	1%
D 55 – 68	32%
E 39 – 54	48%
F 21 – 38	14%
G 1 – 20	5%
Count	*2,590,000*

Table notes: Results are based on future projections of fuel poverty derived from the National Household Model. Fuel prices are based on the CCC's projections to 2030. The modelling assumes no further improvements are made to the housing stock from the 2013 baseline.

3.1.2   Investment and measures needed to achieve a 2020 target

Scenarios were simulated in the NHM to identify measures needed to improve the energy efficiency of the 2020 LIHC fuel poor households to ensure all achieve (where possible): (1) a minimum of Band E (proposed interim target) and (2) a minimum of Band D ('stretch' interim target). In both scenarios, measures are selected by the model on a lowest present cost basis (refer to Box 2.1 and Box 2.2 for details).

The results suggest that a total spend of £1.67 billion is needed on some 1.7 million different measures to improve the rating of the 488,000 F and G-rated LIHC fuel poor households in 2020 to a minimum Band E (Table 3.4). This represents an average spend per dwelling of just over £3,400, with around 47,000 (10%) of the targeted properties requiring measures in excess of £10,000.

Extending the target to achieve a minimum of Band D in all LIHC fuel poor in dwellings below this rating in 2020 requires an additional £5.16 billion investment in measures (Table 3.4). In this scenario over 1.7 million dwellings are targeted with some 5.9 million different measures, at an average cost per dwelling of over £3,900. Whilst this is only £500 more per dwelling on average than the proposed target, over 236,000 (14%) dwellings require measures in excess of £10,000.

The estimated costs of measures needed to meet the proposed and 'stretch' 2020 interim fuel poverty targets are lower than the estimated cost of measures in the CCC's 4th carbon budget projections to 2020, which far exceed the number of measures identified in modelling the fuel poverty targets. The CCCs projections include over 20.8 million different measures being deployed by 2020. In a scenario where these are targeted at the LIHC fuel poor first (with remaining measures allocated to the remainder of the housing stock), the total costs to 2020 are around £42 billion (Table 3.4).

Table 3.4. Costs of measures to 2020

	Proposed target: Min. Band E	Stretch target: Min. Band D	CCC 4th Measures to 2020[c]
Total measures	1,743,900	5,900,900	20,820,000
Total dwellings[a]	487,900	1,727,600	13,210,000
Total costs (£bn)	£1.67	£6.83	£42
Average cost per dwelling	£3,420	£3,950	£3,180
Average annual cost[b] (£m)	£334	£1,366	£8,403
Dwellings costing >£10k	47,100	236,100	
% of Dwellings costing >£10k	10%	14%	

Table notes:

a) In the case of the fuel poverty target scenarios, this is the number of LIHC fuel poor in 2020 that are in dwellings below the target energy efficiency rating. For the CCC scenario, this is the number of unique dwellings that receive measures in total to 2020.

b) The annual costs assume the total investment is spread equally over a 5 year period (e.g. 2015 to 2020)

c) The count and costs of measure shown here only includes those same measures simulated in the fuel poverty target modelling scenarios. The CCC's measures projections include a much wider range of measures (e.g. appliances) which were not included in modelling the fuel poverty targets.

Table 3.6 shows the number of different measures selected by the model to meet the proposed and 'stretch' fuel poverty targets for 2020. Lower-cost insulation measures (draught-proofing, hot water tank insulation, loft insulation and cavity wall insulation (CWI)) dominate in both scenarios, with over a quarter of the targeted population receiving these measures (Table 3.5). The number of gas boiler replacements, PV installations, solid (internal and external) wall insulations and heat pumps increases by over a factor of four on moving from the proposed minimum Band E target to a stretch target of Band D in 2020.

With the exception of draught-proofing and storage heaters, the CCC's measures projections for the 4th carbon budget all exceed the number of measures selected by the model to achieve the 2020 interim fuel poverty target. For the 'stretch' target, there are marginally fewer solid wall insulation measures in the CCC's projections to 2020 compared to the number selected by the model to achieve a minimum of Band D in all fuel poor homes by this date.

Table 3.5. Proportion of targeted households receiving main measures

	Proposed 2020 interim target: Min Band E	'Stretch' 2020 interim target: Min Band D
Draught-proofing	99.7%	99.6%
Low energy lighting	80%	83%
Hot water tank jacket	44%	35%
Top-up loft insulation	36%	30%
Cavity wall insulation	27%	26%
Gas boiler	16%	19%
Storage heater	16%	7%
Oil boiler	11%	5%
PV	9%	15%
Heating controls	8%	7%
External wall insulation	5%	8%
Internal wall insulation	4%	5%

Table 3.6. Measures needed to 2020 to meet fuel poverty targets and CCC 4th carbon budget projections

Total measures to 2020	Proposed 2020 interim target: Min. Band E	Stretch' 2020 interim target: Min. Band D	CCC 4th CB Projections to 2020
Draught-proofing	486,500	1,721,100	76,601
Low energy lighting	392,500	1,435,100	9,650,000
Hot water tank insulation	212,500	606,600	1,269,863
Top-up loft up	176,100	518,100	2,370,000
CWI	131,900	454,800	1,120,000
Gas boiler	77,700	321,700	4,240,000
Storage heater	77,600	112,600	0
Oil boiler	52,600	80,200	260,000
PV	43,600	254,000	460,000
Heating controls	40,900	123,900	300,000
EWI	24,000	132,500	120,000
IWI	17,800	81,800	60,000
Biomass boiler	4,700	17,600	10,000
ASHP	3,100	14,100	640,000
Double glazing	2,400	10,200	480,000
GSHP	0	15,200	470,000
Floor insulation	0	1,400	660,000
Total count of measures	1,743,900	5,900,900	22,186,463
Total targeted households	487,900	1,727,600	

3.1.3 Impact of meeting a 2020 interim fuel poverty target

Impact on energy efficiency ratings

The measures selected by the model appear sufficient to achieve the proposed interim 2020 fuel poverty target, as none of the 2020 targeted LIHC fuel poor households remain in F- and G-rated properties after measures are applied (Figure 3.1) and the average SAP rating of the fuel poor is raised by 4 points (to 52 (Band E); Figure 3.2).

The measures selected in modelling a 'stretch' interim 2020 target fall just short of achieving the minimum threshold, with some 36,000 of the 2020 LIHC fuel poor households remaining in properties below Band D (Figure 3.1).

By contrast, simulating the deployment of the CCC's 4th carbon budget measures at random across the housing stock to 2020 leaves some 400,000 fuel poor households in properties below Band E, and some 1.5 million in properties below Band D (Figure 3.1). However, if the CCC measures are targeted at LIHC fuel poor households in every year of the simulation, by 2020 the average SAP rating of the fuel poor population is on a par with the 'stretch' fuel poverty target scenario (60, or Band D; Figure 3.2). This scenario also sees the highest number of fuel poor households achieve a Band C by 2020. It should be noted however that (a) there are significantly more measures being deployed in the CCC scenarios compared to the fuel poverty target scenarios; and (b) the CCC scenarios were not developed to target the worst rated properties nor maximise SAP, hence this does not show the full potential impact of the CCC measures on SAP ratings.

Figure 3.1. Distribution of fuel poor households by EPC Band in 2020 under different scenarios
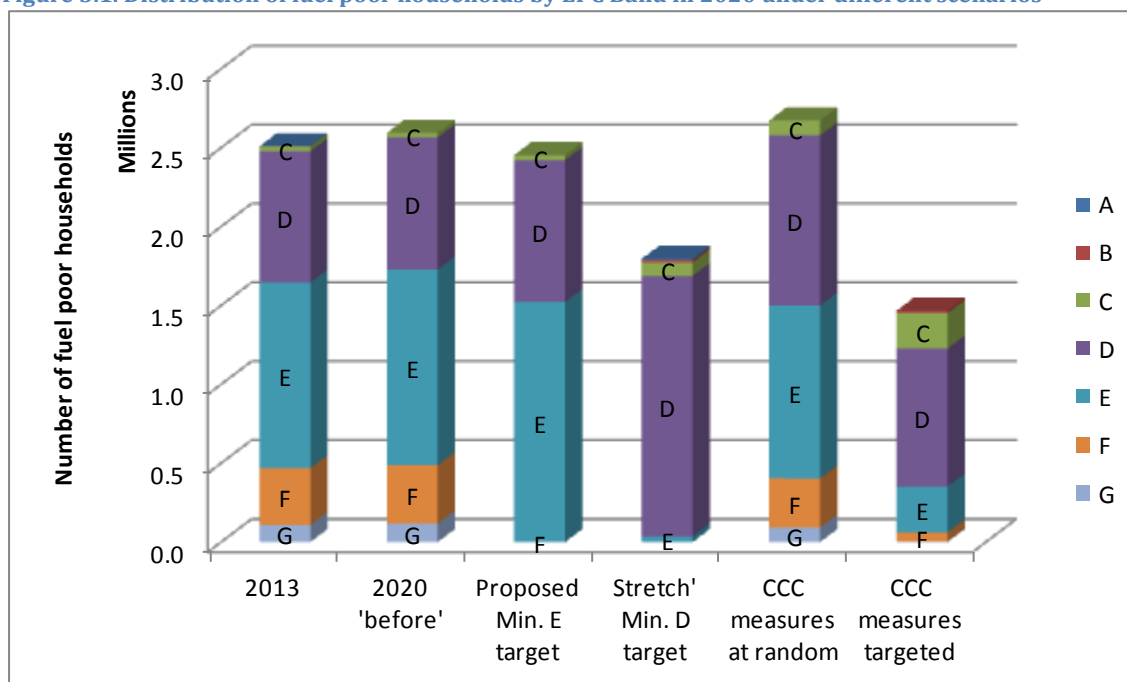
Figure 3.2. Implications for fuel poverty and SAP ratings of achieving a 2020 interim target and the CCC's 4th carbon budget measures projections
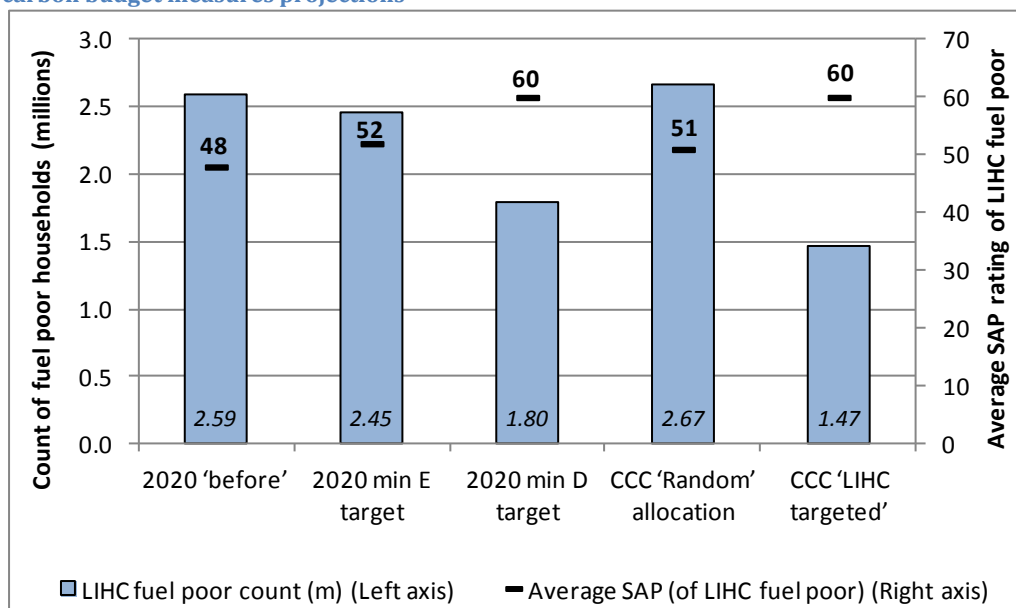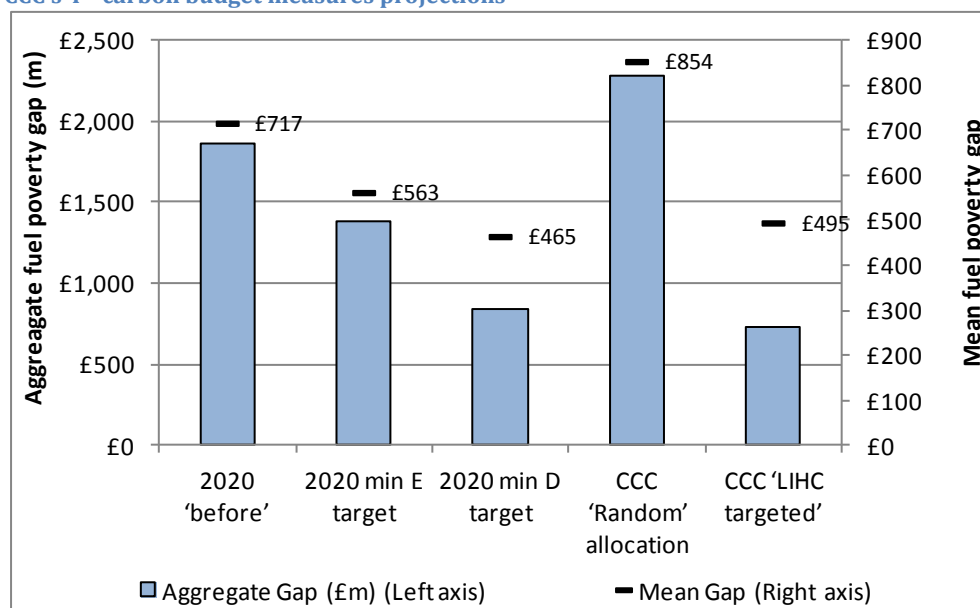

Impact on fuel poverty

Achieving the proposed interim 2020 fuel poverty target of a minimum of Band E in all fuel poor households results in some 140,000 households being lifted out of fuel poverty in 2020 (with the fuel poor count reduced from 2.59 million in 2020 before measures are applied, and 2.45 million after

the measures are simulated to meet the target; Figure 3.2)[14]. Whilst the average and aggregate fuel poverty gap (Figure 3.3) and average (required) fuel bill of the fuel poor (Table 3.7) are all reduced, fuel poverty levels remain high at over 11%. This suggests that despite an investment of nearly £1.7 billion in measures and ensuring that none of the estimated 2020 fuel poor population live in properties below EPC Band E, this level of energy efficiency improvement appears insufficient to alleviate fuel poverty in the majority of cases.

The 'stretch' fuel poverty target, and the scenario targeting CCC 4th carbon budget measures at the LIHC fuel poor on the other hand suggest fuel poverty could be reduced to 8% and 7% respectively in 2020 as a result of applying measures. The average required energy bill of the remaining fuel poor under the 'stretch interim 2020 target scenario is over £300 lower than for the fuel poor population prior to applying measures (Table 3.7). (NB. As a number of households are no longer fuel poor, this latter figure relates to a smaller, subgroup of the previous fuel poor population).

Achieving a minimum target of Band D in all fuel poor homes by 2020 may incur an investment cost of nearly four times that of achieving the proposed minimum Band E target in 2020, but the impact on fuel poverty levels is notably greater, with almost six times as many fuel poor households lifted out of fuel poverty and the aggregate fuel poverty gap reduced by more than a factor of two. Investing in this level of energy efficiency improvements in the earlier years also has implications for the cost of meeting future targets, as discussed later in this report.

Figure 3.3. Implications for fuel poverty gap (aggregate and mean) of achieving a 2020 interim target and the CCC's 4th carbon budget measures projections

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[14] The 'after' fuel poverty estimates are based on the fuel cost threshold for the LIHC definition prior to applying measures, to show the direct impact on fuel poverty of the measures selected. In practice, applying measures to some dwellings and reducing their fuel costs will result in the fuel cost threshold shifting, which will in turn affect which households are in or out of fuel poverty under the LIHC definition.

Table 3.7. Summary of implications for fuel poverty in 2020 of each scenario

	2020 'before'	Proposed 2020 Min. E target	'Stretch' 2020 Min. D target	CCC 'Random' allocation	CCC 'LIHC targeted'
LIHC fuel poor count (m)	2.59	2.45	1.80	2.67	1.47
% of households LIHC fuel poor	12.1%	11.4%	8.4%	12.5%	6.8%
Mean Gap	£717	£563	£465	£854	£495
Aggregate Gap (£m)	£1,859	£1,380	£834	£2,282	£726
Average SAP (of LIHC fuel poor)	48	52	60	51	60
Average energy bill (of LIHC fuel poor)	£2,320	£2,114	£2,009	£2,402	£1,971
Impact on 2020 average energy bill		*-£206*	*-£311*	*£82*	*-£349*

Table notes: Due to households being lifted out of fuel poverty the mean gap and fuel bills of the fuel poor population before and after the simulation of measures are not directly comparable.

3.2   Achieving a 2025 interim target

A second interim fuel poverty target is proposed in the Government's Fuel Poverty Strategy consultation document to ensure that no fuel poor households (as far as "*reasonably practicable*") are in properties below a Band D rating in 2025. An alternative 'stretch' target was modelled to explore the implications of extending this to be a minimum Band C by 2025.

In the results below the modelling follows on from the previous 2020 scenarios; that is, it is assumed that the housing stock remains in the state following the implementation of measures selected by the model to meet the 2020 interim target. The 'before' picture in 2025 is therefore different for the two fuel poverty target scenarios, as these are designed to achieve different minimum energy efficiency standards in 2020 and therefore result in different measures being applied to a different set of households.

The same fuel prices are applied in each scenario however, consistent with the CCC's projections.

3.2.1   Targeted households

Following the implementation of measures to meet the initial 2020 minimum Band E proposed fuel poverty target and with expected fuel price increases applied, an estimated 2.48 million households are in fuel poverty in England in 2025 (Table 3.8). This increase reflects the fuel price rises in the simulation. Nearly two thirds (63%) of these are in the proposed 2025 interim fuel poverty target EPC Bands of E or lower (Table 3.9).

Following the simulation of measures to meet the first 'stretch' target of achieving a minimum of Band E in all fuel poor homes in 2020, some 2.07 million households are estimated to be in fuel poverty by 2025 (Table 3.8). Of these, the vast majority (94%) fall into the second (2025) interim 'stretch' target group of EPC Band D or lower (Table 3.9).

Centre for Sustainable Energy, November 2014

Table 3.8. Fuel poverty in England in 2025 under the proposed, and 'stretch' interim fuel poverty targets[a]

	Proposed target: 2025 'before'	'Stretch' target: 2025 'before'
LIHC fuel poor count (m)[a]	2.48	2.07
% of households LIHC fuel poor	11.6%	9.6%
Mean Gap	£574	£453
Aggregate Gap (£m)	£1,424	£936
Average SAP (of LIHC fuel poor)	52	60
Average energy bill (of LIHC fuel poor)	£2,092	£1,931
LIHC fuel poor in target Bands	**1,552,100[b]**	**1,937,100[c]**
% of LIHC fuel poor population in target Bands	63%	94%

Table notes:

a) Figures represent a snapshot of the housing stock in 2025, assuming measures have been implemented to achieve the 2020 targets, but with no further changes to the housing stock. Fuel prices are consistent with the CCC's projections.

b) Target households are all LIHC fuel poor in EPC E, F and G properties

c) Target households are all LIHC fuel poor in EPC E, F and G properties

Table 3.9. Estimated distribution of the LIHC fuel poor households by EPC Band in 2025 under the two fuel poverty target scenarios (prior to simulating measures to meet the 2025 target)

EPC Band	Proposed target	Stretch target
A 92 plus	0%	0%
B 81 – 91	0%	1%
C 69 – 80	1%	5%
D 55 – 68	36%	88%
E 39 – 54	62%	5%
F 21 – 38	0.2%	0.4%
G 1 – 20	0.1%	0.1%
Count	*2,480,300*	*2,070,000*

Table notes: This shows the distribution of the estimated LIHC fuel poor households in 2025, following the implementation of measures to meet the 2020 targets and with fuel price increases applied consistent with the CCCs projections.

3.2.2   Investment and measures needed to achieve a 2025 target

Scenarios were simulated in the NHM to identify measures needed to improve the energy efficiency of the 2025 LIHC fuel poor households to: (1) a minimum of Band D (the Government's proposed interim target) and (2) a minimum of Band C (the 'stretch' interim target). In both scenarios, measures are selected by the model on a lowest present cost basis (refer to Box 2.1 for details of the cost-effectiveness calculation) and take account of measures allocated in meeting the earlier 2020 targets (e.g. no household can receive the same measure twice).

The results suggest that a total spend of £5.1 billion is needed on some 4.2 million different measures to improve the rating of the 1.55 million E, F and G-rated LIHC fuel poor households in 2025 to a minimum Band D (Table 3.10). This represents an average spend per dwelling of £3,300, with around 166,000 (11%) of the targeted properties requiring measures in excess of £10,000.

Extending the target to achieve a minimum of Band C in all LIHC fuel poor dwellings in 2025 requires an additional £6 billion investment in measures (a total investment of £11.2 billion; Table 3.10). This is substantially more than the estimated costs of meeting the proposed 2025 target, yet the count of households targeted and number of measures identified is not so different. This suggests therefore

that more costly measures are required to achieve a minimum Band C, which is shown by the higher average cost per dwelling and the proportion of households requiring measures in excess of £10,000. Table 3.11 provides further evidence of this: the model selects around twice as many gas boilers and over three times as many PV installations and GSHP in the scenario to achieve a minimum of Band C in all fuel poor homes in 2025, compared the proposed target D. Double-glazing and floor insulation also feature more prominently in the 'stretch' target scenario.

The number of measures and overall costs are again lower in both the fuel poverty target scenarios compared to the estimated measures needed between 2020 and 2025 in the CCC's 4th carbon budget projections. Other than draught-proofing and storage heaters, the CCC's projections suggest the mix of measures needed to meet the fourth carbon budget exceed those identified by the model to achieve the 2025 fuel poverty targets (see Annex Table 2 and Annex Table 4 for details[15]).

Table 3.10. Costs of measures to meet 2025 targets

	Proposed target: Min. Band D	Stretch target: Min. Band C	*CCC 4th Measures 2021 to 2025[b]*
Total measures	4,240,800	4,470,900	*16,920,000*
Total dwellings	1,552,100	1,937,100	*12,510,000*
Total costs (£bn)	£5.10	£11.16	*£49*
Average cost per dwelling	£3,290	£5,760	*£3,887*
Average annual cost[a] (£m)	£1,021	£2,233	*£9,724*
Dwellings costing >£10k	165,600	344,200	
% of Dwellings costing >£10k	11%	18%	

Table notes:
a) The annual costs assume the total investment is spread equally over a 5 year period (e.g. 2021 to 2025)
b) The count and costs of measure shown here only includes those same measures simulated in the fuel poverty target modelling scenarios. The CCC's measures projections include a much wider range of measures (e.g. appliances) which were not included in modelling the fuel poverty targets.

Table 3.11. Measures needed to 2020 to meet fuel poverty targets and CCC 4th carbon budget projections

Total measures 2020 to 2025	Proposed 2025 interim target: Min. Band E	'Stretch' 2025 interim target: Min. Band D	*CCC 4th CB Measures Projections to 2020-2025*
Top-up loft insulation	341,800	328,100	2,160,000
Cavity wall insulation	328,400	180,900	405,000
Gas boiler	240,900	456,000	1,935,000
PV	204,000	703,600	480,000
External wall insulation	82,900	147,300	840,000
Internal wall insulation	79,300	105,100	895,000
Air source heat pump	15,100	49,300	810,000
Ground source heat pump	13,000	41,600	295,000
Double glazing	9,000	73,500	220,000
Solid floor insulation	1,400	18,500	790,000
Total count of measures	4,240,800	4,470,900	16,760,000

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[15] Whilst the number of PV installations appears slightly lower in the CCC's mix for the period 2020 to 2025 compared to the 'stretch' interim target count, this 'deficit' only reflects that 5-year period; overall to 2025 (and to 2030) the CCC's projections for PV exceed the fuel poverty modelling scenario estimates.

3.2.3   Impact of meeting a 2025 interim fuel poverty target

Impact on energy efficiency ratings

The measures selected by the model go some way to achieving the Government's proposed interim 2025 fuel poverty target, with fewer than 41,000 fuel poor households remaining in EPC E-rated properties after measures are applied in 2025 (and none in F and G-rated dwellings; Figure 3.4). The average SAP rating of the remaining fuel poor in 2025 after measures are simulated is raised by another 8 points to 60 (Band D); Figure 3.5).

Whilst under the scenario of an interim stretch target of achieving Band C in fuel poor homes in 2025 the average SAP rating of the remaining fuel poor reaches 72 (Band C; Figure 3.5)), some 283,000 fuel poor households remain short of this target (Figure 3.4).

Simulating the deployment of the CCC's 4th carbon budget measures at random across the housing stock to 2025 leaves some 1.3 million and 2.5 million fuel poor households in properties below Band D and Band C respectively (Figure 3.4). However, if the CCC measures are targeted specifically at LIHC fuel poor households in every year of the simulation, by 2025 the average SAP rating of the fuel poor population exceeds the Government proposed fuel poverty target scenario (62, or Band D; Figure 3.5).

Figure 3.4. Distribution of fuel poor households by EPC Band in 2025 under different scenarios
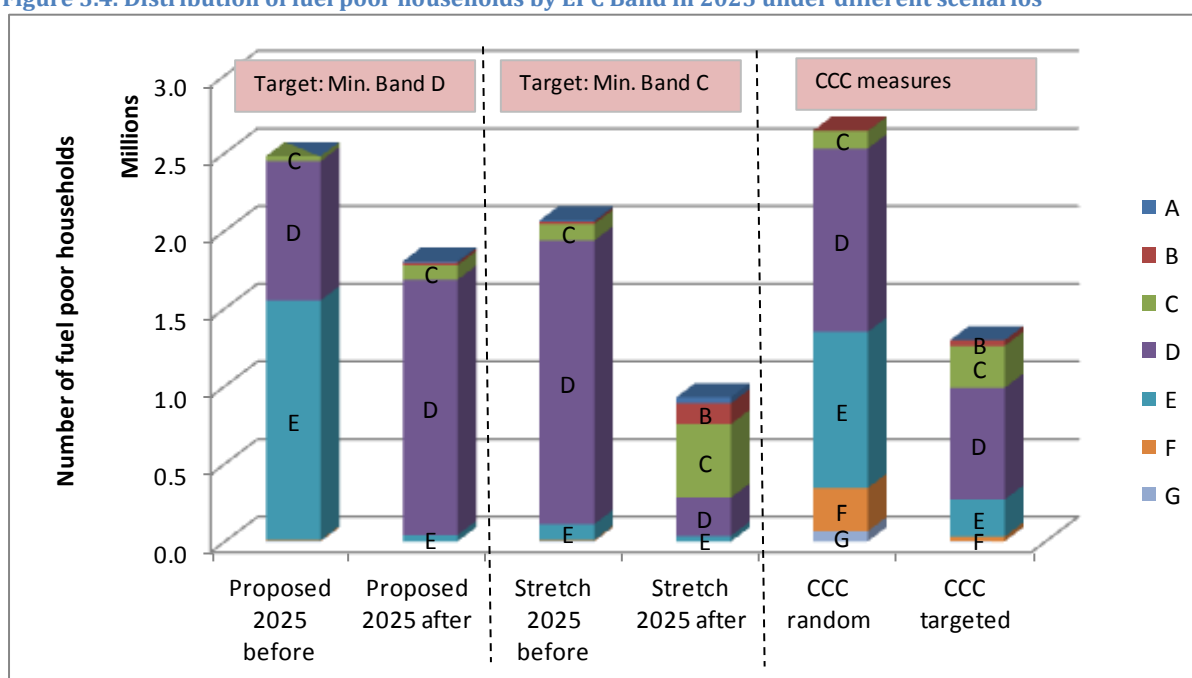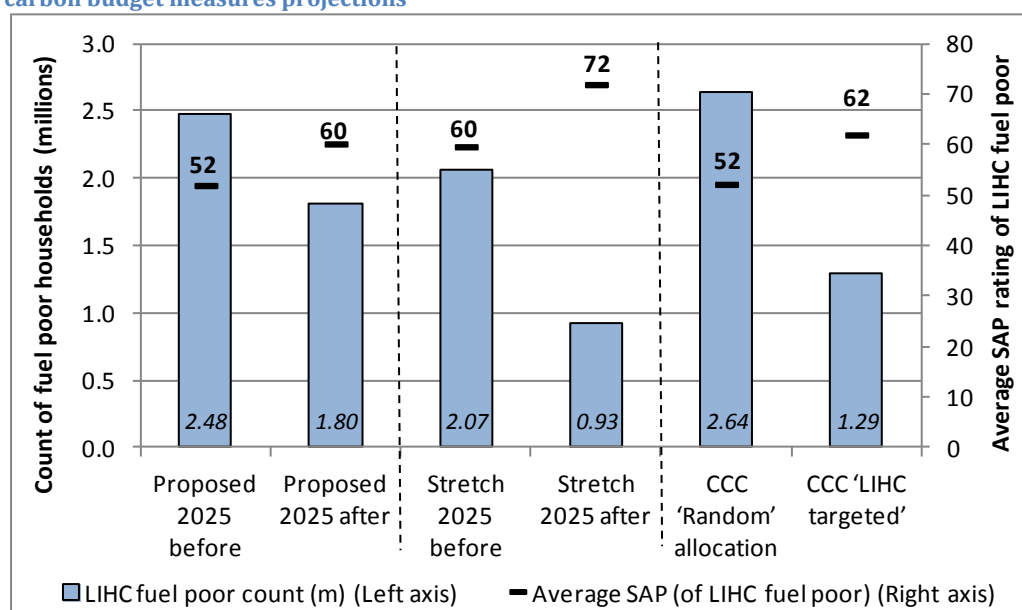
Figure 3.5. Implications for fuel poverty and SAP ratings of achieving a 2025 interim target and the CCC's 4th carbon budget measures projections


Impact on fuel poverty

Achieving the second proposed interim fuel poverty target of a minimum of Band D in all fuel poor households in 2025 results in some 678,000 households being lifted out of fuel poverty (with the fuel poor count reduced from 2.48 million in 2025 before measures are applied, and 1.8 million after the measures are simulated to meet the target; Figure 3.5)[16]. Whilst the average and aggregate fuel poverty gap (Figure 3.6) and average (required) fuel bill of the fuel poor (Table 3.12) are all reduced, fuel poverty levels remain relatively high at nearly 8.4%. This suggests that despite an investment of £5.1 billion (on top of the £1.67 billion already invested in achieving the 2020 interim target) and ensuring that most of the estimated 2025 fuel poor population live in properties of EPC Band E or above, this level of energy efficiency improvement appears insufficient to alleviate fuel poverty and/or offset the impact of fuel price rises in the majority of cases. This finding should be considered in the context of the relative, moving threshold of the LIHC fuel poverty definition. As a result of applying some measures to achieve the earlier 2020 target, the energy costs of some households will be lowered, whilst at the same time fuel prices are expected to rise. The median fuel costs of the population will therefore be shifting overtime, as will an individual households position relative to the median (e.g. depending on whether it received a measure in the 2020 simulation; the heating fuel used and expected price increase in that fuel, and so on).

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[16] This figure is based on the fuel cost threshold for the LIHC definition prior to applying measures, to show the direct impact on fuel poverty at this level. In practice, applying measures to some dwellings and reducing their fuel costs will result in the fuel cost threshold shifting, which will in turn affect which households are in or out of fuel poverty under this LIHC definition.

Table 3.12. Summary of implications for fuel poverty in 2025 of each scenario

	Proposed 2025 Min. D target		'Stretch' 2025 Min. C target		CCC 4th CB Measures	
	2025 'before'	2025 'after' measures	2025 'before'	2025 'after' measures	'Random' allocation	'LIHC targeted'
LIHC fuel poor count (m)	2.48	1.80	2.07	0.93	2.64	1.29
% of households LIHC fuel poor	11.6%	8.4%	9.6%	4.33%	12.3%	6.0%
Mean Gap (of LIHC fuel poor)	£574	£473	£453	£513	£844	£426
Aggregate Gap (£m)	£1,424	£854	£936	£476	£2,232	£552
Average SAP (of LIHC fuel poor)	52	60	60	72	52	62
Average energy bill (of LIHC fuel poor)	£2,092	£1,971	£1,931	£1,975	£2,295	£1,801
Impact on 2025 average energy bill		*-£121*		*£44*		

Figure 3.6. Implications for fuel poverty gap (aggregate and mean) of achieving a 2025 interim target and the CCC's 4th carbon budget measures projections
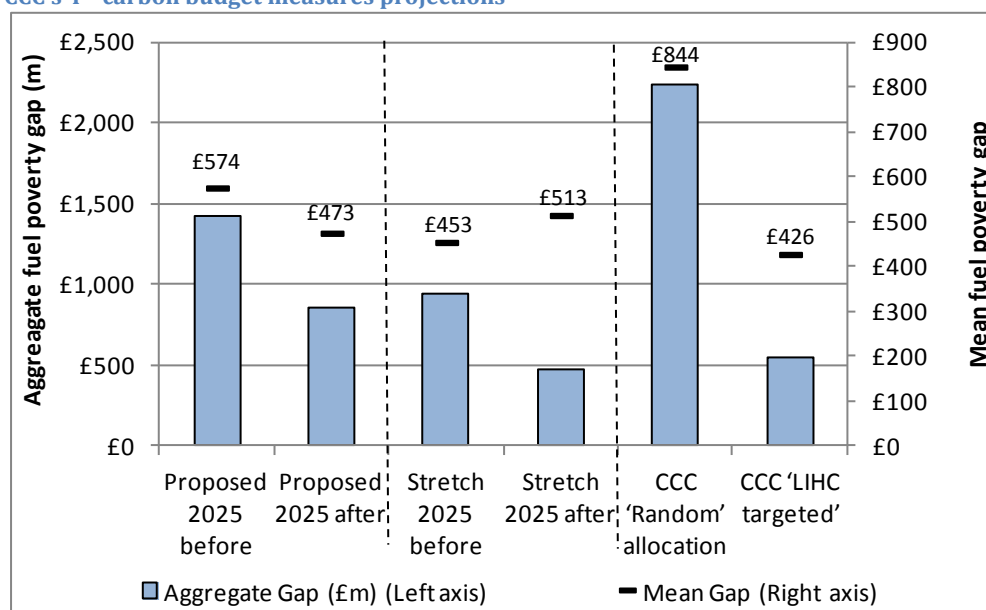
Achieving the interim 'stretch' fuel poverty target suggests that fuel poverty could be reduced to 4% in 2025 and the aggregate gap approximately halved to £476 million (Table 3.12). The average gap of the remaining fuel poor in 2025 after measures have been applied to achieve a minimum Band C target appears slightly higher than before these measures were simulated, as does the average fuel bill of the remaining fuel poor. These figures are somewhat misleading however. Due to the number of households (over 1.1 million) being lifted out of fuel poverty as a result of measures in this scenario, these figures represent different groups of households (one being a subset of the other). Table 3.13 shows some more useful and comparable statistics.

For example, the average energy bill of the estimated 2.1 million fuel poor in 2025 is £1,931; the average bill for this exact same group of households (over 1.1 million of whom are no longer classed as fuel poor) after measures have been simulated is around £350 lower at £1,580.

Similarly, the average fuel bill for the 'stretch' targeted group of households (that is, the fuel poor in 2025 in dwellings rated below Band C) sees a similar reduction from £1,919 to £1,545.

The average fuel poverty gap for households that are in fuel poverty in 2025 both before and after the simulation of measures (928,000, 14% of whom were not targeted, because they were in dwellings rated Band C or higher at the start of the 2025 simulation) is reduced by nearly £300. The average gap for this subset appears substantially higher than the average gap for the fuel poor population as a whole at the start of 2025 (£810 compared to £453). This suggests that these remaining fuel poor represent some of the most severely fuel poor households; hence the application of measures and improvements in their SAP rating are insufficient to lift them out of fuel poverty. The average income of this group is also over £500 lower than the average income of the 2025 fuel poor population as a whole before measures, and of the targeted group of households, which suggests low income is a key driving factor of their fuel poor status.

Table 3.13. Impact on fuel bills and fuel poverty gap of meeting a 2025 'stretch' target (min. Band C)

	Count	% Targeted[a]	Average fuel bill		Mean fuel poverty gap[b]		Mean equivalised income
			'Before'	'After'	'Before'	'After'	
Targeted fuel poor households	1,937,000	100%	£1,919	£1,545	£442	*£57*	£8,090
All fuel poor before	2,066,000	94%	£1,931	£1,580	£453	*£92*	£8,069
Remaining fuel poor 'after'	928,000	86%	£2,266	£1,975	£810	£513	£7,564

Table notes:
a) This is the proportion of households that fit the target criteria for the 'stretch' 2025 target and were therefore targeted with measures in the scenario; i.e. fuel poor in 2025 and living in a dwelling below EPC Band C.
b) The fuel poverty gap only applies to fuel poor households. The figures greyed out in italics indicate a group of households not all of whom are fuel poor.

3.3   Achieving a 2030 target

The ultimate target set out in the Government's new Fuel Poverty Strategy consultation document (2014) proposes "**to ensure that as many fuel poor homes as is reasonably practicable achieve a minimum energy efficiency standard of Band C, by 2030**". An alternative 'stretch' target was modelled to explore the implications of extending this to be a minimum Band B by 2030.

In the results below the modelling follows on from the previous 2020 and 2025 scenarios; that is, it is assumed that the housing stock remains in the state following the implementation of measures selected by the model to meet the two earlier interim targets. The 'before' picture in 2030 presented below is therefore different for the proposed and 'stretch' fuel poverty target scenarios, as different measures have been implemented in the earlier years to align with the different target energy efficiency ratings.

The same fuel prices to 2030 are applied in each scenario however, consistent with the CCC's projections.

3.3.1   Targeted households

Following the implementation of measures to meet the proposed 2025 minimum Band D fuel poverty target and with expected fuel price increases applied, an estimated 2.08 million households are in fuel poverty in England in 2030 (Table 3.14). The majority of these (93%) are in properties below the target energy efficiency rating (below Band C; with most being Band D (Table 3.15).

Following the simulation of measures to meet a 2025 'stretch' target of achieving a minimum of Band D in all fuel poor homes in 2025 and with projected fuel price changes applied to 2030, some 1.42 million households are estimated to be in fuel poverty by 2030 (Table 3.14). Of these, 86% fall into the final (2030) 'stretch' target group of being EPC Band C or lower, with equal proportions in Band D and Band C (Table 3.15).

Table 3.14. Fuel poverty in England in 2030 under the proposed and 'stretch' fuel poverty targets[a]

	Proposed target: 2030 'before'	'Stretch' target: 2030 'before'
LIHC fuel poor count (m)	2.08	1.42
% of households LIHC fuel poor	9.7%	6.6%
Mean Gap	£465	£411
Aggregate Gap (£m)	£966	£582
Average SAP (of LIHC fuel poor)	60	68
Average energy bill (of LIHC fuel poor)	£1,962	£1,863
LIHC fuel poor in target Bands	1,939,400[b]	1,219,700[c]
% of LIHC fuel poor population in target Bands	93%	86%

Table notes:
a) Figures represent a snapshot of the housing stock in 2030, assuming measures have been implemented to achieve the 2020 and 2025 targets, but with no further changes to the housing stock.
b) Target households are all LIHC fuel poor in EPC D, E, F and G properties.
c) Target households are all LIHC fuel poor in EPC C, D, E, F and G properties.

Table 3.15. Estimated distribution of the LIHC fuel poor households by EPC Band in 2030 under the two fuel poverty target scenarios (prior to simulating measures to meet the 2030 target)

EPC Band	Proposed target	Stretch target
A 92 plus	1%	3%
B 81 – 91	1%	11%
C 69 – 80	5%	40%
D 55 – 68	88%	40%
E 39 – 54	5%	6%
F 21 – 38	0.3%	0.6%
G 1 – 20	0.2%	0.2%
Count	2,077,600	1,420,000

3.3.2   Investment and measures needed to achieve a 2030 target

Scenarios were simulated in the NHM to identify measures needed to improve the energy efficiency of the fuel poor households in 2030 to: (1) a minimum of Band C (the Government's proposed target) and (2) a minimum of Band B (the 'stretch' target modelled for this study). In both scenarios, measures are selected by the model on a lowest present cost basis (refer to Box 2.1 for details of the cost-effectiveness calculation) and take account of measures allocated in meeting the earlier 2020

and 2025 interim targets (which dictates that once a dwelling has received a measure in the simulation, that measure remains until the next target year; and no household can receive the same measure twice over the course of the scenario).

The results suggest that a total spend of £11.2 billion is needed on some 4.4 million different measures to improve the rating of the 1.94 million D, E, F and G-rated LIHC fuel poor households in 2030 to a minimum Band C (Table 3.16). This represents an average spend per dwelling of £5,800, with over 345,000 (18%) of the targeted properties requiring measures in excess of £10,000[17].

Extending the target to achieve a minimum of Band B in all LIHC fuel poor dwellings in 2030 requires a lower investment cost (compared to achieving the Band C target) of £6.5 billion (Table 3.16). This lower cost reflects the improved state of the housing stock at the start of the 'stretch' 2030 target simulation (with dwellings being previously targeted to achieve a minimum EPC Band C in 2025) and the subsequent lower count of households that are fuel poor and below the EPC Band B target in 2030.

Table 3.17 illustrates the mix of measures selected by the model to achieve the Government's proposed 2030 target and the 'stretch' target. Some of the more expensive measures (gas boilers, PV and solid wall insulation) account for a greater proportion of the mix for the 'stretch' target than the proposed target (although the overall counts are generally lower due to fewer households being targeted in this scenario).

The number of measures and overall costs in both the 2030 fuel poverty target scenarios are on the whole lower than the CCC's 4th carbon budget projections of measures for the period of 2025 and 2030. The numbers of cavity wall insulation and loft insulation measures in the CCC's projections for the period 2026-2030 are lower as the CCC's scenario assumes that these will have been fully installed by the early to mid 2020's. (Table 3.17 shows measures for the target period (2026-2030 only).

Table 3.16. Costs of measures to meet 2030 targets

	Proposed target: Min. Band C	Stretch target: Min. Band B	CCC 4th Measures 2026 to 2030[b]
Total measures	4,414,600	1,698,200	17,410,000
Total dwellings	1,939,400	1,219,700	12,040,000
Total costs (£bn)	£11.24	£6.47	£54
Average cost per dwelling	£5,800	£5,300	£4,451
Average annual cost[a] (£m)	£2,248	£1,293	£10,713
Dwellings costing >£10k	345,500	256,800	
% of Dwellings costing >£10k	18%	21%	

Table notes:
a) The annual costs assume the total investment is spread equally over a 5 year period (e.g. 2026 to 2030)
b) The count and costs of measure shown here only includes those same measures simulated in the fuel poverty target modelling scenarios. The CCC's measures projections include a much wider range of measures (e.g. appliances) which were not included in modelling the fuel poverty targets.

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[17] These figures are, interestingly, or perhaps not surprisingly, very similar to the results from modelling the 'stretch' 2025 interim target, which sought to achieve a minimum Band C in all fuel poor dwellings in 2025.

Table 3.17. Measures needed from 2025 to 2030 to meet the 2030 fuel poverty target; CCC 4th carbon budget projections of measures over the same period are shown for comparison

	Proposed 2030 target: Min. Band C	Stretch' 2030 target: Min. Band B	CCC 4th CB Projections 2025-2030
Draught-proofing	22%	15%	0%
Low energy lighting	20%	14%	41%
PV	16%	19%	3%
Gas boiler	10%	13%	22%
Top-up loft up	8%	7%	0%
CWI	4%	3%	0%
Heating controls	4%	5%	0%
Hot water tank insulation	4%	2%	2%
EWI	3%	6%	3%
IWI	2%	5%	3%
Storage heater	2%	4%	0%
Double glazing	2%	2%	2%
GSHP	1%	2%	1%
ASHP	1%	1%	12%
Floor insulation	0.4%	1%	7%
Oil boiler	0.4%	1%	2%
Biomass boiler	0.0%	0.0%	2%
Total count of measures	4,414,600	1,698,200	17,711,308

3.3.3   Impact of meeting a 2030 fuel poverty target

Impact on energy efficiency ratings

The measures selected by the model go some way to achieving the proposed minimum Band C 2030 fuel poverty target. The average SAP rating of the targeted households (that is, all the estimated fuel poor in dwellings below EPC Band C at the start of 2030) move from an average SAP score of 58 (Band D) to 73 (Band C) as a result of simulating measures (Table 3.18). However, 29% of the targeted population in 2030 remain below the target EPC Band C (Table 3.18), despite simulating some 4.4 million measures, at a cost of over £11 billion to improve the energy efficiency rating of these homes.

Under the scenario modelling measures to achieve a 'stretch' fuel poverty target of achieving a minimum EPC Band B in fuel poor homes in 2030, the average SAP rating (of the targeted group) is only marginally higher than the proposed (lower EPC C minimum) target, at 76 (Table 3.18). This average is being skewed however by a wider distribution of SAP ratings, with two 'peaks' apparent at the end of this scenario (Figure 3.8). Whilst 40% of the (1.2 million) targeted properties in this scenario achieve the minimum energy efficiency rating (SAP 81 or higher), 35% remain below Band C. This suggests there may be a 'problem' group of dwellings that are difficult to treat with the measures available in the model. This is discussed further in the next section of this report (section 4).

Similarly, simulating the deployment of the CCC's 4th carbon budget measures between 2025 and 2030, targeted specifically at LIHC fuel poor households in every year of the simulation still only achieves an average SAP of 62 for this group (Band D; Figure 3.9). It should be noted however that

whilst the measures were targeted at the fuel poor in this scenario, the worst houses were not specifically targeted, nor where measures allocated to maximise SAP score. Hence this does not show the full potential for the CCC's mix of measures to meet the proposed fuel poverty target.

Table 3.18. Distribution of the 2030 <u>targeted</u> population by EPC Band, under the proposed and 'stretch' fuel poverty target scenarios

EPC Band	Proposed target		'Stretch' target	
	EPC Band Before	EPC Band After	EPC Band Before	EPC Band After
A 92 plus	0%	5%	0%	12%
B 81 – 91	0%	19%	0%	29%
C 69 – 80	0%	47%	46%	25%
D 55 – 68	94%	26%	46%	31%
E 39 – 54	6%	3%	7%	4%
F 21 – 38	0%	0%	1%	0%
G 1 – 20	0%	0%	0%	0%
Total	*1,939,500*		*1,219,728*	
Average SAP score	**58**	**73**	**65**	**76**

Figure 3.7. Distribution of fuel poor households by EPC Band in 2030 under different scenarios
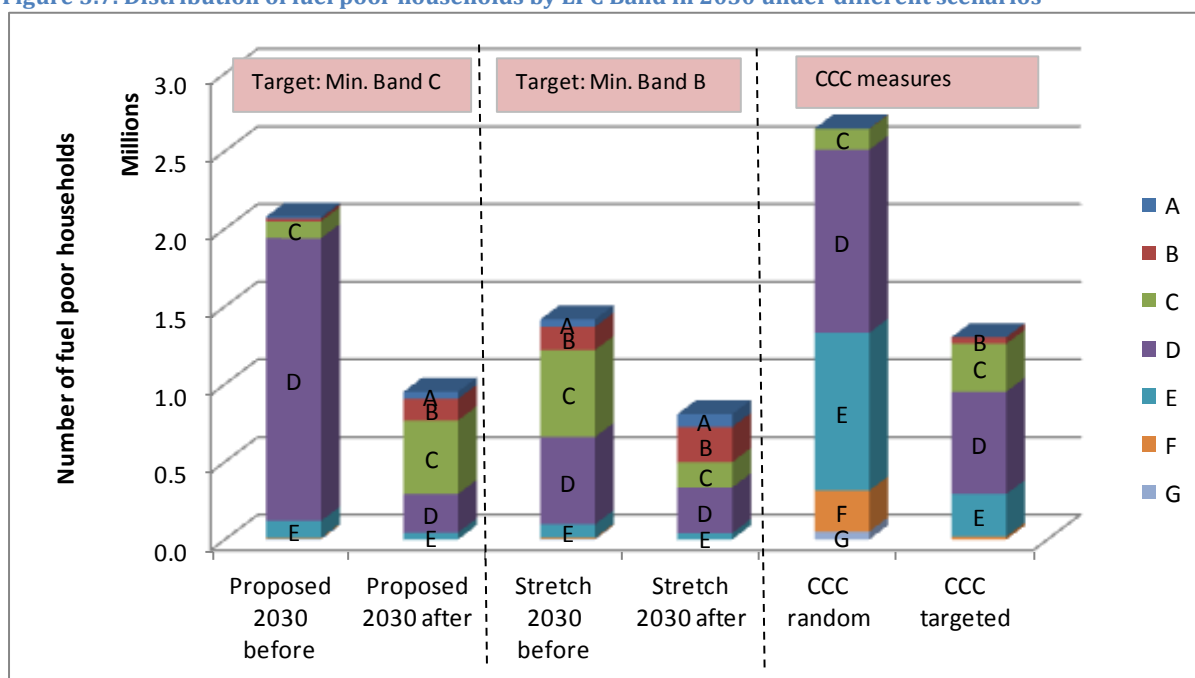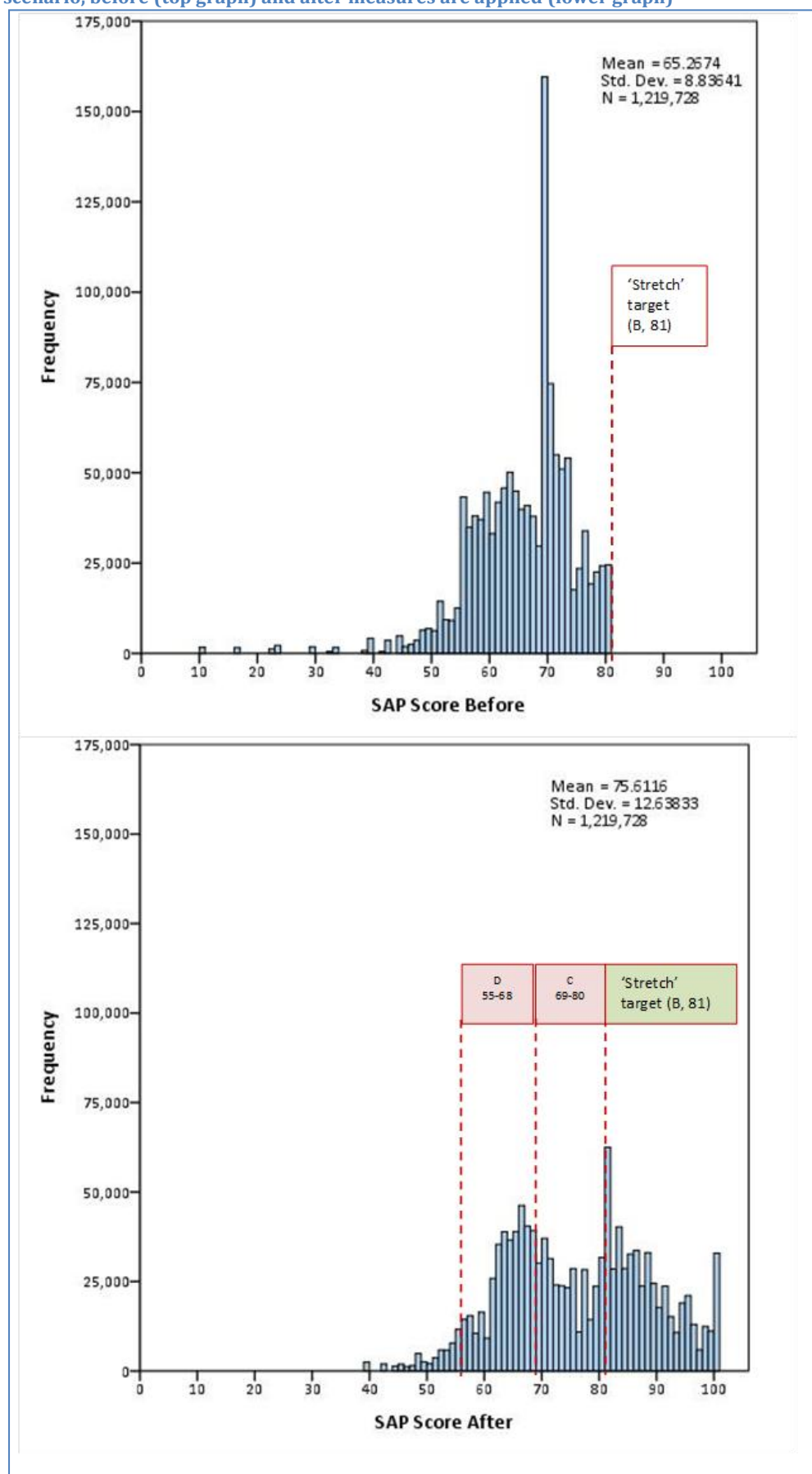
Figure 3.8. Distribution of SAP score of <u>the targeted fuel poor in 2030</u> under the 'Stretch' fuel poverty target scenario, before (top graph) and after measures are applied (lower graph)

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Impact on fuel poverty

Simulating the deployment of measures using the National Household Model to meet the proposed fuel poverty target of a minimum of energy efficiency rating of Band C in all fuel poor households in 2030 halves the estimated number of fuel poor from 2.08 million at the start of 2030 to some 950,000 after measures are applied (Figure 3.9); or rather some 1.13 million households are lifted out of fuel poverty in 2030 as a result of simulating measures to achieve the proposed target. Whilst the aggregate fuel poverty gap is also almost halved as a result (from some £966 million to £518 million), the average fuel poverty gap and (required) energy bills for the remaining fuel poor after measures are applied appear higher than at the start of the simulation in 2030 (Figure 3.10 and Table 3.19).

Figure 3.9. Impact on SAP ratings of the fuel poor and number of fuel poor households of achieving a 2030 target and the CCC's 4th carbon budget measures projections
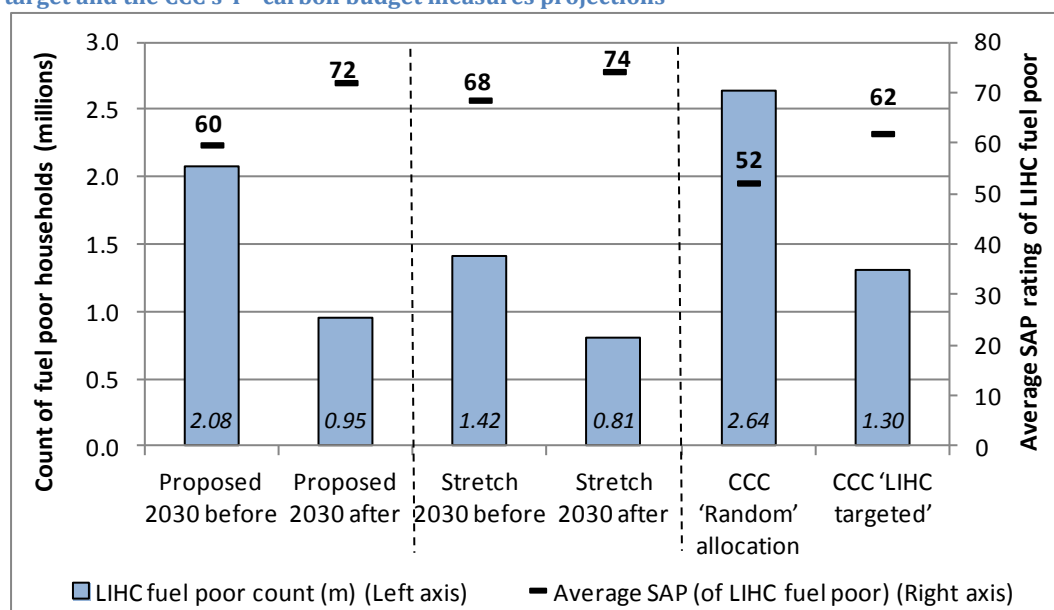
This pattern is also evident in the results from modelling a 'stretch' fuel poverty target of achieving a minimum EPC Band B in all fuel poor homes in 2030. Under this scenario the estimated number of fuel poor households is reduced to around 807,000 (Figure 3.9) and the aggregate gap to £452 million (Figure 3.10). The average gap and required spend on fuel of the remaining fuel poor again appears higher than prior to measures are simulated though, at £560 and £1,990 (compared to £411 and £1,860 respectively; Table 3.19).

As discussed in the previous section, these latter figures (the average gap and required fuel bill of the fuel poor before and after measures) are somewhat misleading, as they represent two quite different groups of households. A high proportion of the fuel poor at the start of the 2030 scenarios are lifted out of fuel poverty and are therefore not part of the group represented by the 'after' figures in Figure 3.10 and Table 3.19.

Figure 3.10. Implications for fuel poverty gap (aggregate and mean) of achieving a 2030 target and the CCC's 4th carbon budget measures projections
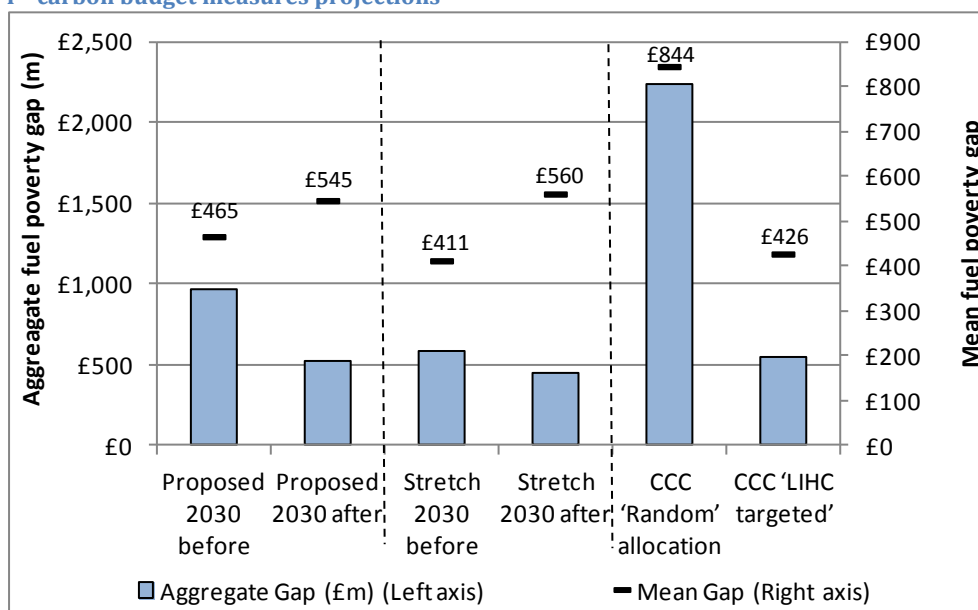
Table 3.19. Summary of implications for fuel poverty in 2030 of each scenario

	Proposed 2030 Min. C target		'Stretch' 2030 Min. B target		CCC 4th CB Measures	
	2030 'before'	2030 'after' measures	2030 'before'	2030 'after' measures	'Random' allocation	'LIHC targeted'
LIHC fuel poor count (m)	2.08	0.95	1.42	0.81	2.65	1.30
% of households LIHC fuel poor	9.7%	4.4%	6.6%	3.8%	12.3%	6.1%
Mean Gap	**£465**	**£545**	**£411**	**£560**	£852	£453
Aggregate Gap (£m)	£966	£518	£582	£452	£2,253	£590
Average SAP (of LIHC fuel poor)	60	72	68	74	53	62
Average energy bill (of LIHC fuel poor)	**£1,962**	**£2,019**	**£1,863**	**£1,990**	£2,267	£1,793
Impact on 2025 average energy bill		*£57*		*£128*		

Table 3.20 and Table 3.21 more clearly show the impact on fuel bills and average fuel poverty gap for consistent, discrete subsets of the population.

Under the proposed fuel poverty target scenario, for example, the average (required) energy bill of the estimated 2.1 million fuel poor in 2030 is £1,962; the average bill for this exact same group after measures have been simulated is around £350 lower at £1,616. As a result, some 1.1 million of these households are no longer classed as fuel poor (i.e. their new required spend on fuel is less than the 'high cost' threshold).

Similarly, the households targeted with measures in 2030 under the proposed fuel poverty targets are on average better off following the simulation of measures with a lower average fuel bill of just under £1,580, compared to £1,950 at the start of 2030.

The fuel poverty gap is only relevant and meaningful to the fuel poor population. As some of the targeted group and fuel poor population at the start of the 2030 simulation are no longer fuel poor after measures are simulated, this figure is not applicable (hence the greyed out italic figures in the tables below). It is however possible to meaningfully show the impact on the gap of the subgroup of the population who start out fuel poor in 2030 and remain so, even after measures are applied (the "*Remaining fuel poor 'after'*" in Table 3.20 and Table 3.21 below).

Table 3.20 shows that under the proposed fuel poverty 2030 target scenario, whilst the measures applied in the model have been insufficient to lift some 950,000 households out of fuel poverty[18], their gap (and required fuel bills) is substantially reduced, from around £830 to £545 (a reduction of over £275). The average gap of this group is notably higher (by almost £400) than the average gap for the fuel poor population as a whole prior to measures (£829 compared to £465). This suggests that these (remaining) fuel poor represent some of the most severely fuel poor households and hence the application of measures and improvements in their SAP rating are insufficient to lift them out of fuel poverty. The average income of this group is also over £600 lower than the average income of all fuel poor households (before measures) and of the targeted group of households, suggesting income is an important driving factor in their fuel poverty status.

Table 3.20. Impact on fuel bills and fuel poverty gap in 2030 of achieving the <u>proposed fuel poverty target</u>

	Count	% Targeted[a]	Average fuel bill		Mean fuel poverty gap[b]		Mean equivalised income
			'Before'	'After'	'Before'	'After'	
Targeted fuel poor households	1,939,400	100%	£1,950	£1,579	£450	*£66*	£8,185
All fuel poor before	2,077,600	93%	£1,962	£1,616	£465	*£107*	£8,147
Remaining fuel poor 'after'	949,800	85%	£2,297	£2,019	£829	£545	£7,575

Table notes:
a) This is the proportion of households that fit the target criteria for the 'stretch' 2030 target and were therefore targeted with measures in the scenario; i.e. fuel poor in 2030 and living in a dwelling below EPC Band C.
b) The fuel poverty gap only applies to fuel poor households. The figures greyed out indicate a group of households not all of whom are fuel poor.

Table 3.21. Impact on fuel bills and fuel poverty gap in 2030 of achieving <u>a 'stretch' fuel poverty target</u>

	Count	% targeted[a]	Average fuel bill		Mean fuel poverty gap[b]		Mean equivalised income
			'Before'	'After'	'Before'	'After'	
Targeted fuel poor households	659,867	100%	£1,835	£1,573	£386	*£110*	£7,766
All fuel poor before	1,416,085	86%	£1,863	£1,638	£411	*£173*	£7,871
Remaining fuel poor 'after'	806,456	76%	£2,063	£1,990	£637	£560	£7,709

Table notes:
a) This is the proportion of households that fit the target criteria for the 'stretch' 2030 target and were therefore targeted with measures in the scenario; i.e. fuel poor in 2030 and living in a dwelling below EPC Band C.
b) The fuel poverty gap only applies to fuel poor households. The figures greyed out indicate a group of households not all of whom are fuel poor.

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[18] And noting that a proportion – those above the minimum energy efficiency rating - were not targeted with measures.

3.4 Achieving minimum energy efficiency ratings in fuel poor homes: summary

3.4.1 Costs and measures

The results of simulating a scenario using the NHM to identify measures needed to meet (where possible and within the parameters and limitations of the model) the Government's proposed fuel poverty targets to 2030 suggest that in total, an investment of around £18.01 billion is needed in some 10.4 million measures (Table 3.22).

Extending the target to increase the energy efficiency rating of all fuel poor households in 2030 to a minimum Band B where possible requires an additional £6.45 billion investment in some 12 million measures (Table 3.23).

Table 3.22. Meeting the proposed fuel poverty target: summary

	2020 Min. Band E	2025 Min. Band D	2030 Min. Band C	Total to 2030
Total measures	1,743,900	4,240,800	4,414,600	*10,399,300*
Total dwellings[a]	487,900	1,552,100	1,939,400	*3,979,400[c]*
Total costs (£bn)	£1.67	£5.10	£11.24	*£18.01*
Average cost per dwelling	£3,420	£3,290	£5,800	*£4,530*
Average annual cost (£m)[b]	£334	£1,021	£2,248	*£1,201*
Dwellings costing >£10k	47,100	165,600	345,500	*558,200*

Table notes:
a) This is the total number of dwellings that meet the target criteria of being fuel poor and below the minimum EPC Band threshold.
b) The average annual cost is the total cost of measures identified spread equally over a five year period; or, in the case of the total cumulative cost to 2030, spread over 15 years.
c) This is the total number of dwellings targeted over the lifetime of the scenario. Some dwellings are targeted more than once – i.e. if they remain fuel poor and below the proposed minimum EPC Band in multiple target years.

Table 3.23. Meeting an extended 'stretch' fuel poverty target: summary

	2020 Min. Band D	2025 Min. Band C	2030 Min. Band B	Total to 2030
Total measures	5,900,900	4,470,900	1,698,200	12,070,000
Total dwellings[a]	1,727,600	1,937,100	1,219,700	4,884,400
Total costs (£bn)	£6.83	£11.16	£6.47	£24.46
Average cost per dwelling	£3,950	£5,760	£5,300	£5,010
Average annual cost (£m)[b]	£1,366	£2,233	£1,293	£1,631
Dwellings costing >£10k	236,100	344,200	256,800	837,100

Table notes:
a) This is the total number of dwellings that meet the target criteria of being fuel poor and below the minimum EPC Band threshold.
b) The average annual cost is the total cost of measures identified spread equally over a five year period; or, in the case of the total cumulative cost to 2030, spread over 15 years.
c) This is the total number of dwellings targeted over the lifetime of the scenario. Some dwellings are targeted more than once – i.e. if they remain fuel poor and below the proposed minimum EPC Band in multiple target years.

In both scenarios, low-cost insulation measures (draught-proofing, loft insulation, hot water tank insulation and cavity wall insulation) and replacement gas boilers appear important, with over a quarter of dwellings receiving these (Table 3.24). Draught-proofing appears particularly important, but this result should be considered within the context of the model and scenario design: draught-

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proofing represents a low cost measure that is, it appears, applicable in almost all properties, even if only in minimal quantities (the model will consider a dwelling suitable for draught-proofing if its current state is less than 100%).

PV also features highly in the mix, with 35% and 43% of dwellings receiving this measure under the proposed and 'stretch' fuel poverty target scenarios respectively. This result is again a consequence of the nature of the scenarios modelled here, which are designed to achieve the target energy efficiency rating at lowest cost (based on lowest present cost calculation). This is discussed further in section 4.

Table 3.24. Mix of measures to meet the proposed and 'stretch' fuel poverty targets

Cumulative to 2030	Proposed Min. Band C by 2030		'Stretch' Min. Band B by 2030	
	Count	% of dwellings[a]	Count	% of dwellings[a]
Draught-proofing	2,724,000	100%	2,980,600	99%
Low energy lighting	2,340,300	86%	2,572,600	86%
PV	953,300	35%	1,276,300	43%
Top-up loft up	853,200	31%	961,800	32%
Gas boiler	776,600	28%	1,006,500	34%
Hot water tank insulation	766,200	28%	806,000	27%
CWI	635,600	23%	687,700	23%
Heating controls	315,200	12%	397,500	13%
EWI	255,900	9%	379,500	13%
Storage heater	225,900	8%	254,200	8%
IWI	201,900	7%	264,700	9%
Oil boiler	117,100	4%	125,800	4%
Double glazing	83,900	3%	124,900	4%
ASHP	56,600	2%	83,900	3%
GSHP	54,400	2%	90,400	3%
Floor insulation	19,900	1%	39,100	1%
Biomass boiler	19,300	1%	18,500	1%
Total count	**10,399,300**	**2,735,300**	**12,070,000**	**2,995,600**

Table notes: a) the count of dwellings shown here represents unique properties receiving measures over the lifetime of the scenario. A dwelling may be targeted more than once (i.e. if it remains fuel poor and below the target energy efficiency threshold) but it cannot receive the same measure more than once in these scenarios.

Figure 3.11 shows the total (cumulative to 2030) count of the main measures identified in modelling the proposed and 'stretch' fuel poverty targets in the NHM compared to the number of each measure in the CCC's projections for meeting the fourth carbon budget (Annex I provides a full and detailed comparison of all measure counts). Whilst the CCC's estimates exceed both the proposed and 'stretch' fuel poverty target estimates (by some margin on most measures) it is important to bear in mind the different purposes and underlying inputs and assumptions behind these projected mix of measures. (See Box 2.3 for discussion).

Figure 3.11. Main measures identified in the modelling to meet the proposed and 'stretch' fuel poverty targets as a proportion of the total count in the CCC's fourth carbon budget projections
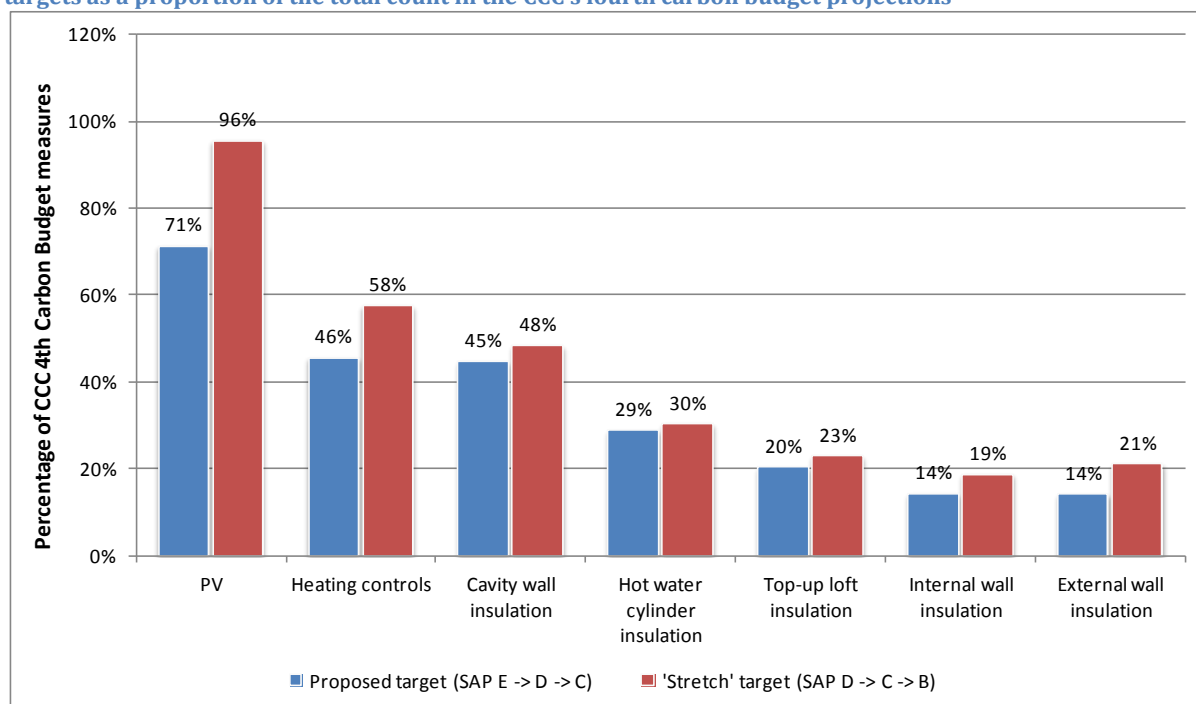
3.4.2   Implications for fuel poverty and the housing stock

As a result of applying measures identified by the model to achieve (where possible) the proposed 2030 fuel poverty target of a minimum energy efficiency rating of Band C in all fuel poor households in 2030 (including meeting the interim 2020 and 2025 targets) an estimated 950,000 (4%) of dwellings remain fuel poor following the simulation of measures. Extending the target to ensure a minimum energy efficiency of Band B in fuel poor homes in 2030 further reduces fuel poverty levels to an estimated 3.8% in 2030. The aggregate fuel poverty gap appears substantially lower than baseline levels as a result (Table 3.25). The average energy efficiency rating of fuel poor homes in 2013 is estimated to be Band E. As a result of simulating measures to meet the Government's proposed fuel poverty targets (where possible), the average energy efficiency rating of the remaining fuel poor in 2030 is substantially higher at Band C. Extending the target to a minimum Band B in all fuel poor homes by 2030 results in a slightly higher average rating (74).

Table 3.25. Implications for fuel poor households in 2030 of meeting the proposed and 'stretch' fuel poverty targets

	2013 baseline	Proposed target Min. C by 2030	Extended target Min. B by 2030
LIHC fuel poor count (m)	2.51	0.95	0.81
% of households LIHC fuel poor	12%	4.4%	3.8%
Mean Gap	*£648*	*£545*	*£560*
Aggregate Gap (£m)	£1,625	£518	£452
Average SAP (of LIHC fuel poor)	48	72	74
Average energy bill (of LIHC fuel poor)	*£2,113*	*£2,019*	*£1,990*

4   Discussion: Modelling 'health warnings' and implications of inputs and assumptions

4.1   Overview

This research employs one particular modelling tool and a number of assumptions and inputs, all of which have implications for the results. Outputs should therefore be interpreted in the context of these inputs, including:

- All modelling is simulated using the National Household Model and a housing stock dataset based on the 2011 English Housing Survey, modified to represent England in 2013.
- Fuel poverty levels are dependent on fuel prices, which have been projected to 2030 consistent with the CCC's projections.
- There is no shifting of method of payment nor fuel tariff in the simulation (e.g. households moving to electric heating as a result of receiving measures are not assumed to move to an off-peak (e.g. Economy 7) tariff).
- The scenarios were designed such that measures are selected by the model that will, where possible, achieve the _minimum_ energy efficiency target in each target year, and do so at lowest present cost. It only seeks to _maximise_ the SAP rating if the target threshold cannot be met (i.e. it will select measures to get as near to the target as possible).
- Measures are selected from a finite list and assumptions have been made about the cost of measures and household (physical property) suitability for measures.
- The costs modelled in this study include only the capital costs of measures (based on assumed costs at the time of the research). It does not include any additional costs associated with implementing an energy efficiency/ fuel poverty scheme or housing stock retrofit (such as search costs – finding eligible households, assessing suitability for measures; and administrative costs – scheme management, customer service etc) nor allow for any potential reductions in costs over time (e.g. as supply chains develop).
- Measures are simulated at a single point in time in the model. In practice, improvements will be made incrementally to the housing stock. This has implications for costs and fuel poverty levels (as the fuel cost threshold is affected by changes to the housing stock which impact on modelled (required) household energy demand).

As a result, the outputs from these scenarios represent just one (modelled) approach to (and analysis of the implications of) meeting the proposed fuel poverty targets.

4.2   Measures selection and SAP-based energy efficiency targets

Varying the assumptions and inputs - for example, changing the list of measures available and the assumed costs - will affect which measures are selected by the model, which in turn has implications for achieving the targets and the total costs of doing so.

The assumed costs of measures are particularly relevant to these results as the model is programmed to select measures on a least cost basis. Underestimating the cost of a measure may therefore make it appear more favourable and feature more prominently in the resulting 'mix'.

The use of SAP as a metric for target delivery also has implications for the selection of measures, specifically of heating measures. In particular the impact of heating controls is underestimated by

SAP as a standard heating regime is used in the SAP methodology (i.e. the potential savings and benefits of improved thermal comfort and behavioural changes are not accounted for).

Assumptions about the suitability of a dwelling to receive a particular measure also have implications for the resulting mix and impact on fuel poverty/ progress towards achieving the targets. PV is particularly affected by this in these scenarios. The lack of detailed information in the housing stock dataset about suitability of dwellings for PV necessitated an assumption that 60% of the housing stock (excluding flats) may be suitable for this measure. The identification of this 'suitable 60%' is done at random by the model. Thus, any dwellings flagged randomly as unsuitable cannot receive PV in the simulation, even thought this may not be the case. As PV fairs particularly well under SAP, this has significant implications for how far the energy efficiency targets are met in the modelling presented here. For example, increasing the proportion of households that could get PV would result in more dwellings achieving the minimum targets.

The analysis of the results from simulating an extended ('stretch') fuel poverty target of achieving a minimum Band B in all fuel poor homes in 2030 showed a high proportion of targeted households could not achieve this target (refer to Figure 3.8, an extract of which is shown again below).

More detailed analysis of the subset of households that were targeted in 2030 and remain fuel poor after measures were simulated in this scenario highlights the importance of the PV assumption in meeting the energy efficiency thresholds. There appears a clear overlap in the allocation of PV and the cluster of households that achieve the minimum energy efficiency rating (Band B, or SAP 81) and the assumed (randomly flagged as) 'unsuitable' for PV and failure to achieve this minimum energy efficiency target.

Figure 4.1. Distribution of SAP scores of the remaining fuel poor in 2030 under the 'stretch' fuel poverty target scenario
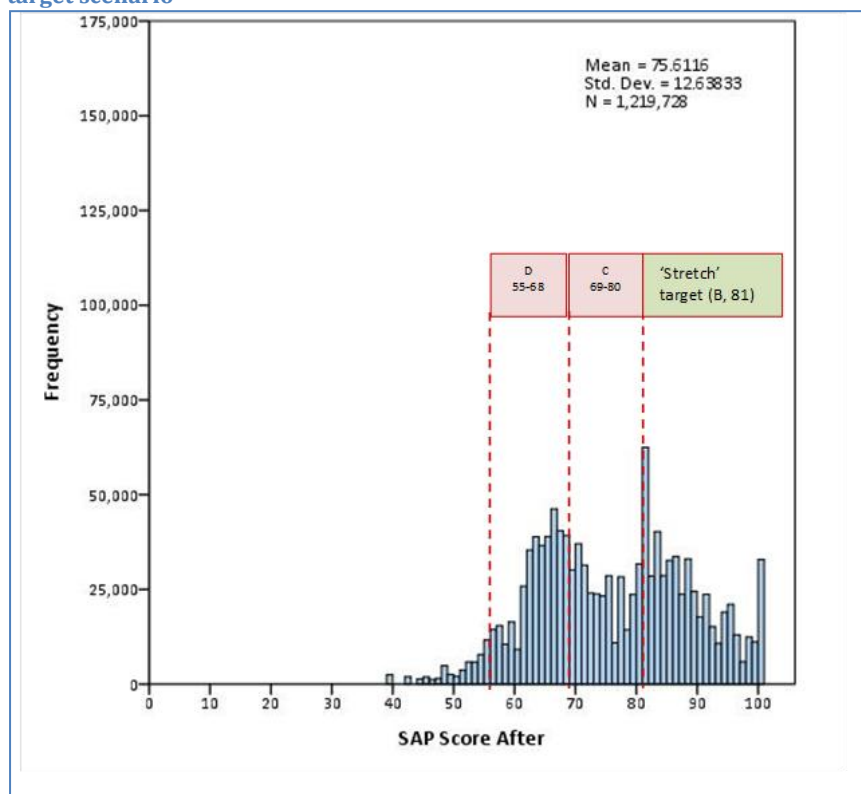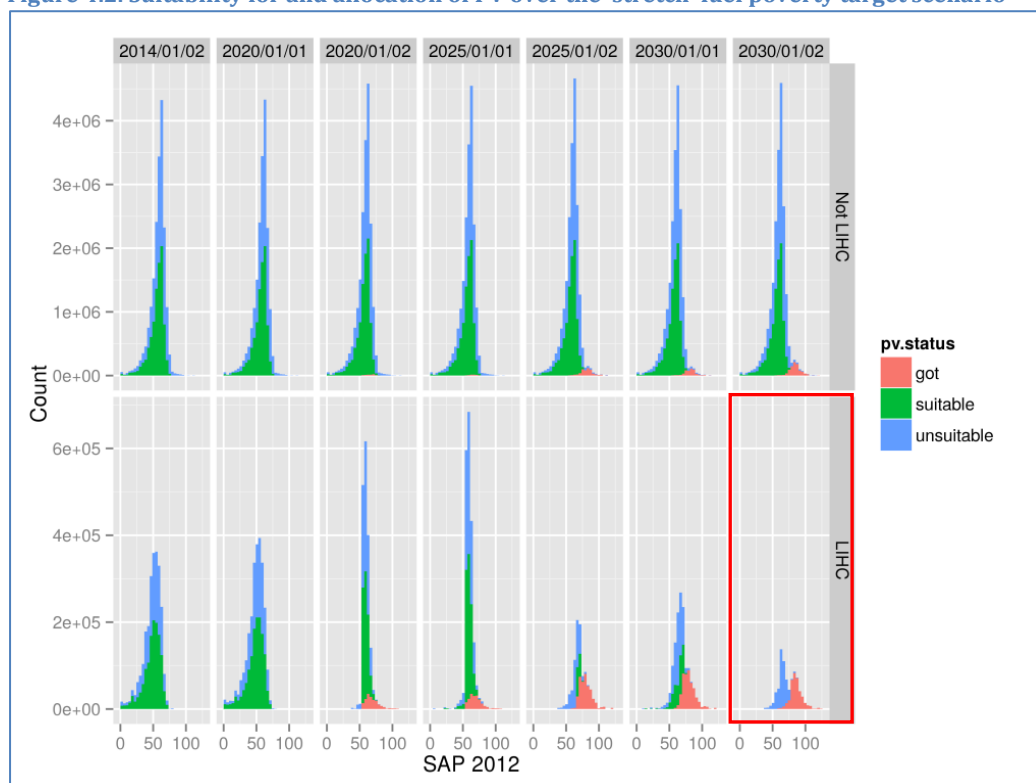
Figure 4.2. Suitability for and allocation of PV over the 'stretch' fuel poverty target scenario

4.3   Paying for measures

The modelling undertaken for this research has not explored the potential for, nor implications of, how measures identified to meet the proposed fuel poverty targets could be paid for. In the scenarios simulated here, no costs of measures have been passed on to consumers. In effect the scenario assumes therefore that there is a state-funded scheme in place to support the installation of measures needed to meet the proposed fuel poverty targets. The recent pattern of energy policy is in fact converse to this, with policy costs increasingly being passed on to consumers through electricity and gas bills. If this is the case, fuel poverty levels would likely appear worse than those presented here. (It is difficult to estimate the impact of passing costs on to consumers due to the moving fuel cost threshold in the LIHC definition, but it would be safe to assume there would be distributional implications that would likely exacerbate fuel poverty).

4.4   What is "reasonably practicable"?

The Government's proposed fuel poverty targets include the term "reasonably practicable". However no working definition is provided of what this constitutes.

The modelling applied in this study does not address this issue nor seek to define reasonably practicable. An approach was adopted in modelling measures needed to meet the proposed targets, whereby measures are selected on a least present cost basis (see Box 2.2). The discount rate applied in this modelling is relatively high at 10% and the impact on future energy bills has only been considered over a 5 year period. This approach biases (places greater relative emphasis on) the capital costs of the measures, rather than future energy bills in selecting measures. This approach could arguably be considered 'reasonably practicable', particularly from the householders point of view (i.e. they give less consideration to future energy bills and care more about capital outlay in the present). The

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results therefore provide an indication of the (packages of) measures that achieve the proposed targets under one, entirely cost-based interpretation of reasonably practicable.

However, the question of what is "reasonably practicable" in alleviating fuel poverty should look beyond cost considerations. Recent guidance published by NICE on fuel poverty and cold homes has outlined the risk to health and the necessary actions required to mitigate this risk. The risk to health provides a useful frame to examine the term "reasonably practicable", as the Health and Safety Executive uses a similar term as part of its ALARP ('as low as reasonably practicable') assessment process for employers i.e. (to determine if adequate expenditure was made to mitigate risk).

The inclusion of the term 'reasonably practicable' and the absence of any definition of what this actually means in practice is a major weakness of the current proposed fuel poverty targets. If the term is to be used in delivering the Fuel Poverty Strategy this should extend to include measures that ensure a home is both healthy and affordably warm. In assessing 'reasonably practicable' in this context, any cost benefit analysis must include the economic, social and health benefits to the householder.

5   Conclusions

The results from modelling the potential to meet the Government's proposed fuel poverty targets using the NHM identifies some 10.4 million measures, at a total (cumulative) cost to 2030 of over £18 billion. Whilst the average energy efficiency rating of the fuel poor in 2030 is increased in line with the proposed target (Band C), nearly 300,000 fuel poor households remain in properties below this threshold in 2030 (Figure 5.1).

Figure 5.1. Implications for fuel poor households of the proposed targets
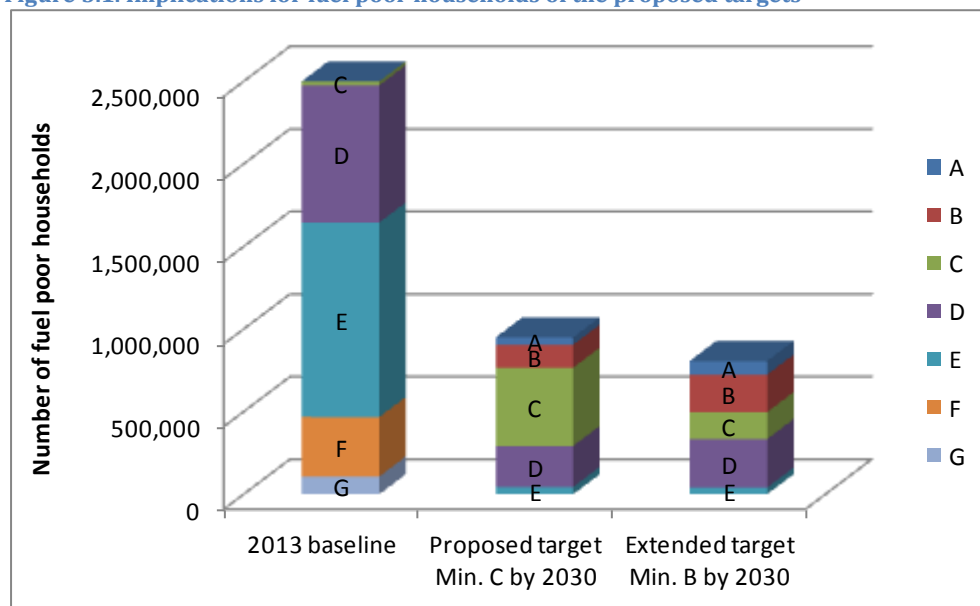
Furthermore, whilst over the lifetime of the scenario used in this study some 2.7 million different (unique) dwellings are targeted with measures by 2030 (Table 5.1), a number of these are identified to receive measures in more than one target year.

This is a consequence of the tiered structure of the proposed targets. Targeting the fuel poor in the least energy efficient homes first makes sense. However, the low initial proposed target of improving these dwellings to only a minimum energy efficiency rating of Band E means that the improvements are insufficient to lift the majority of these homes out of fuel poverty and/or protect them from future fuel price rises. As a result, a number of these dwellings remain both fuel poor and below the second interim target energy efficiency rating in 2025 (minimum Band D). Hence these households have to be targeted again to ensure the 2025 target is met. Achieving the minimum Band D does not guarantee a dwelling will not find itself in fuel poverty in 2030, and hence could potentially be targeted a third time for the final 2030 target.

The analysis presented below explores the extent to which this requirement for repeat targeting may occur if the proposed fuel poverty targets are implemented.

Figure 5.2 shows that by 2030, of the total 1.94 million households who are fuel poor and below the final minimum energy efficiency rating for the proposed target (Band C), some 9% have been targeted previously in an attempt to meet both the 2020 and 2025 interim milestones. Only half of the 2030 targeted households were not targeted in the earlier years.
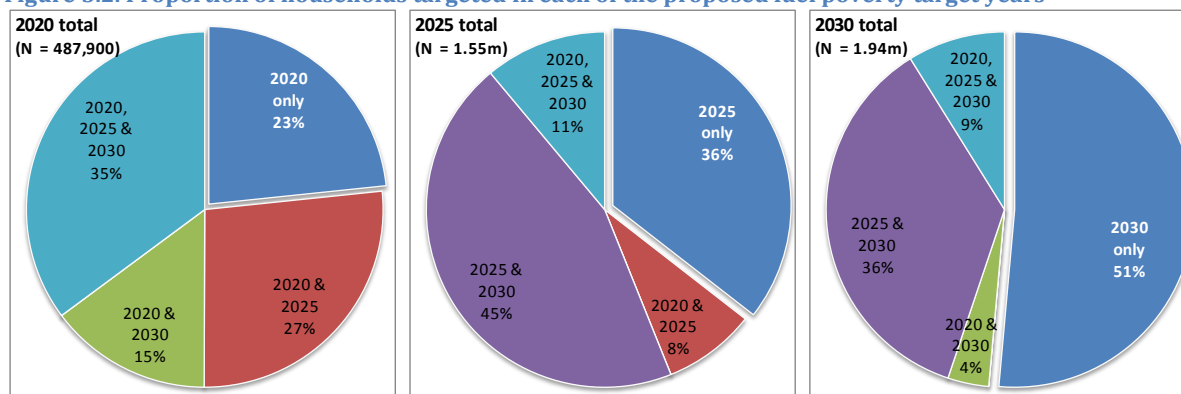
Figure 5.2. Proportion of households targeted in each of the proposed fuel poverty target years

Table 5.1 provides further analysis of the number of 'uniquely' and 'repeatedly' targeted dwellings:

- Over the lifetime of the scenario modelling the proposed fuel poverty targets to 2030, some 2.7 million different (unique) dwellings are targeted with measures;
- Of these, 61% (1.66 million) are targeted only once;
- A third are targeted twice (30% in consecutive target years (i.e. 2020 and 2025 or 2025 and 2030) and 3% in non-consecutive years (i.e. 2020 and 2030));
- 6% (172,000 households) are targeted with measures in all three target years.
- This 'repeat targeting' is worse still in the 'stretch' 2030 target which sees over 450,000 dwellings being targeted with measures in all three target years.

Table 5.1. Number of households repeatedly targeted

	Proposed Target (EPC E-D-C)		Extended Target (EPC D-C-B)	
	Count	%	Count	%
one year only	*1,662,800*	*61%*	*1,562,300*	*52%*
two consecutive years	**828,800**	**30%**	**781,600**	**26%**
two non-consecutive years	**72,100**	**3%**	**196,300**	**7%**
all three years	**171,600**	**6%**	**455,500**	**15%**
Total targeted more than once	*1,072,600*	*39%*	*1,433,400*	*48%*
total unique dwellings	*2,735,300*	*100%*	*2,995,600*	*100%*

These results highlight the potential inefficiency of the tiered approach to improving the housing stock and addressing fuel poverty. This level of repeat targeting has important implications in terms of the added costs associated with getting measures into target households (e.g. finding the eligible households, assessing what work is needed, convincing them to take up the measures, undertaking the work, 'hassle' costs to the household etc).

The results from the modelling applied here suggest over 1 million dwellings would need visiting more than once to meet the interim and proposed fuel poverty targets.

What would seem a far more effective approach (economically, socially and environmentally) would be to drop the interim lower energy efficiency targets and go straight to achieving a higher rating in targeted dwellings. Therefore whilst the worst rated properties could still be targeted first these

dwellings should be improved to a minimum energy efficiency rating of (at least) Band C straight away.

Further modelling is needed to quantify the costs and impacts of this 'straight to Band C' approach (an additional scenario could be simulated using the NHM to model this). However, the implications from the modelling undertaken for this study suggests that whilst a higher target will equate to higher costs of improvement measures in the short term, in the longer term this should represent a more cost-effective approach, with avoided costs associated with finding eligible households and getting measures in. Improving the energy efficiency of these dwellings to a minimum of C would also offer these households (and future occupants) greater protection from rising energy costs (fuel poverty 'future proofing'). In addition to amending the approach to delivery, a new fuel poverty strategy should encompass a workable definition of 'reasonably practicable that looks beyond costs to include consideration of the wider benefits associated with ensuring affordable warmth and healthy living environments.

Annex I – Measures projections

Annex Table 1 shows the total, cumulative count of measures identified in the modelling scenarios to meet the proposed and 'stretch' fuel poverty targets to 2030, alongside the CCC's projections of measures needed in the residential sector to meet the fourth carbon budget.

Annex Table 2 shows the total, cumulative count of measures identified in the modelling scenarios to meet the second proposed and 'stretch' fuel poverty targets to 2025 (so this includes the measures selected for the 2020 target), alongside the CCC's projections of measures to 2025.

A breakdown of measures identified for each target in turn (covering the periods to 2020; 2020 to 2025; and 2025 to 2030) follows, again with the CCC's mix of measures for the same time periods shown for comparison.

Annex Table 1. Total cumulative mix of measures identified by the NHM scenarios to meet the 2030 targets; and the CCC's mix to 2030

Total measures cumulative to 2030	Proposed Targets	'Stretch' Targets	*CCC 4th CB Measures Projections to 2030*
Gas boiler	776,600	1,006,500	9,365,000
Oil boiler	117,100	125,800	1,040,000
Storage heater	225,900	254,200	0
Cavity wall insulation	635,600	687,700	1,420,000
External wall insulation	255,900	379,500	1,795,000
Internal wall insulation	201,900	264,700	1,405,000
Top-up loft insulation	853,200	961,800	4,180,000
Air source heat pump	56,600	83,900	2,695,000
Ground source heat pump	54,400	90,400	1,050,000
Biomass boiler	19,300	18,500	1,010,000
Solid floor insulation	19,900	39,100	2,665,000
Double glazing	83,900	124,900	1,310,000
Low energy lighting	2,340,300	2,572,600	17,050,000
PV	953,300	1,276,300	1,335,000
Programmer	315,200	397,500	690,000
Hot water tank jacket	766,200	806,000	2,650,000
Draught-proofing	2,724,000	2,980,600	150,000
Total count of measures	10,399,300	12,070,000	49,810,000

Annex Table 2. Total cumulative mix of measures identified by the NHM scenarios to meet the 2025 targets; and the CCC's mix to 2025

Total measures cumulative to 2025	Proposed Targets	'Stretch' Targets	CCC 4th CB Measures Projections to 2025
Gas boiler	318,600	777,700	6,020,000
Oil boiler	100,900	101,900	720,000
Storage heater	133,800	194,700	0
Cavity wall insulation	460,300	635,700	1,420,000
External wall insulation	106,900	279,800	950,000
Internal wall insulation	97,100	186,900	1,000,000
Top-up loft insulation	517,900	846,200	4,180,000
Air source heat pump	18,200	63,400	1,375,000
Ground source heat pump	13,000	56,800	595,000
Biomass boiler	18,400	18,500	575,000
Solid floor insulation	1,400	19,900	1,280,000
Double glazing	11,400	83,700	990,000
Low energy lighting	1,460,400	2,336,200	11,780,000
PV	247,600	957,600	995,000
Programmer	139,900	311,800	615,000
Hot water tank jacket	607,800	773,100	2,380,000
Draught-proofing	1,731,100	2,727,900	120,000
Total count of measures	5,984,700	10,371,800	34,995,000

Annex Table 3. Mix of measures identified by the NHM scenarios to meet the 2020 targets; and the CCC's mix to 2020

Total measures to 2020	Proposed 2020 interim target: Min. Band E	'Stretch' 2020 interim target: Min. Band D	CCC 4th CB Measures Projections to 2020
Gas boiler	77,700	321,700	4,085,000
Oil boiler	52,600	80,200	395,000
Storage heater	77,600	112,600	0
Cavity wall insulation	131,900	454,800	1,015,000
External wall insulation	24,000	132,500	110,000
Internal wall insulation	17,800	81,800	105,000
Top-up loft insulation	176,100	518,100	2,020,000
Air source heat pump	3,100	14,100	565,000
Ground source heat pump	0	15,200	300,000
Biomass boiler	4,700	17,600	10,000
Solid floor insulation	0	1,400	490,000
Double glazing	2,400	10,200	770,000
Low energy lighting	392,500	1,435,100	6,075,000
PV	43,600	254,000	515,000
Programmer	40,900	123,900	430,000
Hot water tank jacket	212,500	606,600	1,270,000
Draught-proofing	486,500	1,721,100	80,000
Total count of measures	1,743,900	5,900,900	18,235,000

Annex Table 4. Mix of measures identified by the NHM scenarios to meet the 2025 targets; and the CCC's mix from 2020 to 2025

Total measures 2020 to 2025	Proposed 2025 interim target: Min. Band E	'Stretch' 2025 interim target: Min. Band D	*CCC 4th CB Measures Projections to 2020-2025*
Gas boiler	240,900	456,000	1,935,000
Oil boiler	48,300	21,700	325,000
Storage heater	56,200	82,100	0
Cavity wall insulation	328,400	180,900	405,000
External wall insulation	82,900	147,300	840,000
Internal wall insulation	79,300	105,100	895,000
Top-up loft insulation	341,800	328,100	2,160,000
Air source heat pump	15,100	49,300	810,000
Ground source heat pump	13,000	41,600	295,000
Biomass boiler	13,700	900	565,000
Solid floor insulation	1,400	18,500	790,000
Double glazing	9,000	73,500	220,000
Low energy lighting	1,067,900	901,100	5,705,000
PV	204,000	703,600	480,000
Programmer	99,000	187,900	185,000
Hot water tank jacket	395,300	166,500	1,110,000
Draught-proofing	1,244,600	1,006,800	40,000
Total count of measures	4,240,800	4,470,900	16,760,000

Annex Table 5. Mix of measures identified by the NHM scenario to meet the 2030 targets and the CCC's mix from 2025 to 2030

Total measures 2025 to 2030	Proposed 2030 interim target: Min. Band E	'Stretch' 2030 interim target: Min. Band D	*CCC 4th CB Measures Projections 2025 to 2030*
Gas boiler	458,000	228,800	3,345,000
Oil boiler	16,200	23,900	320,000
Storage heater	92,100	59,500	0
Cavity wall insulation	175,300	52,000	0
External wall insulation	149,000	99,700	845,000
Internal wall insulation	104,800	77,800	405,000
Top-up loft insulation	335,300	115,600	0
Air source heat pump	38,400	20,500	1,320,000
Ground source heat pump	41,400	33,600	455,000
Biomass boiler	900	0	435,000
Solid floor insulation	18,500	19,200	1,385,000
Double glazing	72,500	41,200	320,000
Low energy lighting	879,900	236,400	5,270,000
PV	705,700	318,700	340,000
Programmer	175,300	85,700	75,000
Hot water tank jacket	158,400	32,900	270,000
Draught-proofing	992,900	252,700	30,000
Total count of measures	4,414,600	1,698,200	14,815,000

Annex II – Targeted households

Annex Table 6 shows the number of households that fall into the target criteria in each year of the proposed (and 'stretch) fuel poverty targets. The figures are broken down to show the extent of 'repeat targeting' – that is, the number of households that meet the target criteria in other years.

Annex Table 6. Number of households targeted each year

	Proposed Target (EPC E-D-C)	Extended Target (EPC D-C-B)
2020 total	**487,900**	**1,727,600**
2020 only	113,900	606,900
2020 and 2025	130,300	468,900
2020 and 2030	72,100	196,300
2020, 2025 and 2030	171,600	455,500
2025 total	**1,552,100**	**1,937,100**
2025 only	551,700	700,100
2020 and 2025	130,300	468,900
2025 and 2030	698,500	312,600
2020, 2025 and 2030	171,600	455,500
2030 total	**1,939,400**	**1,219,700**
2030 only	997,200	255,300
2020 and 2030	72,100	196,300
2025 and 2030	698,500	312,600
2020, 2025 and 2030	171,600	455,500
Total unique dwellings	**2,735,300**	**2,995,600**
Total dwellings receiving measures in all target years	**3,979,400**	**4,884,400**

The tables below show the number of households meeting the proposed and 'stretch' fuel poverty target criteria by tenure and dwelling type. A detailed analysis of the distribution of targeted households was beyond the scope of this study, but the results below provide some indication of the socio-demographic make-up.

Annex Table 7. Number of targeted households by tenure

	Proposed Targets			Stretch Targets		
	2020 (E)	2025 (D)	2030 (C)	2020 (D)	2025 (C)	2030 (B)
Housing Association	16,500	112,800	186,700	119,200	187,600	102,500
Local Authority	33,100	142,900	161,500	156,900	168,600	80,300
Owner Occupied	271,100	876,600	1,185,900	969,900	1,168,200	763,900
Private Rented	167,200	419,800	405,300	481,600	412,700	273,100
Total	***487,900***	***1,552,100***	***1,939,400***	***1,727,600***	***1,937,100***	***1,219,800***

Annex Table 8. Number of targeted households by dwelling type

	Proposed Targets			Stretch Targets		
	2020 (E)	**2025 (D)**	**2030 (C)**	**2020 (D)**	**2025 (C)**	**2030 (B)**
Detached	113,900	217,000	380,100	242,900	374,200	276,500
Semi-detached	120,200	546,600	681,900	599,300	677,300	424,100
End-terrace	61,900	264,800	259,200	285,700	260,400	156,900
Mid-terrace	58,400	232,800	325,300	261,600	319,900	175,400
Bungalow	69,500	176,300	131,600	192,100	128,400	100,700
Purpose-built flat	29,400	71,800	102,400	87,700	114,200	59,700
Converted flat	34,500	42,800	58,800	58,400	62,800	26,400
Total	*487,800*	*1,552,100*	*1,939,300*	*1,727,700*	*1,937,200*	*1,219,700*

Annex Table 8. Number of targeted households by dwelling type

Annex III – The National Household Model

The National Household Model (NHM) is the Department of Energy and Climate Change (DECC) new domestic energy policy modelling and analytical tool.

Representing the GB housing stock

Using information from national housing surveys (the English Housing Survey 2010-11 and Scottish House Condition Survey 2007-09[19]), the NHM creates a detailed representation of the physical property and occupancy characteristics of Great Britain's housing stock. The NHM allows analysts to simulate changes to the housing stock overtime (e.g. simulating the installation of energy efficiency measures), to explore different policy scenarios and the potential impacts on domestic energy demand, household bills and emissions.

Modelling household energy demand

A key component of the NHM is the 'energy calculator'. This provides all the code and algorithms needed to estimate household energy demand, using a SAP-based approach. Taking information about the physical property characteristics from the housing stock dataset at a point in time (e.g. building fabric, insulation levels, heating systems) the energy calculator estimates fuel consumption needed to maintain a specified heating regime. The model is calibrated to apply the Government's standard assumptions for heating regimes (21 degrees in living areas, 18 degrees elsewhere), but these can be adjusted by the user as required.

Fuel prices are applied to the estimated energy demand to generate an annual fuel bill for the household. This forms the basis for calculating the SAP rating – an estimate of the energy efficiency of the building, based on the building's performance on energy costs per m^2.

Scenarios and reporting

All modelling and analysis in the NHM is constructed through 'scenarios', written by the user, through a browser-based user interface. Scenarios are expressed using a domain-specific language (structured as s-expressions[20]) that affords a very high degree of flexibility. The housing stock data underpinning the NHM encompasses a wide range of variables, including physical (e.g. dwelling type, age of property), geographical (e.g. region, rurality) and socio-demographics (e.g. tenure, income, number of occupants), all of which can be used within a scenario for policy modelling and/or reporting purposes. In addition there are a number of language elements designed specifically to meet the needs of DECC analysts; for example to enable modelling of the Green Deal Golden Rule and simulation of different energy efficiency and low-carbon measures.

A single scenario can therefore encompass a huge range of functions - from modelling the impact of very complex, multi-layered policies that simulate the installation of measures and fuel tariffs overtime, to a simple report to show characteristics of the housing stock, such as energy demand or SAP rating by different property types.

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[19] The Welsh housing stock model was created from the English Housing Survey 2010-11 using a reweighting process, guided by information available from the Living in Wales Survey 2008.
[20] http://en.wikipedia.org/wiki/S-expression

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Modelling fuel poverty

New functionality was developed in the NHM as part of a research project for the CCC in 2014 to provide tools and data needed to determine whether a household is in fuel poverty, according to both original the 10% definition and the new definition 'low income, high cost' definition, which has been adopted for England. The latter includes a measure of the '**fuel poverty gap**', which assesses the extent to which a household falls above the ('high') energy cost threshold or, rather, the reduction in fuel bill required to lift the household out of fuel poverty.

Annex Figure 1. Modelling fuel poverty in the NHM